# RECORD OF DECISION

**for**

**FINAL SUPPLEMENT I**

**to the**

**FINAL ENVIRONMENTAL STATEMENT**

**MISSISSIPPI RIVER**

**BETWEEN THE**

**OHIO AND MISSOURI RIVERS**

**(REGULATING WORKS)**

**August 2017**

US Army Corps
of Engineers

# RECORD OF DECISION

## FINAL SUPPLEMENT I to the FINAL ENVIRONMENTAL IMPACT STATEMENT MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

The final Supplement I to the final Environmental Impact Statement (SEIS) for the Mississippi River Between the Ohio and Missouri Rivers (Regulating Works) Project, dated May 2017, updates the 1976 Regulating Works Environmental Impact Statement (EIS). The 1976 EIS was reviewed by the St. Louis District (District) of the U.S. Army Corps of Engineers (Corps) to determine whether or not the document should be supplemented. The District concluded that, although the project had not changed substantially, there were significant new circumstances and information relevant to the project and its potential impacts that warranted preparation of a supplement.

The District is charged with obtaining and maintaining a navigation channel on the Middle Mississippi River (MMR) that is nine feet deep and 300 feet wide with additional width in bends as necessary (commonly called the Regulating Works Project and sometimes referred to herein as the Project). As authorized by Congress, the Project is obtained by construction of revetment, rock removal, and river training structures to maintain bank stability and ensure adequate, reliable navigation depth and width. The Project is maintained through dredging and any needed maintenance to constructed features. The long-term goal of the Project, as authorized by Congress, is to obtain and maintain a navigation channel at the authorized dimensions and to reduce federal expenditures by alleviating the amount of annual maintenance dredging through the construction of river training structures.

Based on the analysis presented in the Final SEIS, including input from the public, affected Tribes, state and Federal agencies, and other interested parties, and based on the Project's Congressional authority and continued benefit of the remaining construction, I find the Preferred Alternative as described in the Final SEIS (the Continue Construction Alternative; hereafter, the Selected Plan) to be technically feasible, environmentally justified, in accordance with environmental laws and regulations, and in the public interest.

## ALTERNATIVES CONSIDERED

The Selected Plan consists of continuing with construction of new river training structures and revetment for navigation purposes until such time as the cost of placing more structures is no longer justified by the resultant reduction in repetitive dredging quantities and associated costs, including costs for any mitigation. The remaining construction is currently estimated from programmatic analysis to require approximately 4.4 million tons (2.9 million cubic yards) of rock. This estimate is based on assumptions of Congressional funding levels, rock prices, dredging costs, sediment loads, mitigation costs, etc. Because these assumptions are uncertain, the estimated quantity of construction could differ from actual implementation. Environmental impacts of the work associated with this alternative would continue to be avoided and minimized to the extent practicable. Placement of river training structures is expected to increase the acreage of low-velocity habitat that is considered important habitat for many MMR fish species. However, placement of river training structures is also expected to reduce shallow to moderate-depth, moderate- to high-velocity habitat that is important for some MMR fish guilds. Analysis of the impacts of the Continue Construction Alternative to main channel border habitat suggests that future construction of river training structures will result in the consideration of compensatory mitigation measures.

The Selected Plan would also involve continuing to dredge as necessary, completing known bankline stabilization work to reduce the risk of a channel cutoff, placing additional revetment, and continuing to maintain existing structures. Dredge quantities would be expected to decrease from their current average annual quantity of approximately 4 million cubic yards to approximately 2.4 million cubic yards after construction of new river training structures and preliminary estimates of possible compensatory mitigation is complete.

Given that the exact locations, configurations, and types of river training structures to be implemented at future chronic dredging sites are not known at this time and will not be known until future planning is conducted site by site, the Final SEIS covers the programmatic impacts that can reasonably be anticipated to occur going forward. The specific impacts associated with each work area would be covered in Tier II Site Specific Environmental Assessments (SSEAs). SSEAs would normally be posted for a 30-day public comment period. Dredging activities, revetment construction, and maintenance of existing structures and revetment are not anticipated to require SSEAs as the impacts of these activities are adequately characterized and quantified in the 1976 EIS and in the Final SEIS, but future evaluation of these activities will continue to consider if additional NEPA documentation is necessary.

The Corps will also continue to coordinate all design and implementation activities under the Selected Plan with applicable Federal and state resource agencies, including, but not limited to the U.S. Fish and Wildlife Service, the Illinois Department of Natural Resources, and the Missouri Department of Conservation.

The analysis presented in the Final SEIS also considered the No New Construction Alternative. This alternative involved not constructing any new river training structures for navigation purposes, but continuing to maintain the navigation channel by dredging and maintaining existing river training structures and bankline stabilization to ensure they continue to achieve their intended functions. Under this alternative, maintenance dredging would continue at roughly the current average rate of approximately 4 million cubic yards per year. Environmental impacts of the work associated with this alternative would continue to be avoided and minimized to the extent practicable, as a result of coordination with applicable Federal and state resource agencies. This alternative was not anticipated to have any unavoidable significant impacts that would result in the consideration of compensatory mitigation measures.

Other alternatives were considered but were deemed not to be reasonable or feasible alternatives warranting further evaluation in the Final SEIS. Any alternative outside of the current Project authority would require further study and documentation and potentially additional authority to commence such a study (See Chapter 2.1 of the Final SEIS). Analyses of these alternatives concluded that these were not reasonable or feasible under the current conditions to warrant transitioning the Final SEIS to a planning study.

Other alternatives considered within the Project authority included looking at various levels of new regulating works construction and, thus, different levels of dredging reduction. These alternatives considered the cost-effectiveness of continued construction, the efficiency of continued construction, and the environmental impacts associated with the same. Evaluation and analysis concluded that new construction of a combination of traditional and innovative (avoiding and minimizing) structures (approximately 7.5 million tons of stone) would still be cost-effective to result in a maximum dredging reduction in the MMR to an annual average of 1.3 million cubic yards. However, once the potentially unavoidable environmental impact to main channel border habitat was identified and the estimated cost for compensatory mitigation considered, maximum dredging reduction was no longer cost-effective. With the additional cost for compensatory mitigation, the revised alternative decreased new construction to approximately 4.4 million tons of rock and increased average annual dredging to 2.4 million cubic yards (see Chapter 2.1 and Appendix C of the Final SEIS for more details). Based upon coordination with Federal and state resource agencies and comments received during scoping, it was determined that including a detailed evaluation of a combination of new construction and dredging without consideration of compensatory mitigation in the SEIS was not reasonable.

Therefore, the Final SEIS only fully evaluates two alternatives: 1) continue construction to a cost-effective endpoint using estimated amounts for new construction (including avoid and minimize measures), dredging, and potential compensatory mitigation (the Selected Plan); and 2) stop all new construction and proceed with the current levels of dredging and maintaining existing structures. Guidance from the Council on Environmental Quality (CEQ) states that for an ongoing program, “no action” is no change from current management of that program. Therefore, Alternative 1 (continue construction) represents the No Action Alternative.

**Environmentally Preferable Alternative.** CEQ Regulation 40 CFR §1505.2(b) requires that the Record of Decision identify the alternative or alternatives considered to be environmentally preferable. CEQ guidance indicates that ordinarily the environmentally preferable alternative is the alternative that causes the least damage to the biological and physical environment. Due to the lack of potential for compensatory mitigation, the Corps finds that the No New Construction Alternative is the environmentally preferable alternative. However, based on the Project’s Congressional authority and continued dredging reduction benefit of the remaining construction, the Continue Construction Alternative is the Selected Plan, subject to the avoidance and minimization of potential adverse impacts and consideration of potential compensatory mitigation for unavoidable adverse impacts.

## COMPENSATORY MITIGATION

All practicable means to avoid and minimize environmental harm are incorporated into the Selected Plan. Nonetheless, placement of river training structures is expected to reduce shallow to moderate-depth, moderate- to high-velocity habitat which is important for some MMR fish guilds. Analysis of the impacts of the Selected Plan to main channel border habitat suggests that future construction of river training structures will result in the consideration of compensatory mitigation measures.

The Final SEIS provides a broad, programmatic discussion of potential compensatory mitigation, monitoring and adaptive management associated with the Selected Plan. Specific Project impacts cannot be definitively identified until specific future plans are developed. These future designs will allow the Corps to verify where, when and to what extent Project features will alter river habitat. These details will be outlined within future tiered SSEAs that will address future construction and potential mitigation for new river training structures and detailed mitigation planning, monitoring and adaptive management.

**PUBLIC INVOLVEMENT**

The public scoping process for the SEIS began in December 2013 with the publication of a Notice of Intent in the Federal Register. Three public scoping meetings were held in January 2014. Preparation of the SEIS was coordinated with Federal and state resource agencies at semi-annual coordination meetings in addition to SEIS-specific coordination meetings throughout the process of preparing the SEIS. The Draft SEIS was released for public review and comment in November 2016. The initial 45-day comment period was scheduled to end on December 19, 2016 but was extended upon request by 30 days to January 18, 2017. Two public meetings were held during the public review and comment period. Fifteen comment letters on the Draft SEIS were received from 33 non-governmental organizations and individuals and five Federal, Tribal, and state organizations. In addition, 14,610 comments were generated by the National Wildlife Federation's Action Center. The Corps evaluated each comment received so that issues of concern could be identified and considered by technical experts. Comments received and responses to those comments are provided in Appendix E and Appendix H of the Final SEIS.

The Final SEIS was released for public review on May 12, 2017. The 30-day review period was scheduled to end on June 12, 2017 but was extended upon request by 15 days to June 27, 2017.

The only Federal agency providing comments on the Final SEIS was the U.S. Environmental Protection Agency (EPA), which thanked the Corps for the responses to their comments on the Draft SEIS as well as the Corps' efforts to finish the development of the main channel border habitat model so it can be used to quantify habitat loss and to guide compensatory mitigation. The U.S. EPA also suggested that the Corps' 2017 Channel Improvement Masterplan found in Appendix I of the Final SEIS be included on the Corps' webpage and updated as necessary. The Corps will be taking EPA's suggestion by placing on the webpage and updating as necessary the Channel Improvement Masterplan.

The only other comment letters received on the Final SEIS were two letters signed jointly from 24 non-governmental organizations, along with 10,426 comments generated through conservation organization action center websites. The comments received during review of the Final SEIS were not substantively different from comments received on the Draft SEIS nor were new circumstances or information received relevant to environmental concerns that changed the analysis and findings in the Final SEIS. All comment letters, along with responses to any new information received on the Final SEIS, are included in Appendix A.

**DECISION**

The evaluation of impacts to the human environment outlined in the Final SEIS was done in accordance with all applicable laws, regulations, executive orders, and policies governing the Project. The NEPA documents and supporting documentation contain sufficient information to make a reasoned, informed decision. After careful consideration of the purpose of and need for the Regulating Works Project, the analysis contained in the Final SEIS, input from the public, affected Tribes, state and Federal agencies, and other interested parties, and based on the Project's Congressional authority and continued benefit of the remaining construction, I find that the public interest will best be served by implementing the Continue Construction Alternative.

31 AUG '17
Date

MICHAEL C. WEHR
Major General, USA
Commanding

# Appendix A: Responses to Comment Letters on the Final Supplement I to the Final Environmental Impact Statement, Mississippi River Between the Ohio and Missouri Rivers (Regulating Works)

## Responses to Comments Received on the Final SEIS

Comment letters received on the Final SEIS that was published in May 2017 are attached to this appendix. The comments received during review of the Final SEIS were not substantively different from comments received on the Draft SEIS nor were new circumstances or information received relevant to environmental concerns that changed the analysis and findings in the Final SEIS. Comment letters received on the Final SEIS contained similar themes to the comments received during the public review period for the Draft SEIS. Based on the comments received during scoping and public review of both the Draft SEIS and the Final SEIS, there are five main areas of controversy: flood heights, mitigation, 1976 post authorization change, the geographic scope of the analysis, and the Project authority and applicability of the Fish and Wildlife Coordination Act.

**Flood Heights.** There is research claiming that the construction of river training structures affects flood heights. The Corps takes these claims very seriously. The Corps has conducted several studies on the issue, completed a thorough analysis of all available research (included in the Final SEIS as Appendix A), and concluded that the construction of river training structures on the MMR for the Regulating Works Project do not affect water surface elevations at higher flows.

In comments received from non-governmental organizations on the Final SEIS, two Corps studies from other districts were referenced to support the contention that river training structures increase flood heights. The comments suggested that the Final SEIS improperly concluded that the Regulating Works Project would not have an impact on flood levels. The Corps reviewed the information provided and determined that the specifics provided in these two studies were separate and distinct from the MMR and the Regulating Works Project. Therefore, the analyses in these studies do not change the Corps' conclusion that the Regulating Works Project river training structures do not affect water surface elevations at higher flows. Below is the Corps' analysis and reasoning on this conclusion with respect to the comments received:

- Omaha District Deer Island Restoration Project. The modeling referenced in the comments was a preliminary one-dimensional analysis for a 50% exceedance discharge. This discharge is well below flood discharge and not representative of what would occur at flood stage (see the information in the Final SEIS, Appendix A, on submergence). The alternatives and the impact on flood levels were further refined using a 2D model. The results of this preliminary analysis, conducted for a flow much less than the 1% exceedance discharge, does not give any insight into the impacts of river training structure construction under the Regulating Works Project on flood levels.

- St. Paul District DRAFT Letter Report and Integrated Environmental Assessment, Lower Pool 2 Channel Management Study: Boulanger Bend to Lock and Dam No. 2 (DRAFT June 2017) [hereinafter referred to as the "St. Paul Draft Study"]. Comments received on the Final SEIS referenced a number of items within the St. Paul Draft Study to state to the Corps that the Final SEIS had not properly evaluated the impacts to flood levels from the Regulating Works Project:

1. One of the items referenced in comments on the Final SEIS was an alternative that included “improving existing and/or constructing revetments and wing dams channel control structures” that was screened out because it “showed a significant flood-stage increase for the 1-percent flood elevation” (identified as Alternative 2 in the St. Paul Draft Study). The term “revetment” used to describe the structure in Alternative 2 is different than the revetment used on the MMR. The structure proposed in Alternative 2 (hereinafter referred to as a “sill”) is a linear rock mound or large trapezoidal sill structure constructed roughly parallel to the navigation channel to prevent sediments from dropping out of suspension and limit flow from breaking out of the main navigation channel (a cross section of the structure can be seen in Figure 27 of Appendix D of the EA to the St. Paul Draft Study).

   The wing dams described in Alternative 2 of the St. Paul Draft Study were evaluated by WEST Consultants for their effectiveness in reducing dredging in the reach and not for their impact on flood stage (Appendix E of the EA for the St. Paul Draft Study). The impacts of two variations of the rock sill structure were tested for flood stage impacts in a hydrodynamics-only AdH model by the Corps’ Engineer Research and Development Center (ERDC) (Appendix F of the EA for the St. Paul Draft Study). This model did not test any new wing dam structures. The conclusion of the ERDC model study was that the impacts of the sill structures tested on stage were not “below 0.005 feet along nearby shorelines for the 100 year discharge” and therefore were unacceptable.

   Since the impact of the rock sill structures on flood stages was found to be unacceptable, the proposed Alternative 2 which included both the construction of rock sill structures and improvements to and/or construction of wing dams was assumed to have an unacceptable impact on flood levels although the measures were never tested together for flood stage impacts.

   Therefore, since the rock sills proposed in Alternative 2 of the St. Paul Draft Study are much different than anything that would be constructed on the MMR and the wing dams were not evaluated for their impact on flood levels, the St. Paul Draft Study does not give any insight into the impacts of river training structure construction under the Regulating Works Project on flood levels.

2. Comments on the Final SEIS also pointed out that the St. Paul Draft Study indicated that “it is likely that material not deposited in the main channel in the project area [by the river training structures] would be deposited in another location resulting in increased dredging at that location” (bracketed insertion made by the commenters). The geomorphology of

the Mississippi River and the operation of Pool 2 is very different from the open river system of the MMR. Pool 2 functions more like a lake and has much less energy and ability to move sediment than the MMR. Additionally, the depth in Pool 2 is managed through manipulation of the water surface; whereas, in an open river the depth is managed through the construction of river training structures designed to efficiently pass material through the system. Therefore, the conclusions reached in the St. Paul Draft Study with respect to sediment deposition and river training structure construction are not applicable to the Regulating Works Project.

3. The comments on the Final SEIS also referenced the St. Paul Draft Study's analysis of a chevron-shaped rock sill structure increasing flood levels to some degree because modeling showed an increase on stage of less than 0.005 feet, which is considered zero increase and is the standard for no rise for many states. Further, the chevron-shaped rock sill structure tested in the St. Paul Draft Study is much larger in scale than the chevron-shaped dikes that are constructed on the MMR and not consistent with the type of structure that would be built through the Regulating Works Project.

4. The comments on the Final SEIS also referenced the formal flood stage impact planning constraint adopted as part of the St. Paul Draft Study to show that the St. Paul District was aware of the potential for increasing flood heights. The St. Louis District has the same criteria to not increase flood heights for the Regulating Works Project. This criteria is required for necessary no rise certification from the states. It is exactly for this reason that the St. Louis District has constantly monitored the impact of river training structure construction on flood levels in the MMR, reviewed and analyzed all literature on the topic, and when needed conducted numerical models to evaluate the impact on flood levels for river training structure construction under the Regulating Works Project.

**Mitigation.** Comments received stated that the Corps should mitigate for adverse effects going back to at least 1976. The authority for mitigation of the Regulating Works Project is discretionary, and in general, the Corps plans for and implements mitigation associated with proposed actions (see Appendix K, response to USFWS Comment No. 13 in Appendix E, and response to National Wildlife Federation Comment No. 10 in Appendix H for detailed explanation of the Project's mitigation authority). The potentially significant impact to shallow to moderate-depth, moderate- to high-velocity habitat identified in the SEIS that may result in the consideration of compensatory mitigation was not known until the completion of additional analyses, which were undertaken to obtain unknown and unavailable information as part of the SEIS. Therefore, potential compensatory mitigation for the Regulating Works Project would be conducted for adverse effects that have occurred or will occur since publication of the Notice of Intent to prepare the SEIS in the Federal Register in December 2013 as committed to in the SSEAs for that work. However, the Corps' standing ecosystem restoration mission and associated authorities, outside of the Regulating Works Project authority, could be used to restore ecological resources affected by past activities of the Corps and others (see Appendix K and response to USFWS Comment No. 13 in Appendix E for more details on these other authorities).

**1976 Post Authorization Change Alternative.** Federal and state natural resource agency partners have continued to ask that the Corps seek the Post Authorization Change (PAC) referenced in the 1976 EIS to add fish and wildlife as a Project purpose. The District fulfilled the commitments made in the 1976 EIS by recommending in the Great River Study submitted to Congress in 1982 that a program be initiated to modify, design, and evaluate regulating works structures to benefit aquatic resources in the MMR; however, Congress did not take action on this study to change the authorization of the Regulating Works Project. Additionally, all of the activities described in the 1976 EIS for the PAC can now be accomplished through other authorities either through general environmental policies, consideration, and coordination as part of the Regulating Works Project or through other project authorities. See Appendix K for additional details on the PAC, Congressional action, and other environmental authorities.

**Geographic Scope of Analysis.** The District received comments indicating that the SEIS should address all of the navigation channel operation and maintenance activities in the Upper Mississippi River – Illinois Waterway System (UMR-IWW) instead of focusing only on the MMR. Recognizing the dynamic nature of the river in certain regions, Congress authorized many different navigation projects throughout the UMR-IWW. The Congressional authority for and management of the navigation channel on the MMR is very different from other projects within the UMR-IWW, primarily because the MMR is open river and the rest of the UMR-IWW consists of a series of pools created and managed through locks and dams (e.g., see the distinctions described above on the St. Paul Draft Study). Further, such a comprehensive watershed study including multiple authorized projects would need to be specifically authorized. As such, the District concluded that a separate analysis to update the Regulating Works Project 1976 EIS with new information and circumstances is appropriate.

**Project Authority and Applicability of the Fish and Wildlife Coordination Act.** In the non-governmental organization comments received on the Final SEIS, a comment was raised for the first time that the Corps has been acting outside of the Project authority due to the change in contraction width design for obtaining and maintaining the authorized navigation channel. However, as described in the Final SEIS in Chapter 1.1.1 and Appendix K, Congress authorized the Corps to obtain and maintain a navigation channel nine feet in depth and at least 300 feet in width at low water in the MMR through regulating works and dredging, with the goal to minimize costly dredging.

While the 1926 Chief's Report provided engineering designs on how this could be accomplished based upon the best information then available, the District Engineer at the time also recognized that due to the dynamic nature of the MMR, changes to the engineering design were likely, noting that during construction the low-water surface slope should be observed and remedial action taken.

The 1926 Chief's Report contained analysis with the current information available without any environmental consideration to cutting off side channels, narrowing of the planform, and reduction in diverse environmental habitat. As described in detail in Appendix K, since 1926 various engineering design changes have been made to the Project in order to meet the Congressionally-authorized channel dimensions. These changes were based upon lessons learned as the Project was constructed, incorporating new and up-to-date technology to gather more information about the MMR and the Project, as well as accounting for environmental considerations to avoid and minimize impacts on the environment from the Project. Various engineering designs for regulating works have been incorporated to make the Project both more efficient as well as environmentally sustainable since the 1926 Chief's Report (including changes in dike and revetment materials, changes in dike configurations, lowering of height of structures, notching of structures, and manipulation and/or removal of existing side channel closure structures). As described in the Final SEIS, these changes have resulted in less environmental impact while still carrying out the Project purpose and authority. All of these engineering design changes were approved, and general descriptions of the changes were provided to Congress in the Chief of Engineers Annual Reports, noting the need for increased funding for the Project, which Congress provided.

In conjunction with the comments on the Project's authority, comments were received from Federal and state resource agencies on the Draft SEIS and non-governmental organizations on both the Draft and Final SEIS about the Corps' conclusion that a Fish and Wildlife Coordination Act 2(b) Report was not required for the SEIS. As discussed in Appendices E, H, and K in more detail, under the terms of the act as well as Corps regulations, the requirement for a 2(b) Report is not applicable to this Project because it was substantially completed when the Fish and Wildlife Coordination Act was passed and the authorization to obtain and maintain a navigation channel 9 feet deep and at least 300 feet wide at low water through regulating works and dredging has not been modified. As described above, there have been engineering design changes to adjust to new information and meet the Project's authority and comply with new laws and regulations, but the authorized plan on how to obtain the authorized dimensions while also reducing costly dredging has not been changed. Further, the Corps has and will continue to substantially coordinate with the US Fish and Wildlife Service as well as the state resource agencies to obtain their knowledge and information in consideration of environmental effects of the Project and incorporate these into the design and implementation of the Project. This coordination, started in the early 1970's, has resulted in numerous changes to engineering design to not only avoid and minimize any impacts from the Project but to provide ancillary benefits to the environment where possible, and the analyses conducted as part of the Final SEIS concluded that these measures have been successful in preventing the environmental impacts that were identified in the original EIS.

The Federal and state resource agencies indicated in their comments on the Draft SEIS that a commitment to this coordination was not made clear and that their suggested alternatives were not fully considered in the Draft SEIS. However, revisions were made to the Final SEIS and responses provided to their comments in Appendix E to better describe the current and continued coordination of all activities of the Regulating Works Project. Additionally, a better description of the alternative development process is now included in the Final SEIS, which explains that their suggestions during scoping were considered and incorporated into the Selected Plan. None of the Federal and state resource agencies provided further comment on the Final SEIS in response to the clarifications made from their comments on the Draft SEIS.

Attachment to Appendix A

Comments Received on Final SEIS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUN 07 2017

REPLY TO THE ATTENTION OF:

E-19J

Mr. Kip Runyon
U.S. Army Corps of Engineers
St. Louis District
1222 Spruce Street
St. Louis, Missouri 63103-2833

Re: Mississippi River Between the Ohio and Missouri Rivers Regulating Works
Final Supplemental Environmental Impact Statement; CEQ No. 20170076

Dear Mr. Runyon:

The U.S. Environmental Protection Agency has reviewed the U.S. Army Corps of Engineers' (Corps) Final Supplemental Environmental Impact Statement (FSEIS) pursuant to our authorities under the National Environmental Policy Act, Council on Environmental Quality regulations (40 CFR Parts 1500-1508), Section 309 of the Clean Air Act, and Section 404 of the Clean Water Act.

The Regulating Works Project uses bank stabilization, rock removal, and sediment management to maintain a navigation channel and reduce federal expenditures by minimizing the amount of annual maintenance dredging of the channel. The FSEIS updates the 1976 EIS "Mississippi River between the Ohio and Missouri Rivers (Regulating Works)." The Corps is using the FSEIS programmatically to describe broad impacts of the Project on the environment, while characterizing future site-specific impacts of individual projects in environmental assessments tiered from the FSEIS. As stated in the Draft Supplemental EIS (DSEIS), the 'preferred alternative' is the 'no action' alternative, which would continue construction of new river training structures and consider compensatory mitigation as needed for environmental impacts. With implementation of continued construction, the Corps anticipates constructing future river training structures using about 4.4 million tons of rock, with anticipated reductions in dredging of approximately 2.4 million cubic yards on an average annual basis.

Thank you for the Corps' response to our DSEIS comments on future construction and mitigation for habitat loss. We would like to reiterate our appreciation for your efforts to finish the development of the "main channel border habitat model" so it can be used to quantify habitat loss and to guide compensatory mitigation. This model is important to accurately describe the significance of habitat loss and to inform proposed mitigation beneficial to the River complex.

In response to EPA comments, the FSEIS includes the Corps' 2017 Channel Improvement Masterplan, which provides information critical to partner agencies working with the Corps on specific reaches along the Middle Mississippi River. We suggest that the Corps include the Masterplan on the St. Louis District's website, updating it on a regular basis as determined by the Corps and your partner agencies. This would enable partner agencies and the public to enlarge reach-specific maps, better evaluate detailed actions within the reaches and identify important environmental locations.

If you have any questions regarding these comments, please contact me at (312) 886-2910 or westlake.kenneth@epa.gov or Mr. Josh Tapp, Deputy Division Director, Environmental Sciences and Technology Division, Region 7, at (913) 551-7606 or tapp.joshua@epa.gov.

Sincerely,

Kenneth A. Westlake, Chief
NEPA Implementation Section
Office of Enforcement and Compliance Assurance

Comments on the

Final Supplement I
to the
Final Environmental Statement
Mississippi River Between the Ohio and Missouri Rivers
(Regulating Works) May 2017

Submitted by

National Wildlife Federation
American Rivers
Conservation Federation of Missouri
Great Rivers Environmental Law Center
Great Rivers Habitat Alliance
Missouri Coalition for the Environment
Prairie Rivers Network

June 27, 2017

Submitted by email to: RegWorksSEIS@usace.army.mil

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The National Wildlife Federation, American Rivers, Conservation Federation of Missouri, Great Rivers Environmental Law Center, Great Rivers Habitat Alliance, Prairie Rivers Network, and Missouri Coalition for the Environment (collectively, the Conservation Organizations) appreciate the opportunity to submit these comments on the Final Supplement I to the Final Environmental Impact Statement for the Mississippi River Between The Ohio And Missouri Rivers (Regulating Works) (May 2017) (the "Final SEIS"). The Conservation Organizations strongly oppose the recommended alternative in the Final SEIS and urge the Corps of Engineers to develop and select an alternative that will protect communities, wildlife, and the ecological health of the Middle Mississippi River.

The National Wildlife Federation (NWF) is the nation's largest conservation education and advocacy organization. NWF has almost six million members and supporters and conservation affiliate organizations in 51 states and territories. NWF has a long history of advocating for the protection, restoration, and ecologically sound management of the Mississippi River. NWF also has a long history of working to modernize federal water resources planning to protect the nation's rivers, wetlands, floodplains, and coasts and the fish and wildlife that depend on those vital resources.

American Rivers protects wild rivers, restores damaged rivers, and conserves clean water for people and nature. Since 1973, American Rivers has protected and restored more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and an annual America's Most Endangered Rivers® campaign. Headquartered in Washington, DC, American Rivers has offices across the country and more than 200,000 members, supporters, and volunteers. The Upper Mississippi River is one of 11 priority river basins where American Rivers is concentrating and integrating our work to protect and restore rivers over the next 5 years.

Conservation Federation of Missouri (CFM) works to ensure conservation of Missouri's wildlife and natural resources and preserve Missouri's rich outdoor heritage through advocacy, education and partnerships. CFM is made up of thousands of Missourians who work together to better our natural resources, and represents Missouri's citizen conservationists. CFM speaks for sportsmen and sportswomen whenever and wherever it is necessary, to support our collective opinions on the future of Missouri outdoors.

Great Rivers Environmental Law Center is a nonprofit organization dedicated to providing free and reduced-fee public interest legal services to individuals and organizations working to protect and preserve Missouri's environment.

Great Rivers Habitat Alliance is a nonprofit organization working to protect wetland habitat and promote sensible use of flood plains in the confluence region of the Mississippi, Missouri, and Illinois Rivers. Great Rivers Habitat Alliance supports preservation of the flood plains of the Mississippi and Missouri Rivers, and seeks to save the region's natural flood plain and rural agricultural heritage.

The Missouri Coalition for the Environment is Missouri's independent, citizens' environmental organization for clean water, clean air, clean energy, and a healthy environment. The Missouri Coalition for the Environment works to protect and restore the environment through education, public engagement, and legal action.

Prairie Rivers Network (PRN) is Illinois' advocate for clean water and healthy rivers. PRN champions clean, healthy rivers and lakes and safe drinking water to benefit the people and wildlife of Illinois. Drawing upon sound science and working cooperatively with others, PRN advocates public policies and cultural values that sustain the ecological health and biological diversity of water resources and aquatic ecosystems.

## General Comments

The Conservation Organizations call on the U.S. Army Corps of Engineers (Corps) to reject the Final SEIS and its recommended alternative. The Corps should prepare a new SEIS that examines the direct, indirect, and cumulative impacts of the full suite of actions used to maintain navigation on the Middle Mississippi River; and select an alternative that protects people, wildlife, and the ecological health of the Middle Mississippi River. As the first step in the new SEIS process, the Corps should initiate—and then fully account for the findings of—a National Academy of Sciences study on the impact of river training structures on flood heights.

The Corps' rejection of extensive peer-reviewed science demonstrating that river training structures increase flood heights fundamentally taints the Final SEIS and the entire Regulating Works Project. The rejection of this science in the Final SEIS is incomprehensible in light of an Environmental Assessment released by the Corps' St. Paul District just two weeks ago that both confirms and demonstrates that river training structures in fact increase flood heights.[1] Among other things, that Environmental Assessment rejected a proposed river training structure alternative because modeling of that alternative **"showed a significant flood-stage increase for the 1-percent flood elevation."**[2] A copy of this Environmental Assessment is attached at Appendix A to these comments.

To ensure development of a scientifically and legally sound new SEIS, the Conservation Organizations urge the Corps to:

1. **Initiate a National Academy of Sciences study on the effect of river training structures on flood heights to inform development of the new SEIS.** A National Academy of Sciences review is critical for ensuring that: (a) the SEIS is based on the best possible scientific understanding of the role of river training structures on increasing flood heights; (b) the SEIS produces recommendations that will provide the highest possible protection to the public; and (c) the public will have confidence in this aspect of the Corps' evaluation and recommendations.

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[1] The Conservation Organizations have also been advised that modeling conducted by the Army Corps of Engineers' Omaha District for the Deer Island Restoration Project showed a 0.34 foot increase in flood heights from adding a series of dikes to a 2-mile stretch of the Missouri River. This flood height rise occurred even though the project would also involve considerable bank excavation at the site, which would drive water levels down. *See* U.S. Army Corps of Engineers Omaha District, Office Report, Deer Island SWH Hydraulic Analysis CENWO-ED-HF, 9 July 2010; U.S. Army Corps of Engineers Omaha District, Missouri River Recovery Program Lower Little Sioux Bend Shallow Water Habitat Construction Project Draft Project Implementation Report May 2011.

[2] U.S. Army Corps of Engineers St. Paul District, DRAFT Letter Report and Integrated Environmental Assessment, Lower Pool 2 Channel Management Study: Boulanger Bend to Lock and Dam No. 2 (DRAFT June 2017) at 42 (emphasis added) (available at http://www.mvp.usace.army.mil/Home/PN/Article/1219079/draft-lower-pool-2-channel-management-study/, visited June 22, 2017). This Lower Pool 2 Environmental Assessment also highlighted that: "It is likely that material not deposited in the main channel in the project area [by the river training structures] would be deposited in another location resulting in increased dredging at that location." *Id*. at 43.

2. **Impose a moratorium on the construction of new river training structures pending completion of the National Academy of Sciences Study and new SEIS.** An extensive body of peer-reviewed science demonstrates that river training structures have significantly increased flood levels and flood risks in the Middle Mississippi River. The Corps' St. Paul District recently confirmed that river training structures increase flood heights. As a result, it is critical that the Corps not build any additional river training structures unless, and until, a National Academy of Sciences study and new SEIS establish that such construction will not increase flood risks. The stakes are simply too high for river training structure construction to continue without input from the National Academy of Sciences.

3. **Fully evaluate the impacts of all reasonable alternatives—including the alternative outlined in paragraph 6 below.** The new SEIS must evaluate all reasonably foreseeable site-specific impacts of the full range of activities used to maintain navigation in the Middle Mississippi River. This includes the direct, indirect, and cumulative impacts of: building and maintaining new river training structures; maintaining and rehabilitating existing river training structures; constructing and maintaining revetment on the river's banks; dredging the river channel; and disposing of the dredged material. The new SEIS must carefully examine the biological implications of these activities (and not simply the engineering outcomes) on the full range of habitat types and fish and wildlife resources in the river and the river floodplain. The new SEIS should carefully examine the cumulative impacts of the project on the ability of fish, wildlife, and human communities to thrive in the face of more frequent and extreme weather events. The new SEIS should also be expanded to evaluate the full suite of operations and maintenance activities for the Upper Mississippi River – Illinois Waterway navigation system.

4. **Formally consult with the U.S. Fish and Wildlife Service and state agencies as required by the Fish and Wildlife Coordination Act, and incorporate the resulting comments and recommendations into the new SEIS.** The formal consultation process provides information critical to ensuring that the Regulating Works Project will protect and restore fish and wildlife resources and that wildlife conservation will receive equal consideration to all other project purposes, as required by the Fish and Wildlife Coordination Act (FWCA). 6 U.S.C. §§ 661, 662. The Corps' claim that the FWCA does not apply is incorrect because the Regulating Works Project has been significantly modified at least twice since the FWCA was enacted in 1958. The Regulating Works Project originally authorized in 1927 was substantially modified in 1934 (adopting a more damaging contraction plan of 1,800 feet versus the originally authorized 2,500 to 2,000 feet), in 1965 (requiring maintenance of a year round navigation channel), and in 1972 (adopting an even more damaging contraction plan of 1,500 feet). Under these circumstances, the FWCA and the Corps' own engineering regulations require formal FWCA consultation. 16 U.S.C. 662(b); ER 1105-2-100 (22 Apr 2000) at C-22.

5. **Appoint a new and fully independent external peer review panel (IEPR) and respond fully to the concerns raised by the IEPR panel that reviewed the 2016 Draft SEIS.** The new IEPR panel should evaluate: (a) the adequacy and appropriateness of the models, science, and methodology used in the new SEIS; (b) whether the selected alternative will protect communities; and (c) whether the selected alternative will protect and restore the natural functions of the Mississippi River system. While the IEPR panel that reviewed the 2016 Draft SEIS raised important concerns, the panel provided only an extremely limited review of the

project. That panel also lacked the independence required for a meaningful independent review, as collectively its members have worked directly for the Corps for 63 years.

6. **Select an alternative that protects people and wildlife.** To comply with longstanding Congressional directives, including the National Water Resources Planning Policy, the Corps must select an alternative that will protect and restore the natural functions of the Mississippi River system and mitigate any unavoidable damage. For the Middle Mississippi River, such an alternative would: (a) abandon construction of new river training structures, unless it has been demonstrated that they will not increase flood risks; (b) abandon construction of new revetment that will further harm the river's nature functions by creating additional areas where the river will be locked in place; (c) remove and/or modify some of the existing river training structures and revetment to reduce flood risks and restore habitat; (d) restore habitat that has been lost to navigation activities over at least the past four decades; and (e) fully mitigate the adverse impacts of past and future navigation maintenance activities.

## Detailed Comments

The Final SEIS Preferred Alternative must be rejected because it will increase flood risks for Mississippi River communities and lead to further significant declines in the ecological health of the Middle Mississippi River. The Preferred Alternative also must be rejected because it vastly exceeds the scope of the Congressional authorization for the Regulating Works Project and fails to comply with key federal laws and policies.

The Final SEIS must be rejected because it does not comply with the important requirements of the National Environmental Policy Act (NEPA), the statutory mitigation requirements for Corps civil works projects, the mandatory requirements of the Fish and Wildlife Coordination Act, and the National Water Resources Planning Policy.

The Conservation Organizations urge the Corps to prepare a new SEIS for public review and comment, and adopt a fundamentally different alternative for maintaining navigation in the Middle Mississippi River that: (a) abandons construction of new river training structures, unless it has been demonstrated that they will not increase flood risks; (b) abandons construction of new revetment that will further harm the river's nature functions by creating additional areas where the river will be locked in place; (c) removes and/or modifies some of the existing river training structures and revetment to reduce flood risks and restore habitat; (d) restores habitat that has been lost to navigation activities over at least the past four decades; and (e) fully mitigates the adverse impacts of past and future navigation maintenance activities.

### A. The Preferred Alternative Must Be Rejected

The alternative recommended by the flawed Final SEIS should be rejected because it will increase flood risks for river communities and cause wide-spread and highly significant harm to the Middle Mississippi River and the fish and wildlife that depend on that vital resource.

The U.S. Fish and Wildlife Service has also made clear that it "does not concur with the preferred alternative." Final SEIS, Appendix H, at E-58. The Service has advised the Corps to "consider [the Service's January 2014 comments] and recommendations and work with the USFWS and State natural resource agencies to develop an alternative that ensures adequate and equitable protection, mitigation, and enhancement of fish and wildlife resources." *Id*. The Service has also recommended that the Corps include "side channel protection, maintenance, and restoration in the alternatives to be considered" and "include main channel border habitat protection, maintenance, and restoration in the alternatives to be considered." Final FEIS at E-60, E-61.

### 1. The Preferred Alternative Increases Flood Risks

The recommended alternative will increase flood risks for communities by adding significantly more river training structures to the Middle Mississippi River. Additional flooding will lead to increased human suffering, family and community dislocations, additional costs to the Federal government through flood insurance payments and federal emergency assistance, and additional costs to states, localities, and private interests for recovery efforts.

As the Corps is aware, extensive peer-reviewed science demonstrates that river training structures have increased flood levels by up to 15 feet in some locations and 6 to 10 feet in broad stretches of the Middle Mississippi River where these structures are prevalent.[3] The impacts of river training structures are cumulative; the more structures placed in the river, the higher the flood stages.[4] The Middle Mississippi River has been so constricted by river training structures and levees that it is now exhibiting "the flashy response" to flooding "typical of a much smaller river,"[5] with extremely troubling implications for public safety.

The Corps' rejection of this extensive body of peer-reviewed science—and its repeated refusals to engage the National Academy of Sciences on this issue—fundamentally taints the Final SEIS and the entire Regulating Works Project. The rejection of this science in the Final SEIS is incomprehensible in light of an Environmental Assessment released by the Corps' St. Paul District just two weeks ago that both confirms and demonstrates that river training structures in fact increase flood heights.

On June 15, 2017, the Corps' St. Paul District released an Environmental Assessment that rejected a proposed river training structure alternative because modeling of that alternative **"showed a significant flood-stage increase for the 1-percent flood elevation."**[6] The Environmental Assessment further

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[3] *See, e.g.,* Pinter, N., A.A. Jemberie, J.W.F. Remo, R.A. Heine, and B.A. Ickes, 2010. Empirical modeling of hydrologic response to river engineering, Mississippi and Lower Missouri Rivers. River Research and Applications, 26: 546-571; Remo, J.W.F., N. Pinter, and R.A. Heine, 2009. The use of retro- and scenario- modeling to assess effects of 100+ years river engineering and land cover change on Middle and Lower Mississippi River flood stages. Journal of Hydrology, 376: 403-416; Numerous other studies and analyses provided to the Corps through public comments on the scope of the SEIS and on the Draft SEIS.

[4] See, e.g., Discussion and scientific references at pages 34-35 of the January 2017 Conservation Organization.

[5] Robert E. Criss, Mingming Luo, *River Management and Flooding: The Lesson of December 2015–January 2016, Central USA*, Journal of Earth Science, Vol. 27, No. 1, p. 117–122, February 2016 ISSN 1674-487X (DOI: 10.1007/s12583-016-0639-y).

[6] U.S. Army Corps of Engineers St. Paul District, DRAFT Letter Report and Integrated Environmental Assessment, Lower Pool 2 Channel Management Study: Boulanger Bend to Lock and Dam No. 2 (DRAFT June 2017) at 42 (emphasis added) (available at http://www.mvp.usace.army.mil/Home/PN/Article/1219079/draft-lower-pool-2-channel-management-study/, visited June 22, 2017) ("St. Paul District EA").

concludes that this "alternative is not considered implementable due to the unacceptable flood stage increases produced by the structures necessary to make this alternative effective."[7]

That same Environmental Assessment acknowledged that the chevrons in the alternative it did recommend would also increase flood levels to some degree.[8] Indeed, the St. Paul District was so well aware of the potential for increasing flood heights that it adopted a formal flood stage impact planning constraint to guide the Environmental Assessment: "Flood Stage Impacts – Any project features should not increase flood heights or adversely affect private property or infrastructure."[9]

Because the Final SEIS rejects and ignores the impacts of river training structures on flood heights, it lacks scientific integrity in direct violation of NEPA.[10] This lack of scientific integrity has led to the adoption of a dangerous Preferred Alternative that will significantly increase flood risks. To correct this situation, the Corps' Chief of Engineers should: (1) direct the St. Louis District to prepare a new SEIS that accounts for the impact of river training structures on flood heights, including by conferring closely with outside academic experts and the St. Paul District on such impacts; (2) initiate a National Academy of Sciences study on the impact of river training structures on flood heights to inform that new SEIS; and (3) impose an immediate moratorium on the St. Louis' Districts construction of new river training structures unless and until the National Academy of Sciences Study and new SEIS demonstrate that new structures will not contribute to increased flood heights.

A National Academy of Sciences Study, which would cost less than a single river training structure, is critical for protecting river communities and for restoring the public's trust in the Corps' Regulating Works Project decision-making. As the Corps is aware, there is currently intense public opposition to constructing new river training structures in the Middle Mississippi River and elsewhere, due to the risk of flooding that those structures create.[11]

### 2. The Preferred Alternative Destroys Vital Fish And Wildlife Habitat

The Preferred Alternative will cause significant and widespread loss of vitally important fish and wildlife habitat. The Final SEIS acknowledges that the Preferred Alternative's river training structure construction will destroy at least 1100 acres of border channel habitat—this will bring to more than 40% the total loss of this vital habitat in the Middle Mississippi River since just 1976.

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[7] *Id*. at 43. This Lower Pool 2 Environmental Assessment also highlighted that: "It is likely that material not deposited in the main channel in the project area [by the river training structures] would be deposited in another location resulting in increased dredging at that location." *Id*.

[8] Lower Pool 2 Environmental Assessment, Appendix D: Hydrology and Hydraulics at 20 ("Stage impacts of 0.005 feet are present along the north shore of Pool 2 near the downstream end of the Grey Cloud Channel. The structures to the north and west of Freeborn Island and riverward of the railroad should not have 1 percent ACE (100 Year) stages increase more than 0.005 feet. The structures below Schaar's Bluff on the south side of the pool at the downstream end of Spring Lake should see stage increases between 0.002 and 0.004 feet. A stage reduction of 0.005 feet (-0.005 feet shown in Figure 7) is seen upstream of the project limits in the navigation channel and in Spring Lake.").

[9] Lower Pool 2 Environmental Assessment at 36.

[10] Additional, significant problems with the scientific integrity of the Final SEIS are discussed at pages 22-31 and throughout the January 2017 Conservation Organization Comments.

[11] *See, e.g.*, the extensive public scoping comments for this Project, the extensive public comments on this DSEIS, and the strong opposition by local community members to the revised Grand Tower Environmental Assessment expressed at the March 9, 2016 and February 19, 2014 public hearings on the Grand Tower project.

The full extent of adverse impacts from the Preferred Alternative will certainly be much higher, as the Final SEIS fails to examine and identify a host of additional impacts, including: the ecological and biological implications of the direct, indirect and cumulative losses of this important border channel habitat; the impacts from constructing additional revetment; the impacts from maintaining and rehabilitating existing river training structures; the impacts from dredging the river channel and disposing of the dredged material; the impacts from river navigation; the impacts on important habitats including wetlands, floodplains, side channels (including impacts to side channel connectivity), and braided river habitats; and the specific impacts to a host of fish and wildlife species that depend on these habitats. These failings are discussed in more detail in Section B of these comments.

As noted above, the U.S. Fish and Wildlife Service also believes that the Preferred Alternative should not be adopted due to its adverse impacts on fish and wildlife resources. Final SEIS, Appendix H, at E-58 (The Service "does not concur with the preferred alternative" and calls on the Corps to "consider [the Service's January 2014 comments] and recommendations and work with the USFWS and State natural resource agencies to develop an alternative that ensures adequate and equitable protection, mitigation, and enhancement of fish and wildlife resources.").

### 3. The Preferred Alternative Is Not Authorized

The Preferred Alternative vastly exceeds the scope of the Regulating Works Project authorized by Congress. As the Corps is aware, the parameters of the Regulating Works Project are established by the 1926 Chief of Engineers' Report[12] that was authorized by the Rivers and Harbors Act of 1927. Those parameters establish explicit limitations, including:

(1) Constriction of the channel through regulating works and revetment is limited to a conservative width of 2,500 to 2,000 feet at low water, as follows: 2,250 foot contraction at low water from River des Peres to Grays Point; 2,500 foot contraction at low water from Commerce to Commercial Point, and 2,000 foot contraction at low water from Commercial Point to Ohio River;[13] and

(2) "That after completion of regulating works, dredging be continued, as needed, to maintain a channel 9 feet deep and 300 feet wide with requisite increased width at bends: *Provided*, That dredging of channels deeper than 8 feet and wider than 200 feet be authorized only when the needs of navigation then existing are not adequately met by such 8-foot channel."[14]

The Chief's report explicitly rejected more aggressive contractions of the river:

> "The contraction to be brought about by the regulating works proposed is a conservative one. The practical result of these works will be merely narrowing the abnormally wide sections of the

[12] Rivers and Harbors Act of 1927; December 17, 1926 Chief of Engineers Report (69th Congress, 2d Session, Doc. No. 9 at paragraphs 55-57, 80, 84).
[13] 1926 Chief's Report—December 17, 1926 (69th Congress, 2d Session, Doc. No. 9). The contraction width is measured from the riverside toe of a river training structure on one side of the river to the bank or riverside toe of another river training structure on the opposite side of the river.
[14] 1926 Chief's Report—December 17, 1926 (69th Congress, 2d Session, Doc. No. 9).

> river to the present mean widths. The project of 1881 contemplated contraction to a width of about 2,500 feet. Through St. Louis Harbor a contraction to a low-water width of 1,500 feet to 1,800 feet has been carried out. The contraction proposed causes much less change in the original condition of the river than either the project of 1881 or the work in St. Louis Harbor. **Calling for very little change from the original condition of the river the equilibrium of natural forces in the river will be but slightly disturbed.**"[15]

As a result, Congress established very specific limits on the Regulating Works Project—once the river was contracted to a width of 2,000 to 2,500 feet (depending on location), the Corps was to maintain the navigation channel only through dredging as needed. Congress also explicitly rejected more aggressive contraction plans.

Despite the explicit rejection of both 1,800-foot and 1,500-foot contraction plans in the 1927 Rivers and Harbors Act, the Corps has chosen to implement those very same plans without obtaining new Congressional authorization.[16] In 1934, the Corps adopted the more damaging contraction plan of 1,800 feet. In 1972, the Corps adopted the even more damaging contraction plan of 1,500 feet upon the recommendation of the District Engineer.[17] To date, the Corps has been unable to locate a higher level approval.[18]

The Corps' adoption of the unauthorized, more aggressive 1,500 foot contraction plan has resulted in significant additional environmental harm and flood stage increases than would have occurred under the plan actually authorized by Congress.

The Preferred Alternative vastly exceeds the explicit limits of the 1927 authorization by: (1) utilizing a 1,500 contraction plan; (2) building river training structures to achieve the unauthorized 1,500 foot contraction plan; and (3) building river training structures to reduce dredging costs associated with maintaining the navigation channel even where both the authorized (2,000 to 2,500 foot) and unauthorized (1,500 foot) contraction widths have been achieved.

Both the Final SEIS and Draft SEIS helped drive development of the unauthorized Preferred Alternative by establishing an improper project purpose that could only be satisfied through continued construction of river training structures regardless of the degree of contraction of the river:

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[15] 1926 Chief's Report—December 17, 1926 (69th Congress, 2d Session, Doc. No. 9) at Paragraph 57 (emphasis added).

[16] In 1965, the Corps also determined that it was required to maintain the navigation channel year round.

[17] While Congress can ratify an otherwise unauthorized agency action through appropriations acts, the "appropriation must plainly show a purpose to bestow the *precise* authority which is claimed." *Schism v. United States*, 316 F.3d 1259, 1289 (Fed.Cir.2002); *Fund for Animals v. United States Bureau of Land Management*, 460 F.3d 13, 19 n. 7 (D.C.Cir.2006). In other works the appropriations act must "clearly identify[] the action to be ratified." *Fund for Animals*, 46 F.3d at 19 n.7. Thus, to ratify the alternate contraction plans, Congress would have had to have been formally informed of the change in the plan, and would have had to clearly state in an appropriations act that it was approving the alternate plan. The Conservation Organizations are not aware of any such notification to Congress or any such Congressional approval.

[18] Email to Melissa Samet, Senior Water Resources Counsel, National Wildlife Federation from Keli N. Broadstock, Assistant District Counsel, Army Corps of Engineers St. Louis District, dated June 7, 2017.

> 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**.

Final SEIS at ES-1; Draft SEIS at ES-1 (emphasis added).

#### 4. The Preferred Alternative Violates Federal Law and Policy

As discussed in detail in Section B of these comments, the Preferred Alternative, like the Final SEIS, fails to comply with critical planning laws and policies, including: the goals and requirements of the National Environmental Policy Act, the statutory mitigation requirements applicable to Corps civil works projects, the mandatory requirements of the Fish and Wildlife Coordination Act, and the National Water Resources Planning Policy.

### B. The Final SEIS Must Be Rejected

The Final SEIS must be rejected because it does not comply with the important requirements of the National Environmental Policy Act (NEPA). Indeed, the Final SEIS appears to have been formulated to justify continuation of the status quo, rather than to take advantage of NEPA's important framework to develop, evaluate, and select an alternative that would cause less harm to the environment. The Final SEIS must also be rejected because it fails to comply with the statutory mitigation requirements applicable to Corps civil works projects, the mandatory requirements of the Fish and Wildlife Coordination Act, and the National Water Resources Planning Policy.

The Corps contends that it is exempt from numerous evaluation requirements because the SEIS is not a "planning document."[19] While the Conservation Organizations recognize that the Corps typically uses the phrase "planning document" to refer to a feasibility study, the rejection of the SEIS as a tool to affect planning completely undermines the fundamental purpose of NEPA, which is to fully evaluate project impacts in order to identify alternatives approaches that cause less harm to the environment. As is discussed in detail in Appendix A to these comments, the Final SEIS must evaluate all reasonable alternatives, including those outside of the Corps current authorization and jurisdiction. Rather than utilize the Final SEIS to evaluate these different "planning" options, the Corps instead appears to have viewed the NEPA process as little more than a box to check off with no real change in approaches possible or appropriate.

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[19] *See, e.g.*, Final SEIS at E-7 ("During the evaluation process for the SEIS the USACE did not discover any reasonable or feasible alternatives that warranted transitioning the SEIS to a planning document."); Final EIS, Appendix H, at H-588 ("Since the SEIS is not a planning document but merely an update to the 1976 EIS, there is no need to conduct a valuation of ecosystem services lost for this document."); Final EIS, Appendix H, at H-579 ("See response below to Comment 8 that the revised National Water Resources Planning Policy is not applicable to the SEIS because it is not a planning document."); Final EIS, Appendix H, at H-580 ("And as explained in the revised Chapter 2, there was not a viable or reasonable alternative that suggested that the document should shift to a planning document for reevaluation or modification of the project.").

### 1. The Final SEIS Does Not Comply With the Requirements of NEPA

The Final SEIS, like the Draft SEIS, does not comply with NEPA. Detailed comments on this lack of compliance were provided in the January 2017 Conservation Organization comments on the Draft SEIS.[20] While we appreciate the inclusion of some additional information in the Final SEIS (most notably, information related to the original project authorization), the Corps did not correct or meaningfully respond to the many problems identified in the January 2017 Conservation Organization comments. As a result, the January 2017 Conservation Organization comments remain fully applicable to the Final SEIS and are incorporated by reference into these comments on the Final SEIS as though fully set forth herein. The January 2017 Conservation Organization comments are attached at Appendix B.

The Final SEIS also fails to correct the many problems identified in other comments submitted on the Draft SEIS, including the problems identified by the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Geological Survey, Missouri Department of Conservation, and Illinois Department of Natural Resources. Accordingly, the comments of these state and federal agencies on the Draft SEIS also apply fully to the Final SEIS.

The Conservation Organizations provide the following comments that *add to* the extensive discussion of these issues in the January 2017 Conservation Organization comments:

(1) The Final SEIS fails to evaluate the highly reasonable and practicable alternatives recommended in the January 2017 Conservation Organization comments, the U.S. Fish and Wildlife Service Comments on the Draft SEIS, and the Missouri Department of Conservation Comments on the Draft SEIS.

(2) The Final SEIS fails to properly define the project purpose. As discussed in Section A.3 of these comments, this improper project purpose directly contradicts the plain language of the Regulating Works Project authorization. The Final SEIS project purpose could only be satisfied through continued construction of river training structures. However, the Regulating Works Project authorization explicitly states that: (a) river training structure construction should end once the river has been contracted to the 2,500 to 2,000 foot widths outlined in the 1926 Chief of Engineers' Report; and (b) after that level of contraction has been achieved, the navigation channel should be maintained through dredging.

(3) The Final SEIS is tainted by a fundamental lack of scientific integrity. The lack of scientific integrity regarding river training structures and flood heights is further highlighted by the recent findings of the Corps' own St. Paul District. As discussed in detail in Section A.1 of these comments, on June 15, 2017, the St. Paul District released an Environmental Assessment that both confirms and demonstrates that river training structures in fact increase flood heights.

(4) The Final SEIS fails to demonstrate that future dredging needs are likely to warrant construction of new river training structures. To the contrary, the Final SEIS provides only extremely limited information on possible future dredging needs, and that information suggests that dredging needs will not increase because sediments entering the Mississippi River have decreased. *See*

[20] Comments of the National Wildlife Federation, American Rivers, Missouri Coalition for the Environment, and Prairie Rivers Network on the Regulating Works Project Draft Supplemental Environmental Impact Statement (November 2016), dated January 18, 2017.

Final SEIS at 60-61, 200 ("This degradation has been attributed to the placement of river training structures and a decrease in sediment load in the river due to construction of reservoirs on the Mississippi River tributaries.").

In addition, the St. Paul District Environmental Assessment highlights the very real possibility that river training structures do not actually reduce sediment build up in the river, but instead simply move sediment to other locations that will then need to be dredged. According to the St. Paul District Environmental Assessment: "It is likely that material not deposited in the main channel in the project area [by the river training structures] would be deposited in another location resulting in increased dredging at that location."[21]

(5) The Final SEIS fails to evaluate impacts from significant activities that will continue to be carried out under the Regulating Works Project despite not being addressed in the Preferred Alternative, including: maintaining and rehabilitating existing river training structures and revetment, dredging the river channel, and disposing of dredged material. This failure also has been highlighted by the U.S. Fish and Wildlife Service and the Missouri Department of Conservation.

For example, the U.S. Fish and Wildlife Service has noted that dredging and disposal of dredged materials can have significant adverse impacts particularly when they occur in sensitive fish and wildlife habitats. The Service has also raised concerns about "the potential impacts of dredge material placement on side channels including filling and/or restricting access," the impacts on the "forage base of fishery resources" and the importance of restrictions on timing of dredging and coordination of dredged disposal in accordance with the 2000 Biological Opinion. The Service has recommended that these and other dredging and dredged disposal impacts be evaluated. Final SEIS, Appendix E, at E-48, E-66, E-67. The Missouri Department of Conservation has raised concerns about the timing of dredging, the impacts of fish entrainment during dredging, and the abrupt turbidity changes caused by dredging. Final SEIS, Appendix E, at E-86. The Illinois Department of Natural Resources has raised concerns about the significant adverse impacts to sensitive fish and wildlife habitats that can occur in some locations from in-river sediment disposal. Final SEIS, Appendix E, at E-90.

(6) The Final SEIS fails to evaluate the full suite of impacts from continued construction under the Regulating Works Project. As discussed at length in the January 2017 Conservation Organization comments, the Final SEIS: (a) does not assess the biological and ecological implications of the Preferred Alternative, including by failing to assess the impacts to a wide array of wildlife, fish, reptiles, and amphibians; and (b) does not evaluate the impacts of the Preferred Alternative on important habitat types, including braided river habitats, wetlands, and floodplains.

For example, the Final SEIS does not address the impacts of river training structures on changes in the rate of floodplain aggradation, which occurs where the supply of sediment is greater than the amount of material that the system is able to transport. Rather than providing a meaningful assessment of wetland impacts, the Final SEIS summarily concludes that "the Regulating Works Project is not considered to be a significant contributor to wetland losses in the Mississippi River floodplain" because many of the areas in the Middle Mississippi River floodplain do not qualify as jurisdictional wetlands. Final SEIS, Appendix H, at H-592. This wholly unsupported statement

[21] St. Paul District EA at 43.

appears to be based on the insupportable assumption that an impact to a habitat type that covers a relatively smaller area is not an important impact. This summary conclusion is also at odds with the Final SEIS statement on land cover categories (*e.g*., there are 29,801 (4.5%) of marsh in the Middle Mississippi River floodplain and 14,605 (7.2%) acres of marsh in the Middle Mississippi River batture), and the recognition in the Final FEIS of the value of connectivity and flood pulses to the floodplain. *See* Final FEIS at 207-209. *See also,* the discussion of side channels below.

(7) The Final SEIS fails to identify the amount of additional revetment that will be constructed under the Preferred Alternative, and fails to evaluate the direct, indirect, and cumulative impacts of such construction. The cumulative impacts analysis also fails to take into account the extensive revetment already constructed in the Middle Mississippi River ecosystem.

The Preferred Alternative will add an unknown quantity of addition revetment to the extensive existing revetment that already covers approximately 60% of the banks of the Middle Mississippi River.[22] Final SEIS at 189. The only discussion of the impacts of the proposed new revetment is a summary conclusion (unsupported by analysis or data) that the additional revetment "is not anticipated to have an appreciable adverse effect on the MMR fish community." Final SEIS at 189. Revetment has significant impacts, including preventing the natural lateral movement of the river channel. As the Missouri Department of Conservation makes clear, to remain healthy, a river must have some ability to move laterally:

> "Restricted lateral movement reduces input of woody vegetation and sediments to the river. A healthy river has some level of lateral movement, and this movement helps to further create diverse aquatic habitat. These impacts should be identified and avoided and minimized to the extent practicable, and functional loss to river habitat conditions addressed through restoration projects." FSEIS, Appendix E, at E-27.

The direct, indirect and cumulative impacts of the existing and proposed new revetment must be evaluated.

(8) The Final SEIS fails to evaluate and account for the direct, indirect, and cumulative ecological and biological impacts from loss of an additional 1,100 acres of main channel border habitat. As the U.S. Fish and Wildlife Service has concluded:

> "the loss and continued degradation of this habitat will reduce substrate diversity and riverine productivity, thereby, reducing the natural forage base, and will reduce the availability of fish spawning substrate, larval and juvenile fish rearing habitat, and seasonal refugia. Thus, the USFWS recommends that the USACE include main channel border habitat protection, maintenance, and restoration in the alternatives to be considered." Final FEIS at E-61.

[22] We note that the Final SEIS also provides information suggesting that the actual percentage could be closer to 70%. According to the Final SEIS, "approximately 1,473,000 linear feet of bankline" has been revetted between RM 0 and RM 200. Final SEIS at 18. This is equivalent to 279 miles, which is 69.75% of the 400 river mile bankline between RM 0 and RM 200.

Instead of examining these critical impacts, the Final SEIS essentially limits the evaluation of loss to an accounting of acres that will be affected. The Final SEIS fails even to provide an assessment of the linear stretch of river that will be affected by these losses. Both acreage and linear impacts are critical to understanding the full extent of the harm.

(9) The Final SEIS fails to meaningfully evaluate the impacts of the Preferred Alternative (and the impacts of the other activities carried out under the Regulating Works Project) to side channels, including critically, the impacts to side channel connectivity. The Final SEIS does recognize that the Regulating Works Project has resulted in stage reductions, and that stage reductions have affected connectivity to side channels and the quality of side channel habitat. *See* Final SEIS at 204-205. However, the Final SEIS does not meaningfully evaluate the impact of the Preferred Alternative (and the other significant activities carried out under the Regulating Works Project) on future changes to channel connectivity. For example, while recognizing that there will be close to a one foot (.94 feet) reduction of stage at St. Louis, and more than a one foot (1.1 feet) reduction in stage at Chester during low flows over the next 17 years, the Final SEIS does not evaluate the impact of those stage reductions on side channels and tributaries. The Final SEIS instead summarily concludes that "whatever proportion of the small reduction in stage that future river training structures are responsible for is anticipated to be minor and inconsequential." Final FEIS at 145-146.

The U.S. Fish and Wildlife Service raised significant concerns about impacts to side channels in their comments on the Draft SEIS that were not addressed in the Final SEIS:

> "According to the SEIS, when evaluating side channels based on geomorphology, bathymetry, and connectivity, most MMR side channels appear to be stable or improving and that has been aided by side channel restoration efforts that began in 1990's under the MMR Side Channels Habitat Rehabilitation and Conservation Initiative. However, there continue to be instances where side channels are filling and connectivity is decreasing or has been lost and a majority of side channels continue to be regulated or impacted by closing structures, upstream dike fields, and associated sediment deposition. Information in the SEIS indicates that only one of the existing thirty-two side channels does not have a closing structure and that the original purpose of the closing structures was to direct flow to the main channel to support navigation flows. The continued operation and maintenance of these structures and upstream dike fields will continue to limit flows to side channels and restrict fish use of these extremely important habitats. And while there are efforts being undertaken by the District to implement side channel restoration under different authorities, little to no restoration efforts have been implemented under the Project and this has hindered restoration efforts. Thus, the USFWS recommends that the USACE include side channel protection, maintenance, and restoration in the alternatives to be considered."
>
> * * *
>
> "Under the Continue Construction Alternative the analysis of water surface elevations at low flows indicate that stages are decreasing over time and this is the same conclusion that was reached in the 1976 EIS. The USFWS is concerned that continued river training structure construction will further decrease the stages at low flows and impact connectivity of and sedimentation within side channels. The USACE indicates that an

evaluation on the impacts of river training structures at low flow has not been conducted. The USFWS recommends that additional research be conducted to evaluate the effect of various river training structures on stages at low flow and what if any measures can be developed to reduce this trend."

"According to the SEIS, side channel habitat in the MMR appears to be maintaining at a relatively stable level; however, there is concern that the Regulating Works Project is decreasing river stages at low flows by deepening the channel and decreasing sediment load in the river. This could result in a loss of side channel habitat and reduced connectivity at lower river flows. Based on the anticipated future construction of river training structures, the USACE believes that the effect on river stages would be minor and inconsequential. In addition, any potential future adverse impacts would be addressed with compensatory mitigation. The USFWS remains concerned that the continued operation and maintenance of existing river training structures and construction of new river training structures will continue to limit flows to side channels and restrict fish use of these extremely important fish habitats. And while there are efforts being undertaken by the District to implement side channel restoration under different authorities little to no restoration efforts have been implemented under the Regulating Works Project and this has hindered restoration efforts. Thus, the USFWS recommends that the USACE include side channel protection, maintenance, and restoration in the alternatives to be considered." Final FEIS, Appendix E, at E-12, E-15 to E-16.

The Missouri Department of Conservation also raised significant concerns about impacts to side channels in their comments on the Draft SEIS that were not addressed in the Final SEIS:

"Another consideration to habitat impacts, as the river incises it is not just the side channels that are perched, but also islands themselves and the more shallowly sloping banks that could provide off-channel habitat when the river is high. This is another loss in important habitat that should be quantified."

**"Side Channel Habitats:** Recognizing the importance of side channel habitats in a portion of the river where there is little floodplain connectivity, the river partners have identified the need to ensure side channels are connected to the river channel with suitable flows and that there is a diversity of aquatic habitats. The Department appreciates the efforts of the USACE to restore side channels and encourages continued efforts to ensure that restoration projects are not impacted by the predicted decrease in river stage during low flows. This could result in loss of side channel connectivity, possibly negating some restoration efforts. For example, in Section 2.3.2, the SEIS notes that side channels are a refuge from navigation disturbances; but if the side channels are becoming more and more isolated through reduced connectivity, they aren't going to be very useful to river organisms. Department researchers have also noted that the MMR has lost over half of side channel area in width. An increase in side channel volume is not equivalent to more habitat being added to the system. Restoration practices need more functional evaluation as well; for example we have little understanding of how or if the more benthic organisms move through notches. What notch elevation is necessary to allow passage of these organisms? These questions and others are important to understand as side channels are restored."

> "Additionally, to help estimate decreases in connectivity to side channels, the projected stage reduction values could be used. This would give a quantitative estimate of impact." Final SEIS, Appendix E, at E-28.

(10) The Final SEIS fails to meaningfully evaluate the significant cumulative impacts that will magnify the damage caused by the Preferred Alternative (and the damage caused by the other significant activities carried out under the Regulating Works Project). Proper evaluation of cumulative impacts is critical to all environmental reviews, and is essential for assessing the impacts of the Preferred Alternative in light of the extensive alteration and damage to the Mississippi River over time, including extensive damage caused by the Regulating Works Project which has been underway in various forms since 1881.

For example, while the Final SEIS does recognize that the loss of additional main channel border habitat would be a significant impact, the cumulative impacts analysis does not assess the ecological and biological implications of the Preferred Alternative on top of the already significant loss of this vital habitat. River training structures have already caused a highly significant loss of 35% of main channel border habitat in the Middle Mississippi River since just 1976; the Preferred Alternative will push this loss to more than 40%. The Final SEIS also does not address the cumulative ecological and biological impacts to wildlife, fish, amphibians, reptiles, and habitat from the revetment that covers—and locks in place—60% of the Middle Mississippi River. The Final SEIS also does not evaluate the mitigation that would be required to offset these cumulative impacts, despite strong recommendations to do so by many commenters, including the U.S. Fish and Wildlife Service and the Missouri Department of Conservation.

(11) The Final SEIS fails to meaningfully evaluate the impacts of the Preferred Alternative on the tributary rivers. In their comments on the Draft SEIS, the Nature Conservancy notes that the increased river velocity and scouring caused by river training structures has been shown to impact tributary incising and headcutting, which both impacts tributary streams and can release additional sediment into the main channel causing increased dredging needs. Final SEIS, Appendix H, at H-599. Instead of meaningfully evaluating this significant impact, the Final SEIS summarily concludes that the impacts of river training structures on headcutting and incision in tributaries is "expected to be minor and similar to the impact on side channels." Final SEIS, Appendix H, at H-599.

(12) The Final SEIS fails to evaluate the ability to restore lost ecological and biological functions through mitigation. Indeed, the discussion of possible mitigation is focused almost exclusively on notching or other modifications to river training structures (which, of course, caused the losses in the first place) with the only evaluation of resulting habitat based on the amount of rock removed from the structure:

> "Potential mitigation actions may include, but are not limited to, the following: wing dike notching, dike removal, wing dike creation using alternative designs (e.g., rootless dikes), use of rock piles, dredging or material placement of sand, and other possible activities. Mitigation will be tailored toward the specific habitat features that are significantly impacted. This habitat likely includes shallow to moderate depth, moderate to high velocity main channel border habitat. Such habitat may be challenging to design

and effectively implement. The ability to design for such habitat, including the associated costs, may need to be carefully considered within the context of the impacts. Impacts will be mitigated to the extent practicable. Final FEIS, Appendix C, at C-5.

* * *

*Estimation of Quantity of Habitat Created by Mitigation*
The area of mitigation resulting from the removal of parts or all of a structure was defined as the additional unstructured area created by the structure removal as shown in Figure 6.

***

Since the amount of created habitat was equal for each type of notch (bankline, riverside, center) a relationship was developed between the quantity of rock removed and the amount of habitat created by each notch type (see Figure 7). This relationship was used for each notch type to calculate the amount of habitat created for the equivalent amount of stone removed when removing a typical structure. Final FEIS, Appendix C, *Remaining Construction Estimate* at 7-9.

(13) The Final FEIS fails to account for the critical need to mitigate for past damage to the Middle Mississippi River from the Regulating Works Project. The 1976 EIS committed the Corps to work towards this goal, and the 1976 EIS included a post-authorization change that would include fish and wildlife habitat restoration as a project purpose. The U.S. Fish and Wildlife Service, Missouri Department of Conservation, and Illinois Department of Natural Resources have all called on the Corps to carry out this mitigation and restoration. The Conservation Organizations join this call.

(14) As discussed in more detail below, the Final SEIS fails to comply with critically important federal laws and policies, including the statutory mitigation requirements applicable to civil works projects, the mandatory requirements of the Fish and Wildlife Coordination Act; and the National Water Resources Planning Policy.

### 2. The Final SEIS Does Not Comply with Statutory Mitigation Requirements and Fundamentally Misinterprets Those Requirements

The failure to comply with the statutory civil works mitigation requirements is discussed in detail in the January 2017 Conservation Organization comments (at pages 52-55). In its attempt to respond to those comments, the Corps demonstrated that it has fundamentally misinterpreted the applicability of those requirements to the Final SEIS.

The Corps contends that the mandatory mitigation requirements of 33 USC § 2283(d)(1) are not applicable to the SEIS because "it is not a report being prepared for authorization by Congress." Final SEIS, Appendix H, at H-581. This interpretation is incorrect as section 2283(d) explicitly requires the inclusion of a specific mitigation plan in "any report" that selects a project alternative, including the Final SEIS:

> "After November 17, 1986, the Secretary shall not submit any proposal for the authorization of any water resources project to Congress in any report, **and shall not select a project alternative in any report**, unless such report contains (A) a recommendation with a specific plan to mitigate for damages to ecological resources, including terrestrial and aquatic resources, and fish and wildlife losses created by such project, or (B) a determination by the Secretary that such project will have negligible adverse impact on ecological resources and fish and wildlife without the implementation of mitigation measures. Specific mitigation plans shall ensure that impacts to bottomland hardwood forests are mitigated in-kind, and other habitat types are mitigated to not less than in-kind conditions, to the extent possible. If the Secretary determines that mitigation to in-kind conditions is not possible, the Secretary shall identify in the report the basis for that determination and the mitigation measures that will be implemented to meet the requirements of this section and the goals of section 2317(a)(1) of this title. In carrying out this subsection, the Secretary shall consult with appropriate Federal and non-Federal agencies."

33 USC 2283(d)(1) (emphasis added).

Under the Corps' interpretation, the entire independent clause ", and shall not select a project alternative in any report" would be given no meaning whatsoever.[23] Under the Corps' interpretation the adjective "any" as a qualifier for "report" in that independent clause also would be given no meaning. However, such outcomes violate the most fundamental principles of statutory construction.

It is "'a cardinal principle of **s**tatutory construction'" that "'a statute ought, upon the whole, to be so construed that, if it can be prevented, no clause, sentence, or word shall be superfluous, void, or insignificant.'" *TRW Inc. v. Andrews*, 534 U.S. 19, 31 (2001) (quoting *Duncan v. Walker*, 533 U.S. 167, 174 (2001)). Indeed, it is a court's "duty 'to give effect, if possible, to every clause and work of a statute.'" *United States v. Manasche*, 348 U.S. 528, 538-539 (1955) (quoting *Montclair v. Ramsdell*, 107 U.S. 147, 152 (1883)). As a result, "a statute must, if possible, be construed in such fashion that every word has some operative effect." *U. S. v. Nordic Village*, 503 U.S. 30, 36 (1992).

Moreover, "unless otherwise defined, words [of a statute] will be interpreted as taking their ordinary, contemporary, common meaning." *Perrin v. United States*, 444 U.S. 37, 42 (1979). As a result, the adjective "any" as the qualifier in the phrase "and shall not select a project alternative in any report" means just what it says. "Any" means "any" which is variously defined as every (*i.e*., every report that selects an alternative) or "of whatever kind" (*i.e*., a report of whatever kind that selects an alternative).

As a result, the Corps' claim that mitigation for the Regulating Works Project "is discretionary and subject to funding limitations" is incorrect and cannot stand. The Corps must mitigate the adverse impacts of any alternative that it recommends in a new SEIS, a new EIS, or a new Environmental Assessment for the Regulating Works Project. Any such report must include a specific mitigation plan and comply with the other mandatory mitigation requirements established by 33 U.S.C. 2283(d).

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[23] This intended outcome is amplified by the fact that reports proposing authorization of a water resources project submitted to Congress by the Corps by their very nature select a project alternative.

### 3. The Final SEIS Does Not Comply with Mandatory Fish and Wildlife Coordination Act Requirements and Fundamentally Misinterprets Applicability of Those Requirements

As discussed in the January 2017 Conservation Organization comments, the Corps is required to comply with the mandatory consultation requirements of the FWCA and give full consideration to the consultation recommendations. The formal consultation process provides information critical to ensuring that the Regulating Works Project will protect and restore fish and wildlife resources and that wildlife conservation will receive equal consideration to all other project purposes, as required by the FWCA. 6 U.S.C. §§ 661, 662.

The Corps contends that it is not required to engage in formal FWCA consultation for the Regulating Works Project because "the Project was considered 82% complete in 1958" when the FWCA was enacted. Final SEIS, Appendix E, at E-55.

However, this argument is incorrect because the Regulating Works Project has been significantly modified at least twice since the FWCA was enacted in 1958. The Regulating Works Project authorized in 1927 was substantially modified in 1934, 1965, and 1972:

(1) In 1934, the Corps appears to have adopted a significantly more damaging contraction plan of 1,800 feet versus the originally authorized 2,500 to 2,000 feet.

(2) In 1965, the Corps determined that it was required to maintain the navigation channel year round. Prior to 1965, the Corps had not been required to maintain navigation from mid-December to mid-February, when the lowest flows typically occurred.

(3) In 1972, the Corps adopted an even more damaging contraction plan of 1,500 feet.

Final SEIS, Appendix K. The Final SEIS proposes a further modification, and supplementation of the unauthorized 1,500-foot contraction plan.

As discussed in Section A.3 of these comments, Congress explicitly rejected the more aggressive 1,800-foot and 1,500-foot contraction plans in the 1927 project authorization in recognition of the significant adverse ecological impacts that would result from those plans:

> "The contraction to be brought about by the regulating works proposed is a conservative one. The practical result of these works will be merely narrowing the abnormally wide sections of the river to the present mean widths. The project of 1881 contemplated contraction to a width of about 2,500 feet. Through St. Louis Harbor a contraction to a low-water width of 1,500 feet to 1,800 feet has been carried out. The contraction proposed causes much less change in the original condition of the river than either the project of 1881 or the work in St. Louis Harbor. **Calling for very little change from the original condition of the river the equilibrium of natural forces in the river will be but slightly disturbed.**"[24]

[24] 1926 Chief's Report—December 17, 1926 (69th Congress, 2d Session, Doc. No. 9) at paragraph 57 (emphasis added).

Because the plan was substantially changed after the FWCA was enacted in 1958, the section 662(g) applicability exemption no longer applies. This is made clear by both the plain language of the FWCA and the Corps' own engineering regulations. 16 U.S.C. 662(b); ER 1105-2-100 (22 Apr 2000) at C-22.

The FWCA explicitly states that formal FWCA consultation report:

> "shall be made an integral part of **any report prepared or submitted by any agency** of the Federal Government responsible for engineering surveys and construction of such projects **when such reports are presented** to the Congress or **to any agency or person having the authority or the power, by administrative action or otherwise, (1) to authorize the construction of water-resource development projects or (2) to approve a report on the modification or supplementation of plans for previously authorized projects**, to which sections 661 to 666c of this title apply."

16 U.S.C. §662(b) (emphasis added).

The Corps' own engineering regulations also require formal FWCA consultation for postauthorization activities that modify or supplement a previously authorized plan:

> "(1) FWCA Applicability. The FWCA applies to postauthorization activities if the activity meets the threshold test outlined in Section 2(a) of the FWCA, i.e., the authorized plan is modified or supplemented, and these changes relate to Federal construction which would divert, modify, impound, or otherwise control a waterway.
>
> (2) Section 2(b) Report and Section 2(e) Funding. Sections 2(b) and (e) of the FWCA normally apply during post-authorization activities for Federal projects where the Section 2(a) threshold test has been met.
>
> (a) Mandatory Compliance. Section 2(b) of the FWCA is mandatory when changes to the authorized plan meets the Section 2(a) threshold test and the proposed changes to the authorized plan or project require a report to Congress, or the approval of the Chief of Engineers, or above."

ER 1105-2-100 (22 Apr 2000) at C-22.[25] The "Discretionary Compliance Determination Criteria" established in the Corps' Engineering Regulations also clearly apply to the Regulating Works Project Final SEIS such that formal FWCA consultation is required. *See* ER 1105-2-100 (22 Apr 2000) at C-22 to C-23.

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[25] The Section 2(a) threshold test referred to in these regulations would appear to refer to 16 U.S.C. § 662(a) which states in pertinent part that formal consultation is required: "whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States . . . ." 16 U.S.C. §662(a).

### C. The Final SEIS Does Not Comply With the National Water Resources Planning Policy and Fundamentally Misinterprets the Applicability of That Policy

The failure to comply with the National Water Resources Planning Policy is discussed in the January 2017 Conservation Organization comments. In its attempt to respond to those comments, the Corps demonstrated that it has fundamentally misinterpreted the applicability of this policy to the Final SEIS.

The National Water Resources Planning Policy was established by Congress in 2007. It states in pertinent part that:

> "It is the policy of the United States that all water resources projects . . . should protect the environment by . . . protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

42 USC § 1962–3(a).

The Corps contends that this policy is not applicable to the Regulating Works Project based on the Corps' interpretation of "applicability" language in 42 U.S.C. § 1962-3(b)(7). *See* Final SEIS, Appendix H, at H-580. However, the Corps' interpretation fundamentally ignores both the structure and the express language of this provision—and notably refers to the applicability section as § 1962-3(7) rather than the actual section number which is § 1962-3(b)(7).

As evident from the actual text of 42 U.S.C. § 1962-3, subsection (a) establishes the National Water Resources Planning Policy. That policy is immediately applicable and on its face applies to "all water resources projects." *Id*. The applicability provision relied on by the Corps applies only to subsection (b), which establishes a process and criteria for updating the Corps' Principles and Guidelines:

> §1962–3. Water resources principles and guidelines
> (a) National water resources planning policy
> It is the policy of the United States that all water resources projects should reflect national priorities, encourage economic development, and protect the environment by-
>
> > (1) seeking to maximize sustainable economic development;
> > (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and
> > (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.
>
> (b) Principles and guidelines
>
> > (1) Principles and guidelines defined
> > In this subsection, the term "principles and guidelines" means the principles and guidelines contained in the document prepared by the Water Resources Council pursuant to section 1962a–2 of this title, entitled "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies", and dated March 10, 1983.
> >
> > * * *
> > (7) Applicability
> > After the date of issuance of the revisions to the principles and guidelines, the revisions shall apply-

(A) to all water resources projects carried out by the Secretary, other than projects for which the Secretary has commenced a feasibility study before the date of such issuance;
(B) at the request of a non-Federal interest, to a water resources project for which the Secretary has commenced a feasibility study before the date of such issuance; and
(C) to the reevaluation or modification of a water resources project, other than a reevaluation or modification that has been commenced by the Secretary before the date of such issuance.

16 U.S.C. § 1962-3.

As a result, the National Water Resources Planning Policy applies to the Regulating Works Project. Both the Final SEIS and the Preferred Alternative violate the National Water Resources Planning Policy because the Preferred Alternative will significantly harm, not protect and restore, the functions of the Middle Mississippi River and its floodplain.

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## Conclusion

For the reasons discussed above, the Conservation Organizations urge the Corps to reject the Final SEIS and its recommended alternative. The Corps should prepare a new scientifically and legally sound SEIS that examines the full suite of actions used to maintain navigation on the Middle Mississippi River, relies on input from the National Academy of Sciences regarding river training structures and flood heights, addresses the many important comments provided during the public comment periods, and selects an alternative that protects people and wildlife.

Respectfully submitted,


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# Attachment A

U.S. Army Corps of Engineers St. Paul District, DRAFT Letter Report and Integrated Environmental Assessment, Lower Pool 2 Channel Management Study: Boulanger Bend to Lock and Dam No. 2 (DRAFT June 2017)

DRAFT Letter Report and
Integrated Environmental Assessment

# Lower Pool 2 Channel Management Study: Boulanger Bend to Lock and Dam No. 2

Upper Mississippi River
Dakota and Washington Counties, Minnesota

US Army Corps of Engineers
St. Paul District

**DRAFT June 2017**

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# Contents

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## FIGURES



## PLATES

## APPENDICES

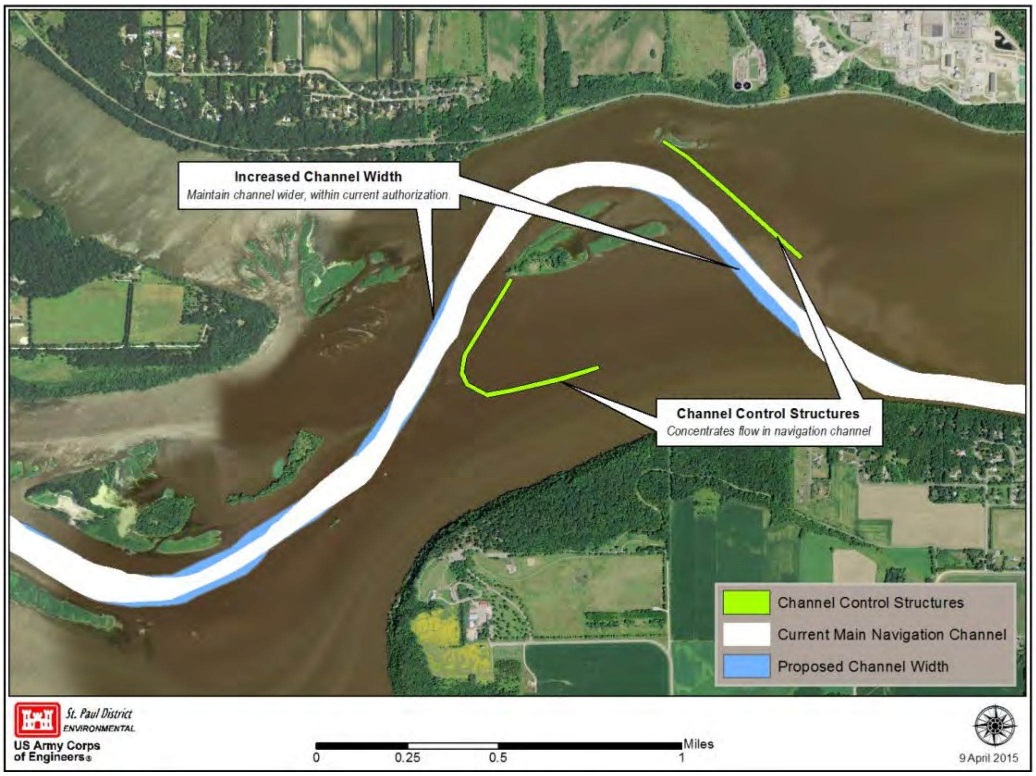
# Executive Summary

The Boulanger Bend to Lock & Dam No. 2 Study Area is located on the Mississippi River in Lower Pool 2 between river miles 815.2 and 821.0. The site lies within the Minneapolis-St. Paul metropolitan area near Cottage Grove, MN (Executive Figure 0-1).

**Executive Figure 0-1 Project Location**

This segment of the nine foot navigation channel has experienced changing sedimentation patterns that have exceeded the U.S. Army Corps of Engineers' (USACE) ability to maintain the channel. The degraded channel has adversely affected commercial navigation and is more costly for the U.S. Coast Guard to delineate and maintain safe conditions for all users.

The recommended plan is to excavate/maintain a wider channel than has been maintained in the past and that is still within authorized dimensions and to place two new rock sills (acting as training structures): one on the right descending bank from River Mile 819.5 to 819.8, and one on the left descending bank from River Mile 818.4 to 818.9. These minor changes would improve navigability and safety and reduce channel maintenance requirements. The estimated first cost for construction of this plan is $9.3 million. The proposed channel improvement is depicted in Executive Figure 0-2.



**Executive Figure 0-2  Tentatively Selected Plan Features**

The USACE in collaboration with stakeholders, identified six alternatives to consider as potential solutions to the problem:

Alternative 1 – No Action (status quo).
Alternative 2 – Revetments and Wing Dams Channel Control Structures
Alternative 3 – Nininger Slough Channel Realignment
Alternative 4 – Increased Channel Maintenance Width within Authorized Dimensions from River Miles 817.8 to 820.5
Alternative 5 – Boulanger Slough Channel Realignment
Alternative 6 – Increased Channel Maintenance Width within Authorized Dimensions from River Miles 817.8 to 820.5 with Rock Sill Training Structures

The costs, benefits, and environmental effects of these alternatives were assessed and considered in selecting an alternative and making design refinements.

The alternative providing the greatest net benefits is Alternative 6 - Increased channel maintenance width within authorized channel dimensions from River Miles 817.8 to 820.5 and construction of two new rock sill training structures. The first cost is estimated to be $9,300,000 which when amortized over 40 years at 2.875% interest equals an average annual cost of $399,000. Average annual benefits are $909,521 with net benefits of $547,000 and a benefit to cost ratio of 2.37. This alternative would require that the channel be widened from 300 feet to 350 feet at River Miles 818.0 to 820.5 and widened from 300 feet to 450 feet at River Miles 820.5 to 821.0 as shown on plate 6. In addition, two new channel rock sills (acting as training structures) would be placed on the left and right descending bank (see plate 6). These structures would help control the breakout flows and also increase channel velocity in conjunction with a wider channel so less sediment would accumulate in this part of the channel. Construction of the proposed channel widening and control structures is anticipated to require two construction seasons and would take place during the navigation season.

The proposed project would have minor adverse impacts on aesthetic values and aquatic habitat; temporary minor impacts on public safety during construction, recurring temporary minor adverse impacts on noise levels, air quality, biological productivity, and surface water quality; substantial beneficial effects on commercial navigation; and minor beneficial effects on public safety (post construction). A complete explanation of these determinations can be found in Chapter 6 of the Letter Report and Integrated Environmental Assessment.

CHAPTER 1.

# Introduction

## 1.1 Authority

The Corps of Engineers is responsible for maintaining a navigable channel on the Mississippi River. Authority for continued operation and maintenance of the Mississippi River Nine-Foot Channel project is provided in the River and Harbor Act of 1930. Original authority for the Corps of Engineers to work on the Mississippi River was provided in the River and Harbor Act of 1878. The project proposed here is authorized by the referenced legislation and its purpose is compatible with the annual Operations and Maintenance appropriation.

The 1930 Rivers and Harbors Act authorizes dredging the straight reaches of the Pool 2 channel to a width of 200 feet. Bends in the channel are authorized at increased widths. The recommended bends widths in Lower Pool 2, as recommended in the Channel Maintenance Management Plan and the Great River Environmental Action Team study are listed below:

- Boulanger Bend (River Miles 820.3 - 821.5): Maximum: 500', Suggested: 500'
- Boulanger Bend Lower Light (River Mile 818.4 - 820.3): Maximum 500', Suggested: 400'
- Nininger Bend (River Mile 817.8 - 818.4): Maximum 500', Suggested: 400'

## 1.2 Project Location and Study Area

The study area is on the Mississippi River 9-Foot Navigation Channel between River Miles 815.2 and 821, and is depicted in Figure 1-1 and as shown on Plate 1. The study area is located near the southeastern edge of the Minneapolis–St. Paul Metropolitan area. The study area is bordered by the municipalities of Cottage Grove, MN to the north and Hastings, MN to the south. The geographic scope for the environmental analysis of the proposed action and alternatives encompasses the immediate project area and surrounding floodplain.

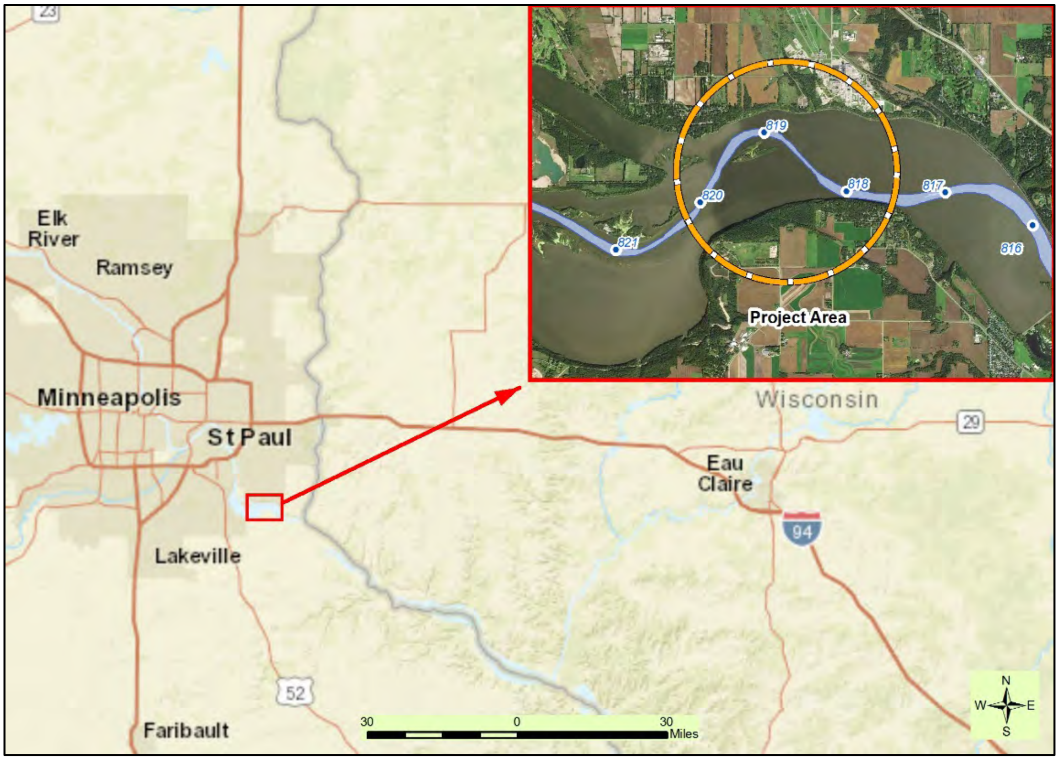



**Figure 1-1 Study Area**

## 1.3 Purpose and Need

The purpose of the project is to provide safe, reliable and efficient navigation through the Boulanger Bend area (RM 817.0 to 821.0). The USACE has been unable to maintain this stretch of channel to authorized dimensions due to increasing amounts of sedimentation and reduced O&M budgets. The reduced channel dimensions have led to reduced towboat sizes, towboat groundings, and difficulty in maintaining the U.S. Coast Guard's Aids-to-Navigation. The reduced channel dimensions were established in the mid 1990's as a result of reduced Operations and Maintenance (O&M) budgets and in order to extend the life of the temporary dredged material placement sites in Lower Pool 2 (Pine Bend, Upper Boulanger and Lower Boulanger islands). Restoring this section of channel to the full dimensions as authorized (plus bend width) would be costly, and past experience suggests that sedimentation of the area can occur very quickly following dredging, leading to wasted effort. Therefore, the USACE determined that studying potential options for optimizing channel maintenance practices in the area would be prudent.

This report documents the plan formulation efforts conducted by the U.S. Army Corps of Engineers. The study product is an implementation document in the form of an Integrated Letter Report and NEPA document in accordance with the Corps' Planning Guidance Notebook, Engineer Regulation (ER) 1105-2-100.

## 1.4 Related Studies and Reports

Numerous studies and reports are available for the Upper Mississippi River that include Pool 2. The following studies and projects addressing channel maintenance, resource management, land use, and recreational planning in pool 2 have the most relevance to this study. Additional reports and studies may be available upon request.

### *1.4.1 Nine Foot Navigation Channel Project Environmental Impact Statement*

This document, completed in 1974, assesses the environmental effects of the operation and maintenance of the 9-Foot Navigation Channel project within the St. Paul District.

### *1.4.2 Great River Environmental Action Team Study (GREAT I)*

This 9-volume report (completed in 1980) documents the results of the 5-year Great River Environmental Action Team study for the St. Paul District reach of the Mississippi River. The report contained numerous recommendations for improved management of the river, the most important of which was a 40-year plan for dredged material placement for all of the historic dredging locations in the St. Paul District. Many of the study's recommendations have been implemented. Of particular application to this study is GREAT I further study item #2 which states – "A plan should be developed to use the river's sediment transport capability to cause necessary dredging requirements to occur near long-term placement sites as environmentally and economically feasible."

### *1.4.3 Channel Maintenance Management Plan and EIS*

This 1996 plan and accompanying environmental impact statement *is* the St. Paul District's plan for management of channel maintenance. Much of the plan is devoted to the designation and design of dredged material placement sites. Included in this report is a discussion of the District's program for channel management. This channel management study for lower pool 2 is part of that program.

### *1.4.4 Lower Pool 2 Channel Management Study (DPR/EA)*

This 2003 report documents an in-depth review of channel maintenance needs and related natural resource considerations from St. Paul to Lock and Dam 2. The 2003 report briefly considered the issue addressed in this report, but recommended that it be considered independently at a later date, due to its scope.

#### *1.4.5 - Dredged Material Placement Reconnaissance Report Lower Pool 2*

This 1995 report recommended the pre-excavation of the Upper and Lower Boulanger islands and Pine Bend sites with material to be placed in the Shiely sand and gravel pits on Lower Grey Cloud Island.

#### *1.4.6 – Pigs Eye Lake Section 204*

This 2017 draft report assesses the feasibility of constructing habitat enhancement features in Pigs Eye Lake using material dredged during maintenance of the main channel of the Mississippi River navigation channel, under the authority of Section 204 of the Corps' Continuing Authorities Program. The Tentatively Selected Plan includes islands, sand benches, marsh habitat, and terrestrial plantings. Such features have the objective of improving aquatic and terrestrial habitat as well as maintaining the shoreline of Pigs Eye Lake.

#### *1.4.7 – Pool 2 Dredged Material Management Plan*

This draft report was under development in 2017. Long term planning for dredged material placement has been ongoing since the mid-1970's to maximize opportunities for beneficial use, starting with the Great River Environmental Action Team (GREAT) study from 1974 -1980. As a result of the GREAT recommendations, seventeen reconnaissance reports were developed in the mid-1980's assessing specific dredging locations and subsequent management of the material. These documents have reached the end of their planning period and are being updated on a pool-by-pool basis. Issues to be addressed in the Pool 2 Dredged Material Management Plan (DMMP) include increased sedimentation throughout Pool 2 and the lack of long-term upland dredged material placement sites available for use.

#### *1.4.8 – Lock and Dam 2 Embankment Repair*

This effort is in plan formulation and the project design will be initiated and completed in 2017, with construction award scheduled for 2018. Lock and Dam (LD) 2 is located at approximately river mile 815, near Hastings, Minnesota, between Dakota and Washington Counties. This site consists of the main lock, and one auxiliary lock on the Washington County side, and the embankment on the Dakota County side. The LD 2 embankment will undergo an embankment repair and improvement project to ensure it is protected from potential erosion due to high waters, ice action, and wind fetch.

#### *1.4.9 – Section 216 Disposition Study, Upper and Lower St. Anthony Falls and Lock and Dam 1, Upper Mississippi River*

An initial appraisal (IA) report was completed in October 2015. The IA recommended further study under the authority of Section 216 of the Flood Control Act of 1970. A Section 216 study would investigate the appropriate future disposition of three locks and dams located in Minneapolis, Minnesota, including Upper St. Anthony Falls, Lower St. Anthony Falls and Lock and Dam 1.

#### *1.4.10 - Grey Cloud Slough Restoration Feasibility Study*

This report and subsequent updates were completed by the South Washington County Watershed District and describe the efforts taken to evaluate the feasibility of restoring connectivity of a 2.8-mile long meander loop in Lower Pool 2 to the main channel. An emergency road-raise in response to flooding in 1965 resulted in the upper end of Grey Cloud Slough being disconnected from the main channel. The Washington County Watershed District is planning to reconnect this slough by installing a new bridge or culvert.

CHAPTER 2.

# Affected Environment

A description of components of the nearby environment is given here to provide a measure of the current state of the project location. This description is necessary to establish an understanding of the resources that may be affected by the alternative actions under consideration.

## 2.1 Socioeconomic Conditions

The project area is located in Pool 2 of the Upper Mississippi River approximately 20 miles downstream of St. Paul, Minnesota and is within the 13-county Minneapolis-St. Paul-Bloomington, MN/WI metropolitan statistical area (MSA). The 2010 population for this area was 3,279,833, an increase of 10.5% over the 2000 population. MSA per capita income in 2010 was $32,226 which is 9.6% greater than the state level and 20.7% greater than the nation as a whole. Important industries for employment include social services (includes education and health care – 23.2% vs. 23.2% for U.S.), trade (14.7% vs. 14.4% for U.S.), manufacturing (13.4% vs. 10.4% for U.S.), professional services (12.4% vs. 10.7% for U.S.), finance (8.5% vs. 6.6% for U.S.), and leisure and tourism (8.4% vs. 9.4% for U.S.).

#### *Land Use*

The project area is located primarily within the Mississippi River floodplain. Islands within the floodplain are mostly low-lying, flood-prone, and undeveloped. Much of these low-lying areas are significantly affected by erosion and sedimentation, which continue to slowly change the island configuration in Lower Pool 2.

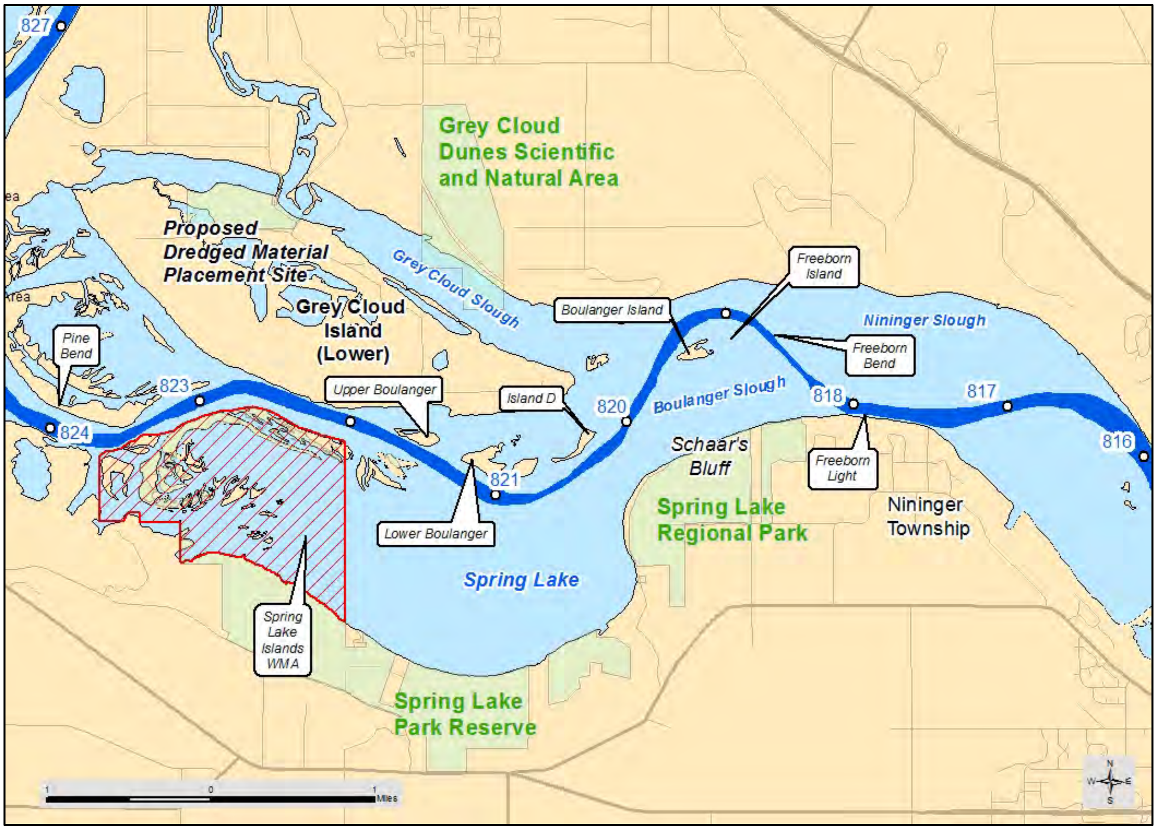



**Figure 2-1 Area Names**

Figure 2-1 identifies nearby locations referenced throughout this document. Upper and Lower Boulanger Islands are utilized by the Corps frequently for temporary dredged material placement. Lower Grey Cloud Island rises out of the floodplain, and land use is dominated by active aggregate mining, as well as previously mined and re-claimed areas. Lower Grey Cloud Island also contains several low-density residential areas at its eastern end, and a small local park on the north side.

Land use outside of the floodplain is a mix of state, county, and city parks and natural areas interspersed with low-density residential areas, including Nininger Township. Notable nearby public lands include Spring Lake Regional Park and Park Reserve, Spring Lake Islands Wildlife Management Area, and Grey Cloud Dunes Scientific Natural Area.

### 2.1.1 Commercial Navigation

The project area serves as a link between the upstream ports of Minneapolis and St. Paul, the Minnesota River, and the remaining Mississippi River navigation system downstream. Between 2007 and 2016 barge freight through Lock and

Dam 2 ranged from 4.7 to 10.2 million tons (average of 7.0 million tons). The most important commodities hauled are farm products moving from local terminals in St. Paul and on the Minnesota River to the Gulf for export. Other important commodities include fertilizer, crude materials (sand/gravel/stone, road salt, scrap metal, etc.), cement, and petroleum products (Figure 2-2).

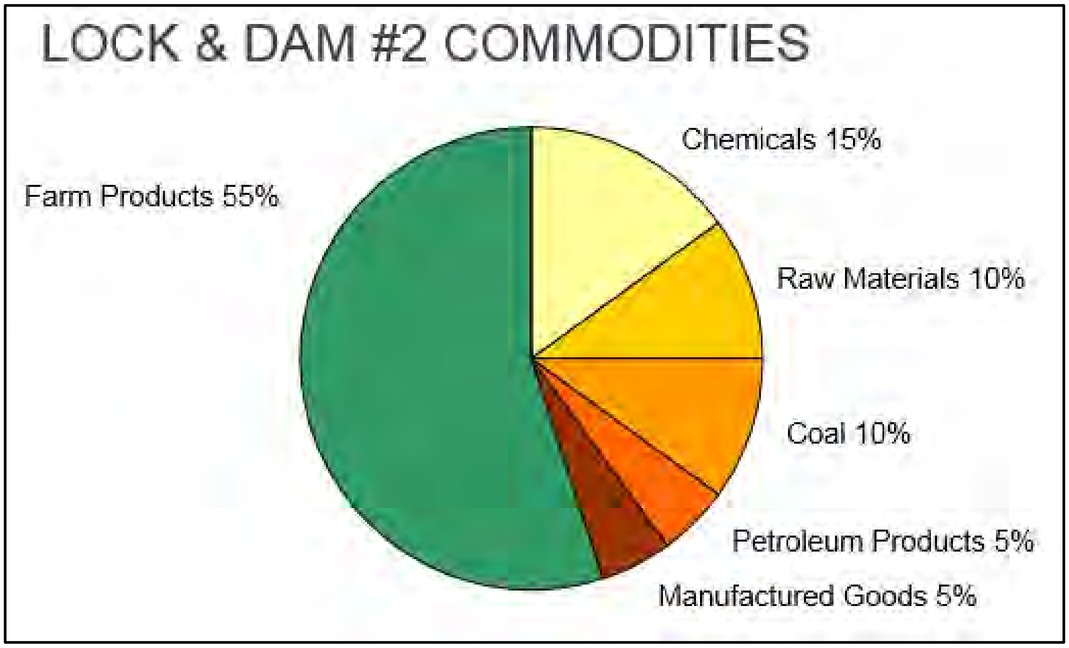



**Figure 2-2 Lock and Dam 2 Commodities**

### 2.1.2 RECREATION

In the past, poor water quality has limited the recreational value of Pool 2. Recent improvements and a persistent interest in the water quality of this region continue to increase the potential for recreational activities. As of 2004, there were 11 boat accesses and 5 marinas in Pool 2. Private docks and accesses are also scattered throughout the region, including several docks at the southern end of Boulanger Slough and a number of users that access the main navigation channel through a side channel to the northwest of the current main channel.

### 2.1.3 AESTHETIC RESOURCES

Schaar's Bluff Vista, located within Dakota County's Spring Lake Park Reserve, provides a scenic overlook of Lower Pool 2 of the Mississippi River. The top of the bluff stands approximately 100-150 feet over the river surface, and the view stretches for miles across the floodplain to the north and west.

## 2.2 Natural Resources

### 2.2.1 PHYSICAL SETTING

The Boulanger Bend project area (Project Area) is located in Lower Navigation Pool 2, Upper Mississippi River (UMR) between River Mile (RM) 817 and 821 in Washington and Dakota counties, Minnesota (Figure 1-1). The Project Area is approximately 26.5 river miles below Lock and Dam 1 in Minneapolis, 18 miles below St. Paul and 1.8 miles above Lock and Dam 2 at Hastings. Corporate jurisdictions run along the main channel sailing line with the City of Cottage Grove (Washington County) to the north and Nininger Township (Dakota County) to the south. The Project Area is within the Mississippi National River and Recreation Area (MNRRA) corridor.

The Project Area is situated in an area where the main-navigation channel meanders back and forth across the floodplain that is mostly inundated from Lock and Dam 2. The river is approximately 160 feet below the surrounding upland bluffs. The floodplain at the upstream portion of the Project Area (RM 821) is just over two miles wide with the main-navigation channel situated between Lower Grey Cloud Island and Spring Lake. Between RM 820 and Lock and Dam 2 the valley width constricts to just less than one mile in width.

Prior to river modification projects during the late Nineteenth Century and Lock and Dam 2 induced inundation after 1930, this stretch of the UMR contained islands, natural levees, point bars, backwater sloughs, lakes, ponds and wetlands (e.g., MRC 1895). The historic channel is shown in Plate 2. Nininger Slough ran north of the main-navigational channel from approximately RM 819.5 to 816.5, above islands No. 17 and No. 18. Grey Cloud Slough ran above Lower Grey Cloud Island, entering the main channel from the west near RM 819.5. Boulanger Slough ran south of the main-navigation channel from approximately RM 820.7 to 818.2, below Boulanger Island (Figure 2-3).

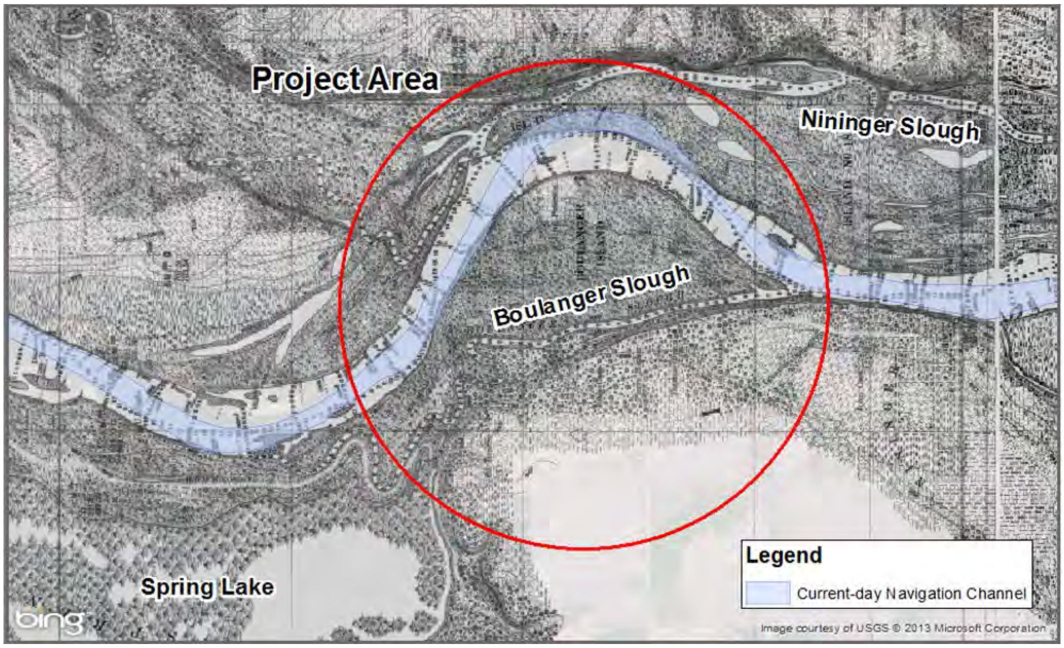



**Figure 2-3 Mississippi River Commission Map, 1890**

The Corps was assigned responsibility for Mississippi River navigation improvements with the General Survey Act of 1824, with most projects occurring below St. Louis. River training structures (e.g., bank revetments, closing structures and wing dams) appeared in the UMR after the 1866 Rivers and Harbors Act authorized a 4-foot navigation channel. However, most of the UMR river training structures were constructed after authorization of 4.5-foot channel (1878) and 6-foot channel (1907) projects (e.g., Anfinson 2003). Between RM 821 and RM 815.2 at Lock and Dam 2, 46 wing dams and approximately three miles of revetments were placed along the main channel between 1875 and 1924 (e.g., Pearson 2003). Lock and Dam 2 was authorized in 1927 and began operating in 1930, coinciding with authorization of the 9-foot channel project and subsequent river impoundment (e.g., O'Brien et al., 1992).

The UMR corridor in Lower Pool 2 includes industrial (e.g., Aggregate Industries), urban, agricultural and natural (e.g., Spring Lake Park Reserve) landscapes. While much of the floodplain is submerged (e.g., island and sloughs) and exhibits lentic characteristics, vestiges of pre-inundation landforms and habitat remain near the upper portion of the Project Area. The corridor supports commercial navigation, recreation, industrial water supply, wastewater treatment and important fish and wildlife habitat.

#### *Physiography*

The landscape of the Project Area is the result of complex interaction of glaciations and bedrock geology. The Project Area is located at the transition between the Eastern St. Croix Moraine and Rochester Till Plain physiographic areas (Wright 1972a). The area is underlain by Paleozoic era sedimentary rocks that formed in marine environments of the Hollandale Embayment. Exposed outcrops include, in descending order, Galena formation dolomitic limestone, Decorah shale, Platteville limestone, Glenwood shale and St. Peter Sandstone (e.g., Mossler 1972).

Overlying the bedrock is glacial drift and glaciofluvial deposits of various thicknesses. The till is largely from the Superior and Des Moines lobes deposited during the late Wisconsin glaciation (ca. 30,000 to 12,000 years before present [BP]) although drift from earlier glacial episodes may be present (e.g., Wright 1972b). The Superior lobe ice margin (St. Croix Moraine), just north of the Project Area, buried previous Glacial Mississippi River channels during its advance that culminated ca. 15,500 BP. The Des Moines lobe margin (Bemis Moraine), a few miles west of the Project Area, reached its furthest extent ca. 14,000 BP. Melt water from the retreating Superior and Des Moines lobes created large outwash plains north and south of the Project Area and partially excavating fill of ancestral Mississippi River channels. Subsequently, the Grantsburg sublobe, an offshoot of the Des Moines Lobe, overrode the St. Croix Moraine ca. 13,500 BP blocking southward drainage with flows diverted to the St. Croix River. With retreat of the Grantsburg sublobe, lower outlets were uncovered, establishing the modern course of the UMR. A series of downcutting events ensued that excavated previous valley fills with sustained high magnitude discharges of sediment free melt water that formed a series of terraces (e.g., Knox 2008; Wright 1972b, 1985). The lowest terrace (e.g., Lower Grey Cloud Island) was established during the drainage of Glacial Lake Agassiz through catastrophic flooding down its outlet stream Glacial River Warren (modern Minnesota River) between ca. 12,000 and 9,400 BP (e.g., Dobbs et al., 1991; Fisher 2003; Upham 1895). As glacial ice receded, diminished flows with increased sediments resulted in alluviation of the deeply incised UMR. In some areas, massive alluvial fans accumulated at tributary mouths, forming dams that produced a series of river lakes (e.g., Lake Pepin). Sediment cores indicate a sequence of riverine lakes (i.e., Vermillion, Cannon, Pepin) occupied Pool 2 that were subsequently filled with sediments of the UMR delta, prograding past Hastings ca. 6,000 BP (e.g., Blumentritt et al., 2009; Zumberge 1952). Additional Holocene environmental changes (e.g., vegetation, climate) deposited a veneer of loess over the till and contributed to remobilization of colluvial and alluvial sediments that influenced floodplain geomorphology and fluvial activity, such as lateral channel migration and Paleoflood events (e.g., Knox 1993, 1998).

#### *2.2.1.1 – Geomorphology*

Before 1875, when construction of river training structures ensued, the lower Pool 2 locality contained a diverse floodplain geomorphology characteristic of an anastimosed (ie. multiple channel) river. The area included outwash terraces (Grey Cloud Island), side channels (e.g., Grey Cloud, Boulanger, Nininger sloughs), islands (Islands 17 and 18), lakes (Balden, Baldwin, King, Spring), ponds, point bars, natural levees and marsh complexes (cf. MRC 1895). The historic channel is shown in Plate 2.

More recently, beginning in the mid-Nineteenth Century, widespread areas of vegetation (i.e., prairie and forests) were removed for grazing and cropland causing erosion and the establishment of basin-wide artificial drainage networks which have accelerated sediment deposition in the floodplain (e.g., Knox 2001). These activities, combined with construction and operation of the lock and dam system have significantly affected the geomorphic processes occurring in Lower Pool 2. Submergence of the natural levees and backwaters, combined with the shift in vegetation communities, has decreased flow resistance in the backwaters causing secondary channel formation and expansion, and leading to increased backwater conveyance over time. Under existing conditions, Baldwin Lake and Spring Lake - the two largest backwaters in Lower Pool 2 – convey significant portions of the total river discharge (approximately 18-percent and 23 percent of the flow at a total river discharge of 20,600). Downstream of Spring Lake, flow is spread out over the completely submerged floodplain, which causes a decrease in stream power in the main channel resulting in sediment deposition.

Several recent geomorphologic changes have impacted the navigation channel. The channel at Freeborn Bend has been migrating downstream. The channel between River Miles 818 and 820 is moving east. Most of the wing dams in this area have been buried due to sedimentation, and a significant portion of the revetment below river mile 819 has been inundated. Each of these factors contributes to allowing significant flows to break out of the main channel and reduce the sediment capacity of the river in the project area.

#### *2.2.1.2 Sediment Transport*

The total sediment transported by a river consists of bed material sediments and wash load sediments. The bed material is the sediment that can be found on the bed of the channel, is transported along the bed of the river or in suspension during flood events, and generally consists of larger-sized particles (e.g. sand and coarse silts). In contrast, wash load sediments are those which are not found on the bed of the channel, are transported suspended in the water column, and generally consist of smaller-sized particles (e.g. silt & clay). Deposition of material commonly occurs where water velocity is not adequate to move as much sediment as is arriving from upstream. Boulanger Bend and Freeborn Bend are areas where the bed material accumulates due to these conditions. The tightness of the bends also contributes to dredging problems because the resulting point bar encroaches into the navigation channel. This is particularly a problem given the narrower channel width that is maintained in this reach of the river.

In general, sediment sources include the upstream portion of the river under study and any tributaries that flow into that river. Sediment sinks are localized areas where stream power decreases, and include backwater areas and dredge cuts in the main navigation channel. The head of Lake Pepin is a major sediment sink and an area where the stream power drops to almost zero. Therefore, the majority of the sediment that makes its way past the other sinks upstream is destined to deposit in Lake Pepin. Major sediment sources that feed the Mississippi River above the head of Lake Pepin are the Minnesota River, the Mississippi River upstream of Anoka, and the St. Croix River. The Minnesota River is the largest source of sediment by far, contributing 1.33 million tons of suspended sediment and 0.31 million tons of bed material each year. The estimated annual contribution of the Mississippi River above Anoka is 0.19 million tons of suspended sediment and 0.14 million tons of bed material. The St. Croix River contributes a minimal amount of suspended sediments and no bed material. Overall, approximately one-million tons of sediment are deposited in Lake Pepin annually (Engstrom, 2009).

#### *2.2.1.3 Hydrology & Hydraulics*

Pool 2 extends approximately 32 river miles between Lock and Dam 1 (RM 847.5) in Minneapolis to Lock and Dam 2 (RM 815.2) at Hastings. The UMR upstream of Lock and Dam 2 extends approximately 579 miles to its source at Lake Itasca and its basin incorporates approximately 22,450 square miles. The major tributary entering Pool 2 is the Minnesota River, extending approximately 332 miles from its mouth in Pool 2 to its source at Big Stone Lake and draining approximately 17,000 square miles. Several named streams (e.g., Minnehaha, Phalen, Battle and Fish creeks) and unnamed drainages enter Pool 2. In addition, bedrock (e.g., St. Peter sandstone) and glacial outwash (e.g., springs on the south side of Spring Lake) aquifers contribute flows to the pool. The UMR through Pool 2 collectively drains approximately 39,450 square miles (MNDNR 2013b).

Discharge rates are variable across the basin, in part driven by a continental climate characterized by extremes and modern landscape use (e.g., vegetation removal, cultivation, drainage of wetlands, tile systems, stream channelization). In the period of record (from 1898 to 2015), annual peak discharges at the St. Paul gage (USGS 2016) range from a low of 9,670 cubic feet per second (cfs) in 1931 to a high of 171,000 cfs in 1965 (USACE 2004). Between 1996 and 2011, UMR annual average flows below Lock and Dam 2 at Hastings were approximately 18,000 cfs (USGS 2013). In general, mean annual flows show an increasing trend over the period of record. On the Minnesota River, average annual discharge increased 68% for the two decade time period 1991 to 2010 compared to the previous two decade period, 1971 to 1990 (Figure 2-4).

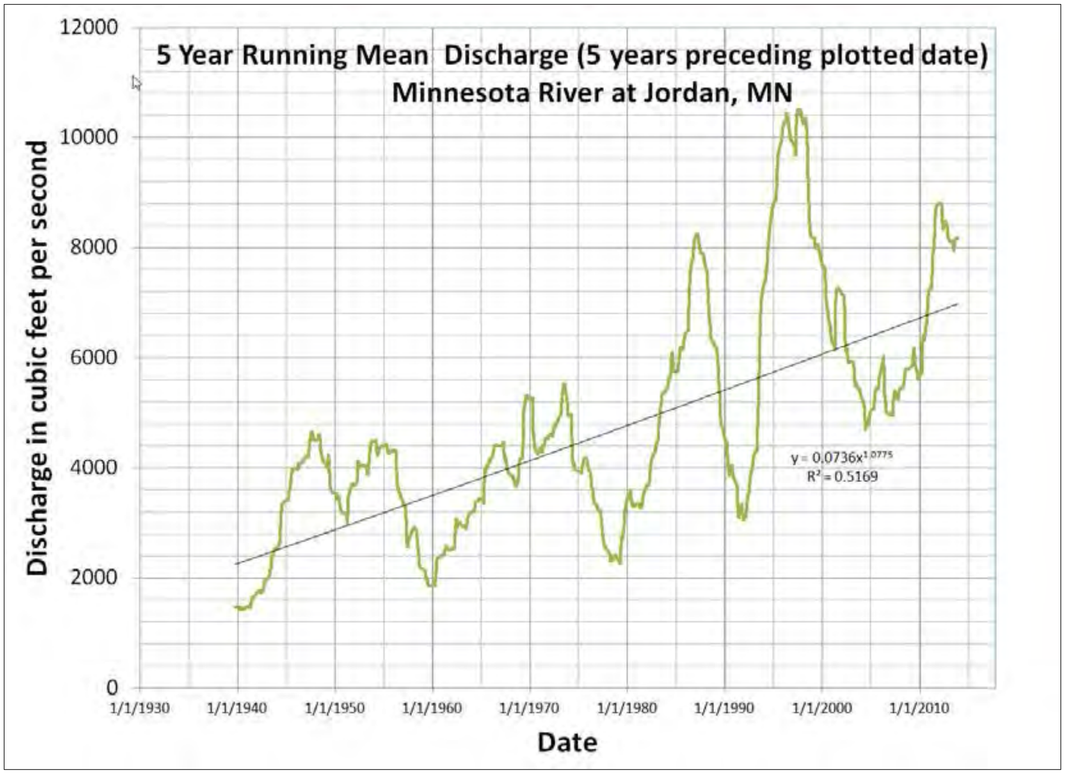



**Figure 2-4 Five Year Running Mean Discharge Minnesota River at Jordan, MN**

On the Mississippi River, average annual discharge increased 24% for the two decade time period 1991 to 2010 compared to the previous two decade period, 1971 to 1990. This shift in total annual flows coincides with the increase in dredging in Lower Pool 2 (Table 1 and Table 2). In addition, the frequency and magnitudes of extreme flood events have increased (e.g., Knox 1993, 2008).

**Table 1 Summary of Lower Pool 2 Dredge Sites Average Annual Dredge Volume 1981-2000**

| Pool | River Mile | Name | 1981 – 2000 Average Annual Total Dredge Volume ($yd^3$) |
|---|---|---|---|
| 2 | 824.3 – 824.6 | Pine Bend Landing | 2,751 |
| 2 | 822.7 – 823.7 | Pine Bend | 14,370 |
| 2 | 820.7 – 821.4 | Boulanger Bend | 18,268 |
| 2 | 819.0 – 819.8 | Boulanger Bend Lwr. Lt. | 4,213 |
| 2 | 818.0 – 818.9 | Freeborn Light | 8,821 |

**Table 2 Summary of Lower Pool 2 Dredge Sites Average Annual Dredge Volume 2001 -2016**

| Pool | River Mile | Name | 2001 – 2015 Average Annual[1] Total Dredge Volume ($yd^3$) |
|---|---|---|---|
| 2 | 824.3 – 824.6 | Pine Bend Landing | 5,010 |
| 2 | 822.7 – 823.7 | Pine Bend | 19,768 |
| 2 | 820.7 – 821.4 | Boulanger Bend | 21,101 |
| 2 | 819.0 – 819.8 | Boulanger Bend Lwr. Lt. | 6,177 |
| 2 | 818.0 – 818.9 | Freeborn Light | 20,154 |

[1]Total dredge volume includes sand volume and other materials (silts, clays, etc).

Although the surface of the water is mostly connected throughout the lower portion of the pool, stream velocity varies through the cross-section of the river. Velocity is highest in the main navigation channel, where velocities can exceed 3 feet per second during high water events. Outside of the main channel, the velocity is generally less than 1 foot per second. There are several smaller tertiary channels, including Boulanger Slough, where current velocities are somewhere between those in the channel and those in the rest of the floodplain.

The bathymetry of the study area is illustrated in plate 3.

### 2.2.2 AQUATIC HABITAT

A variety of aquatic habitats exist in the Project Area as classified by Wilcox (1993). The main navigation channel conveys the majority of river discharge with the 200 foot (61 m) wide navigation channel marked with buoys, lights and daymarks. The navigation channel is maintained so that tow boats drafting nine feet (2.6 m) can travel along its length. Typically, flows within the main channel are at a higher velocity with shifting substrates and devoid of vegetation. Main channel border areas lie between the main navigation channel and the riverbank (i.e., island shorelines) and may harbor river training structures, submerged logs and riprap that provide habitat for a variety of biota. Secondary channels (i.e., Boulanger and Nininger sloughs) are large channels that carry less flow than the main channel, and are defined by the apparent shorelines or inundated natural bank lines. Secondary channels offer variable habitats depending on flow, water depth, substrate, submerged structures, light penetration, wind, water quality, etc. Boulanger Slough ranges between 6 – 20 feet deep, and is dominated by a hard-packed clay substrate with scattered woody debris. Boulanger Slough is situated in the lower portion of Pool 2, in an area that is laterally connected across the entire floodplain because of impoundment. These contiguous impounded areas of large open water exist adjacent to and upstream of Lock and Dam 2, due to the dam's influence on water levels. Habitat in impounded areas is variable and influenced by water depth, substrate, wind, submerged structures, light penetration, water quality, flow, etc. The impounded area that separates Boulanger Slough from the current main channel generally ranges from 4-6 feet deep with a hard clay substrate overlain by a flocculent layer of silt and interspersed by woody debris. The flocculent silt is often suspended by current flowing through the area and by wind-driven waves. Contiguous backwater floodplain lakes (i.e., Spring Lake) are hydraulically connected to the main channel with low current velocity that offer a wide variety of plant and animal habitat determined by local conditions.

### 2.2.3 FISHERIES

The UMR on a whole supports a diverse assemblage of freshwater fish. Approximately 100 species of fish representing as many as 25 families have been recently sampled from the UMR between Minneapolis and Lock and Dam 10 (Schmidt & Proulx, 2009). Most of the fish present are native warmwater species. Common game species include walleye, sauger, northern pike, channel catfish, largemouth bass, bluegill, and white and black crappie. Common non-game fish include freshwater drum, carp, redhorses, buffaloes, and a wide variety of minnows. Exotic species currently residing in the UMR include common carp, grass carp, bighead carp, goldfish, and rainbow and brown trout.

In comparison to other UMR pools, Pool 2 supports a moderate fishery. Surveys have indicated that fish species diversity tends to increase from upstream to downstream between Minneapolis and Lock and Dam 10, reflecting an increase in backwater areas, improved water quality, and improved habitat (Schmidt & Proulx, 2009; Pitlo et al., 1995). Upper Pool 2 provides mostly main channel and main channel border habitat because the floodplain is restricted by bluffs throughout the upper portion. In lower Pool 2 where the floodplain expands, there are a few backwater areas and side channels available. Water quality also influences the fish community in Pool 2 – high turbidity and high nutrient levels decrease the suitability of this habitat for some fish (See also chapter 2.2.8 – Water Quality).

The project area is in the lower, impounded portion of the pool, where the majority of the floodplain is submerged. The most common habitat types are main channel, main channel border, secondary channel, tertiary channel, and artificially impounded river-lake. Main channel habitats typically provide swift current, deep water, and coarse sand, gravel, or rock bottom. Freshwater drum and channel catfish are common commercial fish that use this habitat type. Game fish that use the main channel include walleye, sauger, smallmouth bass, and white bass.

In contrast to main channel and main channel border habitat, river lakes and backwaters in the impounded reach of the river typically have little current and provide habitat for fish species adapted to a lentic environment. Commercial species that commonly utilize backwater habitat include carp, bigmouth buffalo, and catfish, while typical sport fish include northern pike, largemouth bass, crappies, and bluegill.

Secondary and tertiary channels are channels that carry less flow than the main channel. They represent a transition between main channel and backwater habitats. Secondary channels of the Mississippi River tend to provide more varied habitat and support a more diverse fish assemblage than main channel habitat (Weigel, Lyons, & Rasmussen, 2006).

### 2.2.4 AQUATIC INVERTEBRATES

The Upper Mississippi River supports 48 known species of native freshwater mussels. Freshwater mussels are important food items for some mammals like raccoon and muskrat, as well as for some species of fish. They also play a role in maintaining water quality by filtering contaminants and feeding on algae and other small floating particles.

Historically, as many as 41 species have occurred in Pool 2. Presently there are 29 known species living, ten of which are now either federally or state protected. Surveys in the late 1970s revealed that the mussel fauna in the UMR above Lake

Pepin (including Pool 2) had declined significantly since the early 1900s – presumably due to water pollution (Fuller 1980). Since then, the Minnesota Department of Natural Resources conducted mussel surveys in the UMR between the Coon Rapids Pool and Upper Pool 3 in 2000 and 2001 and reported a "recovering mussel community" compared to those reported in the 1970s. These surveys recovered 22 of the 29 species known to be living in Pool 2 and noted areas of high density as well as evidence of recent recruitment (Kelner and Davis 2008).

### 2.2.5 THREATENED AND ENDANGERED SPECIES

The U.S. Fish and Wildlife Service's "Information for Planning and Conservation (IPaC) website was consulted on November 3, 2016 to determine if any proposed, candidate, threatened, or endangered species occurred within the project area. The results indicated that a total of four Federally-listed endangered species and two Federally-listed threatened species may occur in in the vicinity of the proposed project. Three species listed as endangered are freshwater mussels: the Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose (*Plethobasus cyphyus*), and snuffbox (*Epioblasma triquetra*). The other species listed as endangered is an insect – the rusty-patched bumble bee (*Bombus affinus*). Species listed as threatened include one mammal - the northern long-eared bat (*Myotis septentrionalis*), and one flowering plant – the prairie bush-clover (*Lespedeza leptostachya*). These species and their federal status as of January 2017 are listed in Table 3, at the end of this section.

Suitable habitat for the Higgins' eye pearlymussel includes areas of various stable substrates in large streams and rivers (U.S. Fish and Wildlife Service 2004). Although rare, live specimens of the Higgins' eye pearlymussel have been found recently in Pool 2. Higgins' eye are most commonly associated with high-density and diverse mussel beds.

Suitable habitat for the sheepnose is similar to that for the Higgins' eye (Ohio River Valley Ecosystem Team 2002). The Federally-listed endangered spectaclecase is a habitat specialist, found in large rivers in a variety of substrates, but particularly within microhabitats sheltered from strong currents (Butler 2002). The spectaclecase and sheepnose are not known to be extant in Pool 2 of the Upper Mississippi River (Kelner, 2015).

The rusty patched bumble bee occupies grasslands and tallgrass prairies of the Upper Midwest and Northeast. This bumble bee needs areas that provide food (nectar and pollen from flowers), nesting sites (underground and abandoned rodent cavities or clumps of grasses above ground), and overwintering sites for hibernating queens (undisturbed soil) (USFWS 2016).

Suitable habitat for the northern long-eared bat is variable depending on the season and the life stage of the individual. In the summer, these bats often roost under the bark of tree species such as maples and ashes within diverse mixed-age and mixed-species tree stands, commonly close to wetlands. In the winter, the northern long-eared bat hibernates in caves and abandoned mines. During periods of migration and foraging, these bats tend to use the 'edge habitat' where a transition between two types of vegetation occurs (Wisconsin DNR 2013b).

Suitable habitat for the prairie bush clover includes well-drained soils in prairies of the Midwest.

**Table 3 Federally-Protected Species that May Occur Within Project Area**

| Common Name | Scientific Name | Fed Status |
|---|---|---|
| Higgins eye | *Lampsilis higginsii* | END |
| Sheepnose | *Plethobasus cyphyus* | END |
| Spectaclecase | *Epioblasma triquetra* | END |
| Rusty patched bumblebee | *Bombus affinus* | END |
| Northern long-eared bat | *Myotis seprentrionalis* | THR |
| Prairie bush clover | *Lespedeza leptostachya* | THR |

(END = Endangered; THR = Threatened)

***Species of Local Significance***

A number of species that are listed by the State Minnesota as endangered or threatened have been historically documented in the vicinity of the project area. These species include freshwater mussels, a fish, a plant, and a bird, and are listed in Table 4. The table includes species historically documented within one mile of the proposed project features, based on a search of the Minnesota Natural Heritage Information System, conducted December 2016.

The historically-documented mussel species were compared with the results of recent mussel survey efforts in Lower Pool 2 to determine which species have recent records of occurrence. Of the historically-recorded mussel species, four have not been found live within Lower Pool 2 in thirty-five or more years: the mucket (Actinonaias ligamentina), elephant ear (Elliptio crassidens), spike (Elliptio dilatata), and ebonyshell (Fusconaia ebena). Two of these species – the mucket and spike – have been reintroduced in Upper Pool 2, but there has been no evidence of recruitment within Lower Pool 2. Therefore, it is assumed that these species do not currently occur in the proposed project area. The remaining eight species have been recently collected within Lower Pool 2; three of which were found in the surveys conducted specifically for the proposed project: the pistolgrip (Tritogonia verrucosa), butterfly (Ellipsaria lineolata), and wartyback (Quadrula nodulata).

**Table 4 Minnesota State-Protected Species with records within one-mile of the Project Area.**

| Common Name | Scientific Name | Fed Status | MN Status |
|---|---|---|---|
| *Mussels* | | | |
| Ebonyshell [1] | *Fusconaia ebena* | | END |
| Elephant ear [1] | *Elliptio crassidens* | | END |
| Higgins eye | *Lampsilis higginsii* | END | END |
| >Pistolgrip | *Tritogonia verrucosa* | | END |
| Rock pocketbook | *Arcidens confragosus* | | END |
| Washboard | *Megalonaias nervosa* | | END |
| >Butterfly | *Ellipsaria lineolata* | | THR |
| Fawnsfoot | *Truncilla donaciformis* | | THR |
| Monkeyface | *Quadrula metanevra* | | THR |
| Mucket [1] | *Actinonaias ligamentina* | | THR |
| Spike [1] | *Elliptio dilatata* | | THR |
| >Wartyback | *Quadrula nodulata* | | THR |
| *Fish* | | | |
| Paddlefish | *Polyodon spathula* | | THR |
| *Plants* | | | |
| Kitten-tails | *Besseya bullii* | | THR |
| *Birds* | | | |
| Loggerhead Shrike | *Lanius ludovicianus* | | END |

(THR = Threatened; END = Endangered)
> Denotes species collected live in project footprint survey
[1] *Species not collected live in Pool 2 since approximately 1980*



In addition to identifying species that receive state protection, the Minnesota NHIS database also identifies species of special conservation concern, native plant communities, and other natural features. Table 5 lists these features that were identified as existing within one mile of the project area.

**Table 5 Other Rare Species and Native Plant Communities within one-mile of Project Area**

| Common Name | Scientific Name |
|---|---|
| *Species of Special Concern* | |
| American eel | *Anguilla rostrata* |
| American ginseng | *Panax quinquefolius* |
| Perigrine falcon | *Falco perigrinus* |
| Pirate perch | *Aphredoderus sayanus* |
| *Watchlist* | |
| Hickorynut | *Obovaria olivaria* |
| Laurentian bladder fern | *Cystopteris laurentiana* |
| Long-bearded hawkweed | *Hieracium longipilum* |
| Western foxsnake | *Pantherophis ramspotti* |
| **Terrestrial Communities** | |
| Dry Sand – Gravel Oak Savanna (Southern) Type | |
| Dry Sand – Gravel Prairie (Southern) | |
| Oak Forest (Southeast) Mesic Subtype | |
| Southern Seepage Meadow/ Carr Class | |
| Southern Wet Cliff Class | |
| White Pine – Oak – Sugar Maple Forest Type | |
| Willow Sandbar Shrubland (River) Type | |



### 2.2.6 AQUATIC VEGETATION

Aquatic vegetation consists of a wide variety of emergent and submerged flora typical of shallow open-water, shallow marsh and deep marsh communities (e.g., Eggers and Reed 1997; MNDNR 2013a). Shallow, open-water areas are typically encountered along the main channel border and support submergent and floating plants, such as water lilies, pondweed and wild celery. Shallow marshes are characterized by emergent plants, such as cattails, bulrushes and arrowhead. Deep marshes include submergent, emergent and floating plants. Shallow and deep marshes are typically located along tertiary channels and backwater areas. Dense stands of the invasive purple loosestrife are present in wetlands throughout the pool. Wetland areas support a wide variety of fish and wildlife.

Aquatic vegetation is often more prevalent at the upstream portions of navigation pools and less prevalent in the downstream portions. Pool 2 is no exception.

Downstream of Spring Lake in the inundated portion of the pool, aquatic vegetation is scarce and tends to occur mostly in areas almost entirely protected by islands. In this area, wind and wave action, combined with the high turbidity levels contribute to these conditions.

### 2.2.7 BIRDS

At least 300 species of birds, about 60 percent of the total number of species in the conterminous United States, are known to use the UMR. The UMR valley is a major bird migration corridor for the mid-continental United States through which an estimated 40 percent of the continent's waterfowl migrate (U.S. Fish and Wildlife Service, 2006). The Mississippi Flyway also provides migration habitat for songbirds, colonial nesting birds, secretive marsh birds, and raptors, making the UMR a resource of national and international importance.

Waterfowl are considered particularly important due to their large numbers and visibility. Approximately 30 species of waterfowl use the UMR. Widgeon, mallards, scaup, canvasbacks, and wood ducks are species which commonly use the river. Based on weekly waterfowl surveys conducted by the USFWS during the fall of 2011, birds which utilized the lower Pool 2 area in high numbers included Canada geese, mallards, ringnecks, cormorants, white pelicans, and coots.

### 2.2.8 WATER QUALITY

According to the MPCA's online 'Impaired Waters Viewer' tool (accessible at: https://www.pca.state.mn.us/water/impaired-waters-viewer-iwav), the Mississippi River between Rock Island Bridge to Lock and Dam 2 (RM 830 to 815.2) is "suitable for swimming and wading, with low bacteria levels throughout the open water season. Concentrations of PCB, PFOS, and mercury in fish tissue, and mercury in the water column exceed the water quality standard". In 2009, a MPCA water quality assessment of Lower Pool 2 listed the reach as having impaired beneficial use for aquatic life caused by turbidity. Currently, there are two TMDLs that cover Lower Pool 2: Upper Mississippi River Bacteria TMDL and the Lake Pepin Watershed Nutrients TMDL.

#### *Sediment Quality*

Sediment quality in Lower Pool 2 is relatively poor compared with other pools in the Upper Mississippi River. Lower Pool 2 seems to be a sink for surrounding and upstream contaminate sources due to a decrease in water velocity and high silt content of the sediments. In general, silts have a higher affinity to attach to contaminates than larger mineral sands. Historical USACE grain size analyses of the sediment in the navigational channel have shown silts contents of around 75% in the stretch of river around Boulanger Bend (rm 819.7 to 818.5). Off-channel sediments in the vicinity are commonly found to be over 90% silts.

To ascertain the extent of sediment pollution in the Boulanger Bend area, USACE staff completed a sediment survey in 2015 within the footprint of the preferred project plan and compared the results to MPCA's soil reference values (SRVs) and sediment quality targets (SQTs) (See Appendix H Sediment Quality Analysis for further testing details). The MPCA's SRVs are limits on pollutant concentrations for material being placed at two types of upland sites, either Recreational/Residential or Commercial/Industrial. The MPCA is currently in the process of updating their values for SRVs, and therefore the Draft values from August 2016 are used in this report. The Draft values are expected to be finalized in 2017. The SQTs (Level I and Level II) are guidelines used to identify contaminant concentrations that cause harmful effects on sediment-dwelling organisms. Level I SQTs are the concentrations which will provide a high level of protection for benthic invertebrates. Level II SQTs are the concentrations which will provide a moderate level of protection for benthic invertebrates. Results of the 2015 survey showed that the sediment in the preferred project area was fairly clean. Exceedances were restricted to only polycyclic aromatic hydrocarbons (PAHs) and/or metals and except for one sample (15-70M/1), which is from a location that will be buried by fill during project construction, there were no exceedances of Level II SQTs or SRVs. The most abundant contaminant that was detected at levels above the SQT I guidelines was cadmium. Cadmium has been widely dispersed into the environment through the air by its mining and smelting as well as by other man-made routes: usage of phosphate fertilizers, presence in sewage sludge, and various industrial uses such as NiCd batteries, plating, pigments and plastics (ATSDR 1999).

### 2.2.9 TERRESTRIAL HABITAT

The project area is situated within the Eastern Broadleaf Forest Province where the pre-European settlement vegetation consisted of tallgrass prairie and oak savanna (e.g., Marschner 1974). During the Holocene, a succession of vegetation regimes were established after deglaciation in response to climate change driven in part by seasonal air mass boundaries originating from the Arctic, Pacific Ocean and the Gulf of Mexico (e.g., Bryson 1966). Tundra was replaced by a boreal spruce forest, succeeded by pine forests before warm and drier conditions expanded prairie vegetation ca. 8,000 BP. Oak increased with a return of cool and moist conditions and the pre-European prairie-forest ecotone was in place by ca. 4,000 BP (e.g., Blumentritt et al., 2009; Wright 1972b, 1992; Wright et al., 1998). With more stable conditions following episodes of paleofloods, floodplain forests and productive wetland communities were established by the Late Holocene (e.g., Baker et al., 2001; Knox 1993; Wright et al 1998).

#### *Floodplain Vegetation*

Alluvial bottomlands host wet floodplain forests dominated by maple and elm as well as river shore communities typically dominated by willows. Higher elevation landforms support more xeric communities (e.g., MNDNR 2013a). These habitats support a wide of variety of fauna.

#### *Terrestrial Vegetation*

In general, tallgrass prairie and oak savanna occupy uplands and portions of terraces. Maple-basswood dominated forests occupy slopes and ravines in areas protected from fire that occasionally include relict pine stands. Bedrock exposures support an assortment of cliff and talus communities, such as lichens, ferns and patchy trees and shrubs (e.g., MNDNR 2013a).

### 2.2.10 AIR QUALITY

The U.S. Environmental Protection Agency (EPA) is required by the Clean Air Act to establish air quality standards that primarily protect human health. These National Ambient Air Quality Standards (NAAQS) regulate six major air contaminants across the United States. When an area meets criteria for each of the six contaminants, it is called an 'attainment area' for that contaminant; those areas that do not meet the criteria are called 'nonattainment areas.' Washington County is classified as an attainment area for each of the six contaminants and is therefore not a region of impaired ambient air quality (EPA 2011). A portion of Dakota County (approximately 4 miles away from the project site) is classified as a nonattainment area for lead, and the rest of the county is designated as an attainment area for each of the six contaminants (MPCA 2009). This designation means that the project area has relatively few air pollution sources of concern.

## 2.3 Cultural Resources

The Pool 2 locality contains numerous cultural resources indicating continual human occupation over approximately the last 13,000 years. Cultural resources include a variety of precontact and historic archaeological sites. Precontact sites include lithic and artifact scatters, village sites, petroglyphs, and burial mounds. Historic sites include standing structures, early town sites, forts, shipwrecks, bridges and river training structures. Cultural resources are situated on a variety of landforms, such as uplands, terraces, cliffs, islands and the river floodplain. Several cultural resource sites within this locality are listed on the National Register of Historic Places (NRHP) or are eligible for listing on the NRHP. In addition, the pool contains several Historic Districts.

Interest in the archaeological record of the upper Mississippi River Valley, including the Pool 2 area, has been ongoing since the late nineteenth century (e.g., Anfinson et al 2003; Brower 1903; Winchell 1911). Early research in the area centered on the contents of burial mounds and who built them, such as amateur excavations at the Dayton's Bluff mounds (21RA5) just east of downtown St. Paul (e.g., Arzigian and Stevenson 2003). By the early twentieth century most practitioners rejected the popular notion that a race of non-American Indians constructed the mounds and non-scientific investigations gave way to systematic mapping and excavation (e.g., Anfinson et al. 2003). Despite an awareness of cultural resources in the pool, no comprehensive pre-impoundment survey was completed prior to construction and subsequent operation of Lock and Dam 2 in 1930. Modern archaeological research within the pool began during the 1940s with research projects by the University of Minnesota and the St. Paul Science Museum (now the Science Museum of Minnesota) (Johnson 1959; Johnson and Taylor 1956). In the 1970s, the Corps sponsored a survey of dredged material placement sites and the Minnesota Historical Society completed investigations at Grey Cloud Island (Birk 1973; Johnson and Hudak 1975). Since the last quarter of the twentieth century, numerous cultural resource investigations have been completed within the Pool 2 locality near the Project Area as well as several literature based overviews (e.g., Anfinson et al 2003; Dobbs et al 1991; Flemming and Hager 2010; Gronhovd and O'Brien 2008a, 2008b; Harrison 2010a, 2010b; Jalbert et. al. 1996; Jensen 1992; Madigan and Shermer 2001; Meyer and Schmidt 1995; Pearson 2003; Vogel and Stanley 1987; Withrow, et al 1987; Woolworth 1976).

Only one previous investigation in Pool 2 included areas within the project area: Pearson (2003) for an overview and NRHP evaluation for channel structures. In the larger context of Upper Mississippi River constriction works and wing dams appear to be eligible for listing on the NRHP. As navigation features, they have been periodically modified as dictated by river conditions and navigation needs, especially after the 9-foot channel project began operation in the 1930s. In some cases, they were reduced or extended in length and height or outright removed. Under the current operations, the wing dams are submerged, although portions of some of the wing dams may be visible during low water events. While a number of wing dams are extant within the project area none will be affected by the undertaking.

No cultural resources have been identified within the project area. However, no comprehensive surveys have been conducted along island shorelines or for submerged high probability landforms (e.g., natural levees) in the project area. A total of eight recorded cultural resource sites exist within one mile of the project area, all located in upland settings (Table 5). Several of these sites are listed on or eligible for listing on the NRHP. The Shilling Site (21WA1), approximately one-half mile west of the project area, is designated as an archaeological district.

**Table 6 Recorded Cultural Resources within One Mile of the Project Area**

| Site Number | Site Name | Site Type | Cultural Period | Setting |
|---|---|---|---|---|
| 21WA1 | Shilling AD | Mounds/Village | Precontact | Low terrace |
| 21WA8 | Curry | Mounds | Precontact | Upland |
| 21WA55 | Rick Lewis | Foundations | Historic | Shoreline |
| 21DK1 | Sorg | Village | Precontact | Low Terrace |
| 21DK2 | Lee Mill Cave | Camp | Precontact | Cliff |
| 21DK7 | Nininger | Mounds | Precontact | Upland |
| 21DKh | Niniger Mill | Mill | Historic | Low Terrace |
| DK-NIN-001 | Good Templars Hall | Standing Structure | Historic | Upland |

## 2.4 Resource Significance

The Water Resources Council's Principles and Guidelines (1983) define significance in terms of institutional, public, and technical recognition.

Institutional Recognition: In 1986, U.S. Congress designated the Upper Mississippi River System as both a "…nationally significant ecosystem and a nationally significant navigation system…" in Section 1103 of the WRDA 1986. The National Research Council's Committee on Restoration of Aquatic Ecosystems targeted the Upper Mississippi River for restoration as one of only three large river-floodplain ecosystems so designated.

Public Recognition: The public recognizes the Upper Mississippi River as a nationally, regionally, and locally significant resource. Some of the public services the Mississippi River provides include aesthetics, recreation, science, education, raw materials, and flood regulation. In general, these services identified show the wide range of uses from the river, which extend beyond the ecological health of the Upper Mississippi River, and directly relate to public welfare and long-term ecological health of the region.

Technical Recognition: Numerous scientific analyses and long-term evaluations of the Upper Mississippi River have documented its significant ecological resources. Since the early 20th century, researchers, government agencies, and private groups have studied the large river floodplain system.

The Upper Mississippi River ecosystem consists of hundreds of thousands of acres of bottomland forest, islands, backwaters, side channels, and wetlands, all of which support more than 300 species of birds; 57 species of mammals; 45 species of amphibians and reptiles; 150 species of fish; and nearly 50 species of mussels. More than 40 percent of North America's migratory waterfowl and shorebirds depends on the food resources and other life requisites (shelter, nesting habitats, etc.) that the ecosystem provides.

## 2.5 Expected Future Without Project Conditions

If no action is taken at the study area, the channel conditions will remain degraded and may worsen over time as a result of changed sedimentation patterns. The degraded channel will continue to negatively impact commercial navigation, to result in higher maintenance dredging costs, and to strain the U.S. Coast Guard's ability to delineate safe conditions for all users.

### 2.5.1 Climate Change

The U.S. Global Research Program's Third National Climate Assessment was completed in 2014. It states that:

> "in the Upper Midwest extreme heat, heavy downpours, and flooding will affect infrastructure, health, agriculture, forestry, transportation, air and water quality, and more. Climate change will tend to amplify existing risks climate poses to people, ecosystems, and infrastructure. Climate change also alters pests and disease prevalence, competition from non-native or opportunistic native species, ecosystem disturbances, land-use change, landscape fragmentation, atmospheric and watershed pollutants, and economic shocks such as crop failures, reduced yields, or toxic blooms of algae due to extreme weather events."

Important driving climate variables include seasonal precipitation and air temperature and both variables are expected to increase in the future. In the project area this could alter hydrologic characteristics such as the magnitude, duration, and timing of river flows; water quality variables such as temperature, dissolved oxygen, and turbidity; and geomorphic processes like sediment deposition and secondary channel erosion.

While climate change modeling and assessment at the project scale relies on qualitative information at this point in time, the existing hydrologic record can provide some insight on recent changes.  An analysis of the Mississippi River discharge record at the nearby USGS gage at Prescott, Wisconsin indicates that the average annual discharge and the number of days of overbank flows per year have increased over the last 3 or 4 decades.  Most of the increase is occurring during the spring and early summer months with smaller increases in the fall. During the winter months of December, January, and February overbank flooding has not occurred.  Given that climate modeling indicates a wetter climate in the future, the increased flows indicated in the recent hydrologic record are likely to persist and potentially get worse.  These changes will be considered during project planning and design.

CHAPTER 3.

# Planning Process

Plan formulation has been conducted in accordance with the six-step planning process described in Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies (1983) and the Planning Guidance Notebook (ER 1105-2-100, dated April 2000). The six steps in the iterative plan formulation process are:

1. Specify the water and related land resources problems and opportunities of the study area;
2. Inventory and forecast existing conditions;
3. Formulate alternative plans;
4. Evaluate alternative plans;
5. Compare alternative plans; and
6. Select the recommended plan.

The basis for selection of the recommended plan is fully documented below, including the logic used in the plan formulation and selection process.

## 3.1 Problem and Opportunity Identification

One of the critical steps in the planning process is the identification of problems and opportunities within the study area. Problems are issues that will be addressed with the project and opportunities are future desirable conditions. Opportunities can be directly related to solving the problem at hand, but can also be ancillary to the identified problem. Taking the existing and forecasted future conditions into consideration, the following water resource related problems and opportunities were identified:

**The problems in Lower Pool 2 are:**

- Reduced commercial navigability,
- Increased sedimentation, and therefore increased dredging and costs, and
- Increased costs to maintain aids to navigation.

The commercial navigation industry has identified reduced navigability of this stretch as a problem. Historically, the bend was maintained at a width that would allow passage of fifteen-barge tows – the standard operating size on the UMR. The difficulty of navigating the sharp bend combined with the quickly-changing local conditions has led to over 70 tow-boat groundings at Boulanger Bend since 1990 (Figure 3-1). As the maintained channel width has decreased, tows have been forced to reduce the number of barges being transported from fifteen to twelve to safely maneuver through this area, which has reduced the efficiency of barge transportation through this segment of the river.

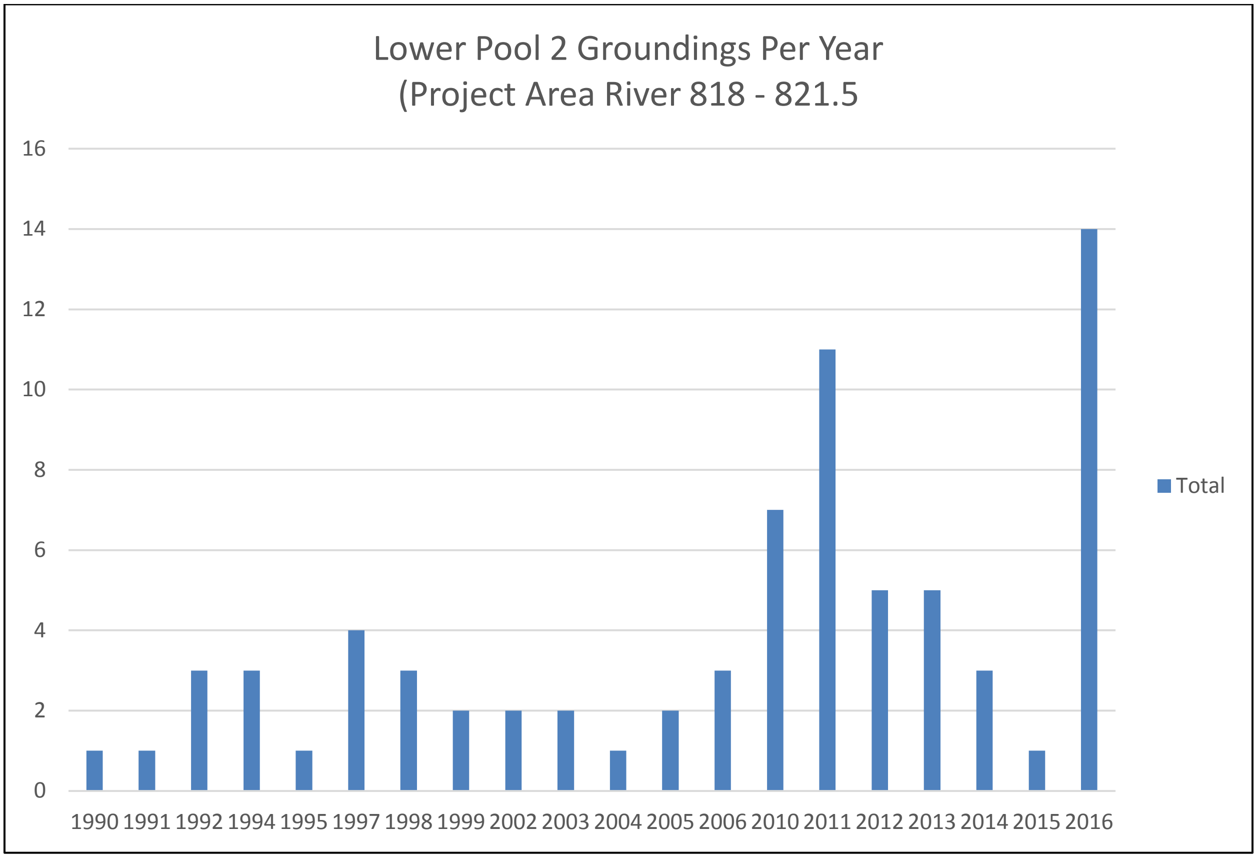



**Figure 3-1 Lower Pool 2 Tow Boat Groundings 1990 – 2016**

In recent years, sediment deposition in the Boulanger Bend area has increased. Historically, the area has required dredging approximately once every three years, but dredging has now been necessary annually for the past eight years (2009 – 2016). The quantity of sediment dredged at Boulanger Bend in the past eight years has been equivalent to the amount that would have been dredged over an average 11-year historical period. This additional dredging and placement of material has resulted in increased costs for the Corps. It is anticipated that under the future without project conditions, the observed trend of increased dredging is likely to continue, and would require increased expenditures to maintain. Dredge cuts since the 1970s are shown in Plate 5.

The U.S. Coast Guard maintains Aids to Navigation (buoys and day marks) in this reach of Pool 2, and has expressed their concerns regarding the difficulty and expense to maintain these features. Frequent changes to the channel conditions and buoys displaced by barge collisions necessitate many trips to the area for maintenance.

**Opportunities in Lower Pool 2 are to:**

- Provide a safe and reliable navigation channel,
- Improve aquatic vegetation growth,
- Enhance recreational opportunities,

A safe and reliable navigation channel provides multiple types of users with passage for purposes of commerce, transportation, or recreation. Under the current maintenance strategy, conditions are frequently unsafe and unreliable, particularly during times when vessels are grounded and obstructing the channel. A safe and reliable channel would optimally consist of the suggested and authorized dimensions and would require minimal and manageable maintenance.

Lower Pool 2, like the lower portion of many navigation pools, has been inundated due to the construction of dams, and has lost most of its natural islands and physical character. This has resulted in large lake-like areas where excessive wind fetch leads to waves and the frequent re-suspension of sediment. This, combined with the uniquely large sediment load delivered to Pool 2 by the Minnesota River makes aquatic vegetation relatively rare in Lower Pool 2.

The effects of inundation also impact recreational use. Waves that result from the high wind fetch can make this stretch of river difficult for a small boat to navigate.

## 3.2 Project Goals and Objectives

Planning goals are broad, conceptual statements that describe the ultimate and overarching purposes for the study. The overarching national goal of water resources planning is to contribute to national economic development while protecting the nation's environment. The overall goal of this project is to maintain a commercially navigable channel in the Upper Mississippi River.

Planning objectives are concise and focused descriptions of what an alternative plan should achieve. They are developed based on the problems and opportunities that are identified for a study. Clear objectives are used to identify measures and formulate alternatives that will achieve the project’s goals. The guidance for developing objectives is provided in USACE planning guidance ER 1105-2-100 and specifies that objectives must be clearly defined, must provide information on the effect desired, the subject of the objective, the location where the effect will occur and the timing and duration of the effect. For the purpose of this report, the timing or duration of the objectives is assumed to be the 40 year period of analysis. The project life is set at 40 years. This is based on the Channel Maintenance Management Plan (CMMP) and associated EIS which were both based on a 40-year planning period. This time period is consistent with the GREAT I study and is meant to address a sufficient time period for measuring the long-term impacts of channel maintenance at a given location.

The objectives for the proposed project are:

- Minimize channel maintenance costs associated with sedimentation in Lower Pool 2.

- Provide an economically-justified level of commercial navigation in Lower Pool 2.
- Minimize maintenance costs of U.S. Coast Guard's Aids to Navigation in Lower Pool 2

## 3.3 Planning Constraints and Assumptions

Planning constraints are temporary or permanent limits imposed on the scope of the planning process and choice of solutions. Constraints represent restrictions that should not be violated. Planning assumptions underlie the logic of the planning process. Although these states of nature and anticipated human activities are not certain, they are assumed to apply in the future. The planning constraints and assumptions identified in this study are specified as follows:

***Constraints***

- Flood Stage Impacts – Any project features should not increase flood heights or adversely affect private property or infrastructure.
- A Federally-listed endangered freshwater mussel species, the Higgins' eye pearlymussel (*Lampsilis higginsii*), was found near the project location in 2010. Any project developed in Lower Pool 2 must avoid unnecessarily adversely affecting this species, or any other Federally-listed endangered species.
- Contaminated Sediments – Avoid or minimize disturbance of contaminated sediments

***Assumptions***

- Funding for the operation and maintenance of the 9 foot channel has declined in recent years and is not expected to improve markedly in the near future.
- Nearby placement sites for dredged material are limited and it is expected that it will be increasingly difficult to secure them in the future.

## 3.4 Alternative Measures

A management measure is a feature (a structural element that requires construction or assembly on-site) or an activity (a nonstructural action) that can be combined with other management measures to form alternative plans. Based on management measures, the alternative plans were developed to address study area problems, to capitalize upon study area opportunities, and to meet the goals and objectives of the study. Alternative plans are different combinations of various sizes and scales of alternative measures that would contribute to attaining the planning objectives. An alternative measure may stand alone as an alternative plan that can be implemented independently of other measures, resulting in some achievement of the planning objectives. Problems, objectives, and measures are summarized in Table 6 at the end of this chapter.

### 3.4.1 NO ACTION

The no action measure is defined as no implementation of a project to modify channel conditions in the study area. This measure is carried forward for further consideration.

### 3.4.2 CHANNEL CONTROL STRUCTURES

Channel control structures could be used to better transport sediment through the study area. Modifications to existing channel control structures could be effective in concentrating the flow through the main navigation channel and preventing sediment from dropping out of suspension around Boulanger Bend. New structures could also be constructed, such as revetments, wing dams, or rock sills, to help concentrate or train the flow to reduce sedimentation in Boulanger Bend. This measure is carried forward for further consideration.

### 3.4.3 CHANNEL REALIGNMENT

Realigning the channel would involve relocating the main navigation channel and dredging a channel in that new location. The relocated channel could be aligned straighter than the existing channel and would be designed for increased conveyance to reduce sedimentation in the area. A channel realignment may require a closing structure to prevent the flow from entering the existing main navigation channel and direct the flow into the new channel. This measure is carried forward for further consideration.

### 3.4.4 INCREASED CHANNEL MAINTENANCE

Increased maintenance would mean maintaining the navigation channel at the authorized width (as shown on Plate 4).

**Table 7 Summary of Problems, Objectives and Measures**

| Problem | Objectives | Measures |
|---|---|---|
| Reduced commercial navigability | Provide an economically-justified level of commercial navigability in Lower Pool 2 | Channel control structures, channel realignment, increased channel maintenance |
| Increased sedimentation and increased dredging costs | Minimize channel maintenance costs associated with sedimentation in Lower Pool 2. | Channel control structures, channel realignment |
| Increased costs to maintain aids to navigation | Minimize maintenance costs of U.S. Coast Guard's Aids to Navigation in Lower Pool 2 | Channel control structures, channel realignment, increased channel maintenance |

CHAPTER 4.

# Alternative Plan Formulation and Evaluation

This chapter describes the full array of alternative plans developed and the evaluation and screening of these alternatives.

The conclusions presented in this chapter are based on a lower level of detail as appropriate for this stage of the planning process. Additional data was collected for the final array of alternatives that were carried forward as project planning progressed, and is described more thoroughly in Chapter 6 – The Evaluation of Environmental Effects.

The purpose of evaluation and screening is to determine which alternative plans meet project objectives, avoid project constraints and should be carried forward for more detailed analysis towards the identification of the National Economic Development (NED) plan. Evaluation and screening also serves to eliminate alternatives that have fatal flaws or do not meet the primary project objectives. Several criteria, including the evaluation criteria identified in the P&G, were used to evaluate and screen alternatives and to further refine alternatives to be considered in detail. For each of the P&G criteria, specific indicators for this feasibility study are described; in addition, risk was added as a criterion for consideration.

- **Effectiveness -** Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified objectives. Specifically in Lower Pool 2 effectiveness is defined by whether or not the alternative would be effective in maintaining an acceptable navigation channel.
- **Acceptable -** Acceptability refers to the workability and viability of the alternative with respect to acceptance by state and local entities and the public compatibility with existing laws. In this study, environmental effects and socioeconomic effects were used as indicators of acceptability.
    - o *Environmental Effects* - Whether or not there would be unacceptable environmental effects including impacts to natural resources as well as historical and cultural resources.
    - o *Socioeconomic Effects* - Whether or not there would be unacceptable effects on socio-economic resources such as transportation, public safety, recreation, public facilities, and public services.
- **Completeness -** Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned effects. Implementability was considered as specific indicator of completeness for this study, consideration of whether or not there are significant outstanding technical, social, legal, or institutional issues that affect ability to implement the alternative.

- **Efficiency -** Efficiency refers to cost-effectiveness and the most efficient allocation of other resources. Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and achieving the specified objectives. For the purposes of the feasibility study, the costs evaluated were the first costs of the project and expected future operation and maintenance costs. Cost impacts may be realized not only in pool 2 where the project would be constructed but also in pools 3 and 4 if dredging needs change as a result of changing sedimentation patterns. Different alternatives would allow more or less material to flow through Pool 2. If more material flows through pool 2, it will later deposit in pool 3 and upper pool 4. Conversely, if less material flows through pool 2, less material will reach pools 3 and 4. These impacts from the project in Pool 2 would impact the dredging requirements and costs for pools 3 and 4.
- **Risk -** The uncertainties, vulnerabilities, and potential consequences of the alternative.

## 4.1 Alternative 1 - No Action Alternative

### *Alternative Description*

Under this alternative, the Corps would continue current channel maintenance practices. This is considered to be the base condition against which the other alternatives are compared. It includes those actions expected to be undertaken in the future in the absence of an additional project. Good indicators of expected future actions are those actions taken in the past. Likewise, the impacts to each of the resource categories under the no action alternative are likely to be a continuation of those that have been caused by current channel maintenance practices resulting from sedimentation in this segment of the river.

The Boulanger Bend area (River Mile 818-821) of Lower Pool 2 is an area where the navigation channel meanders back and forth between the banks of the floodplain, which creates a near 90-degree bend in the river at mile 819. Navigating this area is difficult for commercial towboats: more than 70 groundings have occurred since 1990. The river also deposits a lot of sediment in the area, which periodically narrows the width of the channel around the bend. The Corps maintains this area by frequent dredging. Since 1981, on average, the Corps has dredged the area once every three years, but during the last 8 years (2009 – 2016) the Corps has dredged the area every year. The increase in dredging is likely due to increased flows carrying more sediment into the area. Based on these historical dredging records, it would be assumed that there may continue to be a demand for frequent dredging in the future without project condition. Large quantities of dredging also increase the demand on nearby placement sites.

### *Effectiveness*

The effectiveness of the No Action alternative would vary depending on the year. The historic average dredging frequency has been approximately once every three years. However, the past eight years (2009 – 2016) have required annual dredging. In any case, this location would have a high dredging frequency, and it has been difficult to manage this area to provide a safe and reliable navigation channel.

Overall, the effectiveness of this alternative is considered to be low.

### *Environmental Effects*

Natural Resources: The high sedimentation and shoaling rate in this area would lead to high-frequency dredging events, similar to the current conditions. The dredging events would cause temporary periods of increased turbidity. Turbidity would also increase on occasions when barges are grounded and try to dislodge themselves from the shoal.

Overall, the potential environmental effects of the No Action alternative are considered to be low adverse.

### *Socioeconomic Effects*

The No Action alternative would continue to impair the safety of towboat crews and other river users due to the narrow, shifting channel and subsequent groundings. These conditions increase costs to the navigation industry due to the time lost during groundings and by necessitating reduced tow sizes to fit through the channel. Additionally, the U.S. Coast Guard would incur continued maintenance costs to maintain Aids to Navigation in the project area (buoys and day markers).

Overall, the socioeconomic effects of the No Action alternative are considered to be moderate adverse.

#### *Risk*

The unpredictable nature of the shoaling at this location could cause the main navigation channel to become impassable to navigation traffic (a channel closure). A channel closure could lead to emergency dredging, which needs to be completed very quickly. These situations provide fewer opportunities for planning and review, and therefore have a higher risk of overlooking an environmental concern. Safety is also at risk, because it is often difficult to inform the public about emergency situations in the channel, and underwater obstructions are often not detectable.

Overall, the risk of the No Action alternative is considered to be high.

#### *Cost*

As stated above, cost impacts may be realized not only in pool 2 but also in pools 3 and 4 if dredging needs change as a result of changing sedimentation patterns. For this reason, recent dredging patterns (2007-2016) in Pools 2, 3, and 4 were evaluated to estimate future maintenance dredging costs of the channel in its present condition. The average annual dredging volume from this channel is estimated at 144,600 cubic yard. A Dredged Material Management Plan (DMMP) for Pool 2 is currently in development. This DMMP shows the cost of maintenance dredging in Pool 2 is $13.00/CY to dredge and place sand in its final placement site. In Pool 3 an extra step is required to unload the sand from a temporary site to the final placement site. This annual cost is estimated to be $539,000.

Therefore the average annual maintenance cost over the 40-year planning period for the No-Action alternative is 144,600 CY x $13.00/CY + $539,000 = $2,418,800. This value will serve as the basis for comparison of the dredging cost savings benefit for other alternatives.

#### *Conclusion*

The Future Without Project Condition (No Action) is the base condition against which other alternatives are compared to quantify and determine the significance of impacts. This alternative must be presented in the National Environmental Policy Act (NEPA) document prepared for any Corps project that may be proposed. This alternative will be carried forward for detailed evaluation.

## 4.2 Alternative 2 – Revetments and Wing Dams Channel Control Structures

#### *Alternative Description*

This alternative would include improving existing and/or constructing revetments and wing dams channel control structures. Figure 4-1 shows some potential locations that were considered for placement of revetments and wing dams. These structures would help to concentrate the flow within the current main navigation channel so that sediments would not drop out of suspension around Boulanger Bend. The structures would be constructed of rock or sand and would be placed in areas where hydraulic models have shown flow to break out of the main navigation channel. The major constraint for this alternative is ensuring that the action does not increase flood stages upstream.

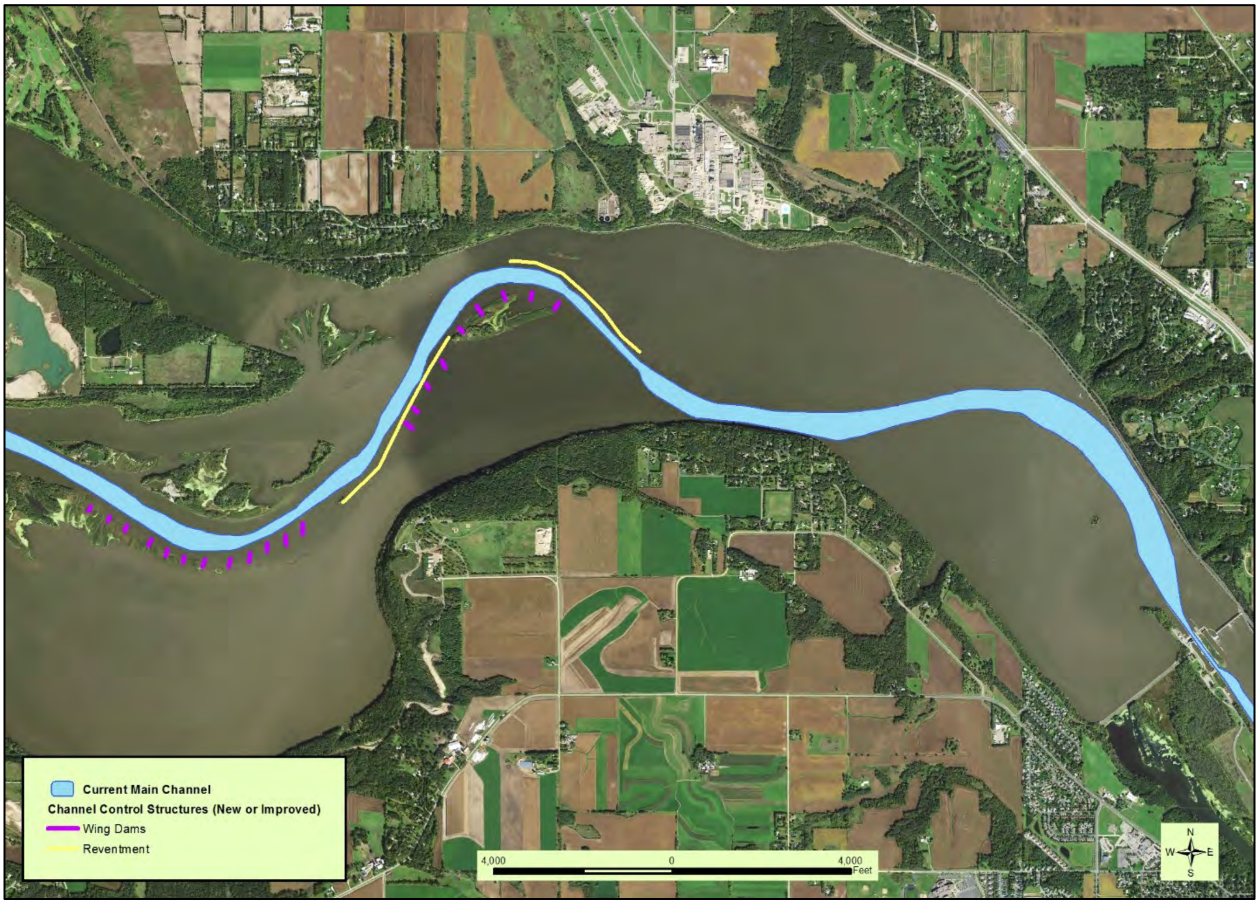


**Figure 4-1 Alternative 2 Revetments and Wing Dams**

***Effectiveness***

Revetments and wing dams would increase the velocity of water flowing through the channel, which would increase the conveyance of suspended sediments through the channel. Steady-state modeling of the originally-proposed structures showed a significant flood-stage increase for the 1-percent flood elevation. It was determined by the hydraulics engineer that in order to meet the flood-stage elevation constraint, the structures would need to be reduced in size such that this alternative would no longer be effective at maintaining the navigation channel.

Overall, the effectiveness of the revetments and wing dams channel control structures alternative is considered to be low.

#### *Environmental Effects*

Natural resources effects would occur from the placement of material in the river. Any macroinvertebrates within the footprint of the material placement, such as freshwater mussels, would be killed. If a dense and diverse mussel bed were to be found in the project footprint, it may be warranted to relocate mussels out of the impact area. Flows would be more concentrated within the main navigation channel, and flows in the backwater areas of the Boulanger and Nininger sloughs would likely be slightly decreased. The sandy main channel border habitat would be transformed into a shallower rock habitat. There would likely be some turbidity caused by construction, but less than the other structural alternatives.

Overall, the potential environmental effects of the revetments and wing dams alternative are considered to be moderate adverse.

#### *Socioeconomic Effects*

The revetments and wing dams channel control structures alternative would improve public safety by reducing the hazard associated with groundings. River users must be cautions of any new underwater structures. The project would also decrease costs to the navigation industry by allowing the more efficient transit of 15-barge tows and reducing the number of trips into and out of the St. Paul harbor. The Coast Guard would also realize cost savings in the form of reduced maintenance of navigation aids.

Overall, the socioeconomic effects of the revetments and wing dams alternative are considered to be moderate positive.

#### *Implementability*

As described under Planning Constraints in Section 3.3, flood-stage increases must be avoided. Hydraulic modeling showed that for features significant enough to keep higher velocities in the channel, stage increases for the 1-percent flood would be unacceptable.

Overall, the implementability of the revetments and wing dams channel control structures alternative is considered to be low.

#### *Cost*

This alternative was screened out before cost analyses were prepared.

#### *Risk*

It is likely that material not deposited in the main channel in the project area would be deposited in another location resulting in increased dredging at that location. There is also the risk that the revetments and wing dams would not convey sediment or maintain the channel as well as predicted.

Overall, the risk associated with the revetments and wing dams alternative is considered to be moderate.

#### *Conclusion*

The revetments and wing dams channel control structure alternative is not considered implementable due to the unacceptable flood stage increases produced by the structures necessary to make this alternative effective. Therefore, this alternative was eliminated from further consideration.

## 4.3 Alternative 3 - Nininger Slough Channel Realignment

#### *Alternative Description*

This alternative would involve re-aligning the channel through Nininger Slough by dredging a channel from approximately River Mile 819 – 816.5. Figure 4-2 shows the approximate location where the channel would be re-located. There is a remnant channel that runs through this area that is up to 20 feet deep (under normal water levels) in some places. A closing structure may be necessary to restrict the flow entering the current main channel and direct the flow into the new channel. The new channel would be dredged through the slough approximately 12 feet deep, 330 feet wide, and 12,500 feet long. Preliminary estimates show that this dredging would produce 487,000 cubic yards of material that would need to be moved to another location.

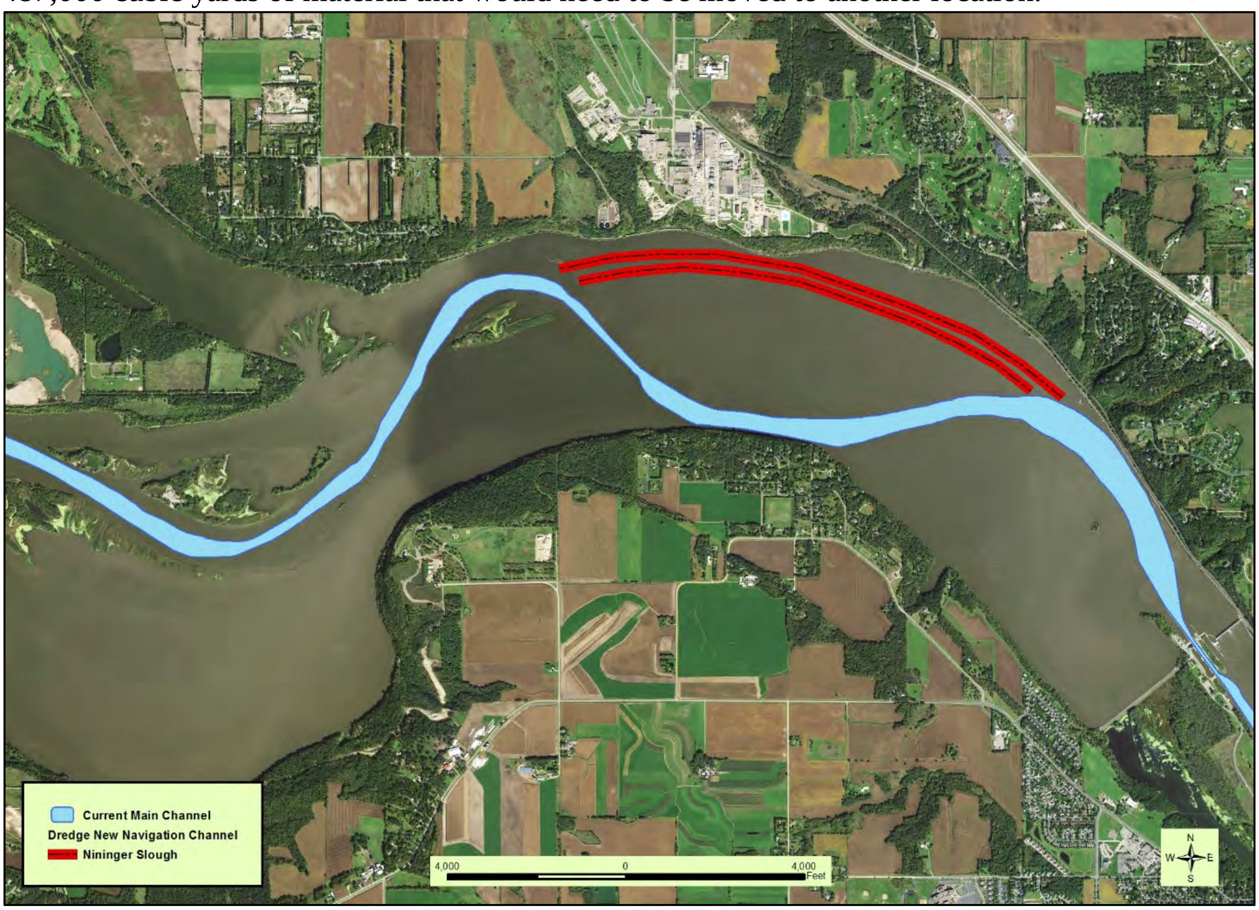



**Figure 4-2 Alternative 3 Nininger Slough Realignment**

#### *Effectiveness*

The channel realignment would reduce the overall need for maintenance dredging by conveying more sediment through the channel, and would remove the near 90-degree bend in the channel and make navigation easier and safer.

Overall, the effectiveness of the Nininger Slough Channel Realignment alternative is considered to be high.

#### *Environmental Effects*

Natural resources effects would be higher in the short-term and likely decreased in the long-term. In general, dredging the new channel would convert the Nininger Slough secondary channel into main channel habitat. The current main channel area would have a reduction in flows and would be expected to become a secondary channel. Freshwater mussels, macroinvertebrates, and fish in the area of the cutoff would be directly impacted by the construction, and animals living in other areas nearby could be indirectly impacted by a change in the hydrology. According to initial surveys, no federally-listed endangered mussels are known to exist at the project location, although there does appear to be a diverse mussel community with high densities in some locations. Some state-listed endangered species have been found within the project footprint, but these species, although rare in Minnesota as a whole, are very prevalent throughout Pool 2. If further surveys identified a dense and diverse mussel bed within the project footprint, it may be warranted to relocate mussels out of the impact area. According to NWI wetland maps, there are some areas of lacustrine wetland that could be impacted by the project. Any impacts to wetland would require appropriate mitigation.

Due to a nearby industrial plant that has been in operation for over 60 years, contaminants would likely be present in the sediment that would need to be dredged. In a 2008 USACE sediment survey of the Upper Mississippi River, three samples collected in Nininger Slough were tested for Perfluorochemicals (PFCs) from the upper 10 cm of the sediment. All three samples had detectable levels in line with samples collected from Lake Pepin and downstream boat harbors located above and below Lake Pepin.

In 2012, Nininger Slough sediment was randomly sampled along the potential channel alignment. Twelve boreholes were drilled and 23 composite samples from varying stratums were analyzed. Sample results from Nininger Slough showed lower levels of silt, but considerably more contamination than samples collected from Boulanger Slough. Throughout the proposed dredge cut, several boreholes had frequent exceedances of level I and level II SQTs and a few boreholes had MPCA’s level 1 Soil Reference Value (SRVs) exceedances of PCBs, and/or mercury and/or manganese. Based on these results, the USACE determined that all material dredged under this alternative would need to be disposed of in a permitted landfill.

Overall, the potential environmental effects of the Nininger Slough Channel Realignment alternative are considered to be high adverse.

#### *Socioeconomic Effects*

The Nininger Slough Alternative would improve public safety by reducing the hazard associated with groundings. The project would also decrease costs to the navigation industry by allowing the more efficient transit of 15-barge tows and reducing the number of trips into and out of the

St. Paul harbor. The Coast Guard would also realize cost savings in the form of reduced maintenance of navigation aids. Compared to the Channel Control Structure alternative, the socioeconomic benefits provided by the Nininger Slough alternative would be of a greater magnitude because the straightening the channel would further reduce the difficulty of navigating this stretch of river.

Overall, the socioeconomic impacts of the Nininger Slough Channel Realignment alternative would be considered high positive.

#### *Implementability*

There are no known insurmountable technical, social, legal, or institutional issues that would prevent this alternative from being implemented, but placement sites would need to be located for all of the dredged material including any contaminated material. A larger placement site would be needed for this alternative than for the Boulanger Slough channel realignment – Alternative 5 because more material would be generated.

Overall, the implementability of the Nininger Slough Channel Realignment alternative is considered to be moderate.

#### *Cost*

Detailed costs were not developed for this alternative. It was determined that the quantity of dredging required to construct this alternative would be approximately twice that necessary for the Boulanger Slough channel realignment; therefore, for the purposes of alternative screening, it was assumed that the cost would be roughly twice that of the Boulanger Bend alternative.

Overall, the cost of the Nininger Slough Channel Realignment alternative is considered to be high.

#### *Risk*

Risks for this alternative include problems with the removal of contaminated material, lack of sediment conveyance, and increased dredging downstream.

Overall, the risk of the Nininger Slough Channel Realignment alternative is considered to be moderate.

#### *Conclusion*

Although this alternative appears to meet the objectives of this study, the risk and costs associated with dredging and disposing of the contaminated material and the high overall project costs make the alternative not feasible. Therefore, this alternative was eliminated from further consideration.

## 4.4 Alternative 4 - Increased Channel Maintenance

***Alternative Description***

Although the Corps does perform regular maintenance dredging to maintain a navigable channel in this area, the dredging is often just enough to make the channel navigable, and does not extend to the full authorized channel width (Figure 4-3). This has been influenced by the increased costs of maintaining the full channel and the priorities and availability of government dredging equipment or contractors to perform the work when problems are discovered. Under this alternative, the channel width in the project area would be increased to a width of 350 and 450 feet, plus an additional bend width (dependent upon location). Total channel width would be 350 feet between River Miles 818 – 820.5 and 450 feet between River Miles 820.5 – 821. The maximum bend width allowed per the CMMP and GREAT Study is 500 feet; the proposed increased channel maintenance falls within the authorized channel widths. The location of the current main navigation channel, and the Increased Channel Maintenance corridor is shown in Figure 4-3. This alternative proposes to increase maintenance dredging where needed to improve navigation efficiency and safety; not necessarily to the maximum authorized in the study area. It is estimated that 306,000 cubic yards would be dredged during the initial event to bring the channel to this condition. The plan is to keep the proposed 350'&450' wide corridor dredged. There may be areas where deep water extends outside of the corridor that make the channel wider. The limits of the corridor will be maintained at the 12 foot dredge depth.


**Figure 4-3 Increased Channel Maintenance Corridor and Current Width Comparison**

***Effectiveness***

This alternative would improve safety and navigability of the channel. The increased channel width would accommodate a fifteen-barge tow, based on historical experience. However, because the channel would still contain the near 90-degree bend and would still allow for significant amounts of river flow to break out of the channel, the project area would still be expected to accumulate sediments and require at least as much maintenance dredging as under current conditions.

Overall, the effectiveness of the Increased Channel Maintenance alternative is considered moderate.

#### *Environmental Effects*

There would be two stages of impacts under this alternative: first would be the initial project construction impacts, and following would be the ongoing future maintenance impacts. The initial construction of widening the channel would disturb an estimated 40 acres of main channel border habitat and 80 acres of main channel habitat. Any benthic organisms currently living there would be removed and likely killed by the dredging. However, much of this habitat is unstable, shifting sand that does not provide suitable habitat for benthic organisms. The effects of ongoing, semi-annual maintenance dredging would be similar to the without project condition, but turbidity caused by dredging events may be slightly increased due to the increased dredging, and turbidity caused by groundings would be decreased.

This alternative would reduce the bed load sediments transported downstream to Pool 3 and Upper Pool 4. This would have a minor positive impact on these downstream resources by reducing the sedimentation in the delta areas of backwaters.

Overall, the potential environmental effects of the Increased Channel Maintenance alternative are considered to be low adverse.

#### *Socioeconomic Effects*

This scenario would create enhanced public safety to towboat crews because the channel would be wider than it is currently maintained. The channel would also provide a greater area of suitable depth for recreational traffic. Navigation outside the marked channel in Lower Pool 2 can be dangerous due to shifting sediments and significant stump fields.

Overall, the socioeconomic effects of the Increased Channel Maintenance alternative are considered high positive.

#### *Implementability*

The implementability of this alternative is highly influenced by resource management. Maintaining a wider channel in this reach of the river would require the commitment of more resources to this area on an annual basis. These resources include funding, human labor, and time. Perhaps the most difficult resource constraint is managing the division of work between the available dredging plants. Currently, there are five dredging plants under employ in the St. Paul District. The workload of the St. Paul District (and sometimes the Rock Island and St. Louis Districts as well) is divided among these plants based on the size and locations of individual dredging jobs during a dredging season. The five year annual dredging average (2007-2011) used in the cost analysis is a sufficient workload to occupy four dredging plants.

Under this alternative, the project area would require additional annual maintenance dredging, and would therefore increase pressure on the dredge plants. During years of high channel maintenance, this alternative would increase the chance that it would be necessary to sacrifice other critical dredging needs or employ an additional plant at a greatly increased expense (as discussed in the 'Cost' screening criteria below). For example, in 2011, a situation arose where emergency channel dredging was required. Because the regular dredge plants already had a full workload, a contract for a one-time dredging event was sought. Cost per cubic yard for this event was $10.50, compared to $8.40 for dredging conducted with other plants. For the 13,191 cubic yard job, this increased the job cost by $27,701. In addition, mobilization costs that would not otherwise be incurred added $46,800. In this instance, the mobilization cost was relatively low because the dredging plant was already close to the job location. However, this is seldom the case, and costs have been significantly higher.

Another institutional constraint is the availability of both temporary and permanent dredged material placement sites from St. Paul to the head of navigation. Currently, there are four active sites throughout Pool 2. One of the four, Southport, is not feasible for placement as it is approximately 16 river miles from the project. All three sites feasible for placement are temporary, thus a cost for excavation will be incurred at some point in time. The three active, temporary sites (Pine Bend, Upper Boulanger, and Lower Boulanger) are all nearing capacity. More importantly, the future availability of nearby and available permanent placement sites in the area is unknown at this point, and may make future temporary site unloading difficult and expensive.

Overall, the implementability of the Increased Channel Maintenance alternative is considered to be low.

***Cost***

The initial enlargement, (the construction) of the channel to the authorized dimensions is considered the first cost of this alternative. It includes the initial dredging and final placement of this material. The first cost is estimated to be $5,700,000.

The Interest During Construction is estimated to be $75,000.

These 2 costs, when amortized over 40 years at 2.875% interest equals an average annual cost of $245,000.

The result of this alternative will be an increase in maintenance dredging. The estimated annual maintenance cost would be $2,472,300, which includes $2,042,300 for the costs of dredging and $430,000 for the cost of unloading the temporary placement sites for Pools 2, 3, and Upper Pool 4.

The total annual cost for this alternative is $245,000 + $2,472,300 = $2,717,300 compared to the No Action Alternative of $2,418,800. This is an increase of $298,500.

Other costs that would be expected to rise under the increased channel maintenance alternative, though difficult to quantify, include:

- Labor costs for inspection, oversight, and management of additional dredge plants
- Costs associated with adding additional plant (mobilization, transportation, etc.)

Cost to navigation industry would decrease as full-sized tows (15 barges) could transit this stretch of the river resulting in fewer trips into and out of St. Paul harbor. Costs to the U.S. Coast Guard would be expected to drop due to the wider channel.

Overall, the costs associated with the Increased Channel Maintenance alternative are considered to be moderate.

#### *Risk*

There is a high risk compared to the other alternatives. This alternative does provide a wider and generally safer channel than without project conditions, but it would be more volatile than any of the other structural alternatives, and would still be prone to the problems discussed in the without project condition. The risks include dredge plant unavailability, placement site uncertainty, increased maintenance costs, and declining budgets.

Overall, the risk associated with the Increased Channel Maintenance alternative is considered to be high.

#### *Conclusion*

Although this alternative appears to meet the objectives of this study, it would not be feasible due to implementation constraints, increased annual costs, and high risk. Therefore, increased channel maintenance as a standalone alternative was screened from further analysis.

## 4.5 Alternative 5 - Boulanger Slough Channel Realignment

#### *Alternative Description*

This alternative would involve re-aligning the navigation channel through Boulanger Slough by dredging a channel from approximately River Mile 820 – 818. Figure 4-4 shows the approximate location of the Boulanger Slough Channel. There is a remnant channel that runs through this area that is up to 20 feet below Low Control Pool (LCP) elevation in some places. A partial closing structure would be necessary to restrict the flow entering the current main channel and direct the flow into the new channel. The new channel would be dredged through the slough approximately 12 feet deep, 330 feet wide (top width), and 8,000 feet long. Preliminary estimates show that this dredging would produce 298,000 cubic yards of material that would need to be moved to another location.

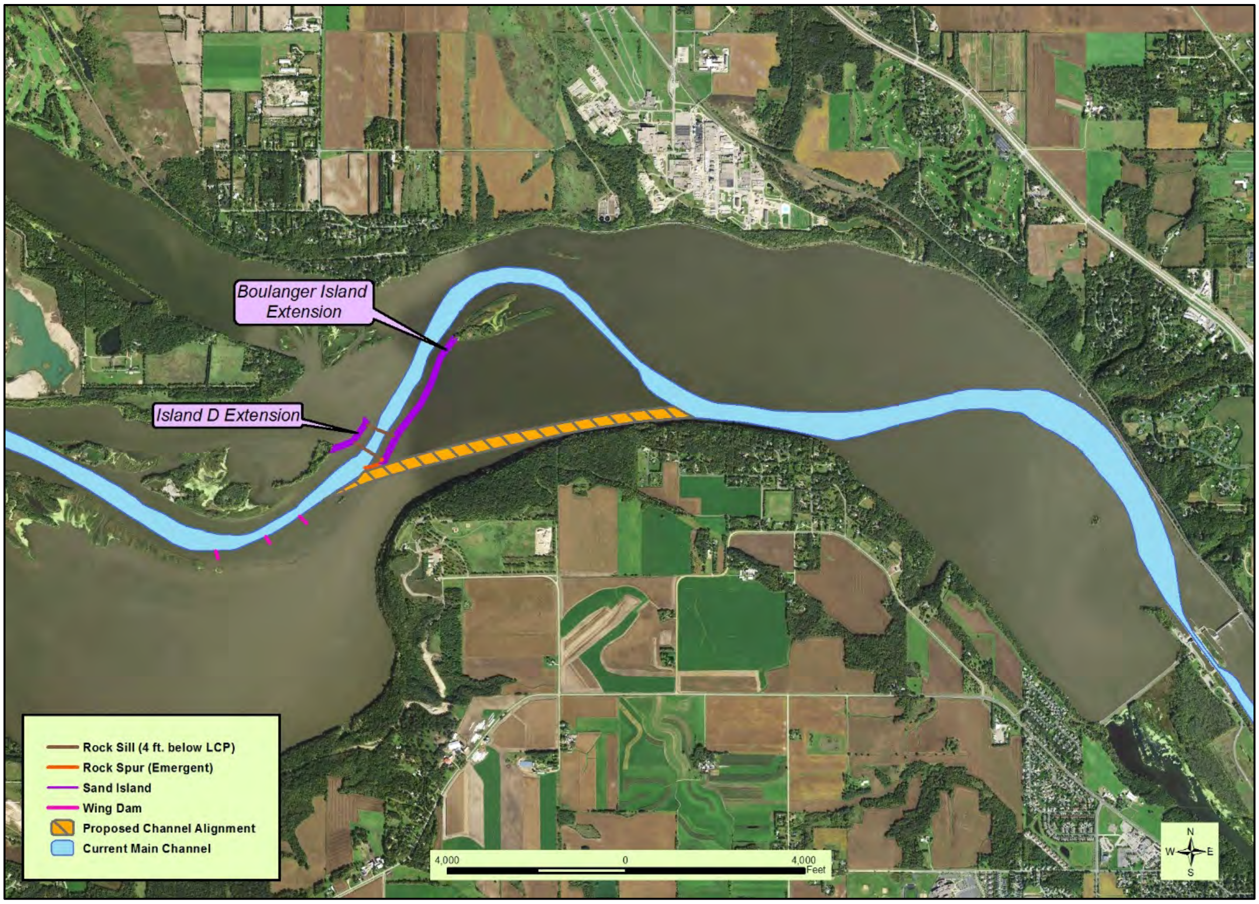



**Figure 4-4 Alternative 5 Boulanger Slough Realignment**

#### *Effectiveness*

Based on hydraulic modeling, this alternative would likely reduce the overall need for maintenance dredging by conveying more sediment through the channel. It would also remove the near 90-degree bend in the channel at Freeborn Bend and would make a safer and more reliable navigation channel.

Overall, the effectiveness of the Boulanger Slough Channel Realignment alternative is considered to be high.

#### *Environmental Effects*

Adverse effects to natural resources would be increased in the short-term and likely decreased in the long-term compared to the no-action alternative. In general, dredging the new channel would convert the Boulanger Slough secondary channel into main channel habitat. The current main channel area would have a reduction in flows and would be converted into a secondary channel that would slowly fill in with sediment over time. This alternative would result in decreasing the channel length by approximately 3,500 feet, or two-thirds of a mile. Freshwater mussels, macroinvertebrates, and fish in the area of the cutoff would be directly impacted by the construction, and animals living in other areas nearby may be indirectly impacted by a change in the hydrologic function. No federally-listed endangered mussels are known to exist within the project footprint. Some state-listed endangered species have been found within the project footprint, but these species, although rare in Minnesota as a whole, are very prevalent throughout Pool 2. It is estimated that approximately 529,000 ± 132,000 mussels currently inhabit the project footprint areas and would be killed during construction of project features. The project would also have indirect effects of increasing sediment deposition in Pool 3, Upper Pool 4, and Lake Pepin because of the reduced sediment deposition in Lower Pool 2.

Some positive environmental impacts would also be expected to occur from this alternative. The total acres of side channel habitat would be increased, while the main channel habitat would be decreased. Side channel habitat is less abundant in Lower Pool 2, and would generally support greater species diversity and abundance than main channel habitat. Also, an island would be constructed along the right descending bank of the current main channel as a part of this alternative. Island habitat would be beneficial to many types of wildlife in Lower Pool 2. This island could help to promote vegetative growth by restricting wind and wave action in the shallow area between Boulanger Slough and the current main navigation channel, and could serve to protect and stabilize this area.

Overall, the potential environmental effects of the Boulanger Slough Channel Realignment alternative are considered to be high adverse.

#### *Socioeconomic Effects*

The Boulanger Slough Alternative would improve public safety by reducing the hazard associated with groundings. The project would also decrease costs to the navigation industry by allowing the more efficient transit of 15-barge tows and reducing the number of trips into and out of the St. Paul harbor. The Coast Guard would also realize cost savings in the form of reduced maintenance of navigation aids.

The socioeconomic benefits provided by the Boulanger Slough Channel Realignment would be similar to those provided by the Nininger Slough alternative. The benefits would be of a greater magnitude than the Channel Control Structure Alternative or the Increased Channel Maintenance Alternative because straightening the channel would further reduce the difficulty of navigating this stretch of river.

Overall, the socioeconomic effects of the Boulanger Slough Channel Realignment alternative are considered to be high positive.

#### *Implementability*

Several factors have been identified that could influence the implementability of this alternative. Two natural gas pipelines cross from one bank of the river to the other and are buried under the river. However, the pipelines may not be buried deep enough under the proposed channel route, and at least one of the pipelines would need to be relocated. Additionally, a special placement site would be necessary for any material dredged from the new channel that is determined to be contaminated. Finally, construction of the new channel and associated training structures would impact a large number of freshwater mussels. Feasible measures to mitigate these impacts would need to be developed, and may be costlier or technically infeasible.

Overall, the implementability of the Boulanger Slough Channel Realignment alternative is considered to be moderate.

#### *Cost*

The construction cost of this alternative is estimated to be $14,000,000.

The mitigation cost for this alternative is estimated to be $2,600,000.

The cost to relocate the Northern Natural Gas pipeline is $18,000,000

The Interest During Construction is estimated to be $454,000.

The above 4 costs, when amortized over 40 years at 2.875% interest equals an average annual cost of $1,486,000.

With this project in place, an increase of sand will flow through the channel and need to be dredged in Pools 3 and 4. Therefore the annual maintenance costs (dredging and unloading) will increase from $2,418,800 to $2,529,800.

The total annual cost for this alternative is $1,486,000 + $2,529,800 = $4,015,800 compared to the No Action Alternative of $2,418,800. This is an increase of $1,597,000.

Overall, the cost of the Boulanger Slough Channel Realignment alternative is considered to be high.

#### *Risk*

There is a small chance that the newly created channel would not convey as much sediment as expected and frequent maintenance dredging remains necessary for the area. Also, the sediment that flows through the channel at this area of Pool 2 will eventually settle out somewhere downstream, so there is a small chance that the extra sediment could cause another area of the channel downstream to build faster and increase the necessary maintenance dredging at another location. The modeling that has been provided has showed the risk of these problems to be low.

Overall, the risk associated with the Boulanger Slough Channel Realignment alternative is considered to be low.

#### *Conclusion*

This alternative meets the primary objectives of the project and appears to be feasible. This alternative has been carried forward for detailed evaluation.

## 4.6 Alternative 6 - Increased Channel Maintenance with Rock Sill Training Structures

***Alternative Description***

Under this alternative, a corridor has been established that would be maintained to a dredging depth of 12 feet. This corridor ranges from 450 feet wide upstream of the daymark in Boulanger Bend and 350 feet wide downstream of the daymark (light). The channel width in the project area would be increased to 350 and 450 feet, within authorized channel dimensions, plus any deeper areas outside of the corridor as described in 4.4, Increased Channel Maintenance. It is estimated that 306,000 cubic yards of material would be dredged during the initial event to bring the channel to this condition. The dredged material would be placed in an inactive mining pit in Lower Grey Cloud Island (See Figure 5-3). In addition, rock sills acting as river training structures would be constructed to help maintain flow in the channel and therefore reduce sediment deposition in this reach. The enlarged channel, were it to be constructed without other additional features, would drop the velocity in many parts of the channel particularly in the northern part of Freeborn Bend. By adding rock sill river training structures it is possible to keep the channel velocity up and also address the breakout flow conditions upstream and downstream of Freeborn Island. The rock sill features are shown with the historic channel in Plate 7 illustrating that the rock sill training structures would be used to maintain the channel approximately in the historic location. The structures would be built of riprap with a top width of approximately 10 feet. The top two vertical feet of the rock sill training structure would have a slope of 5H:1V to allow expanding and moving ice to ramp over the structure without pushing it over. The slopes below two vertical feet from the crest will have a 1.5H:1V side slope. These components together form the Increased Channel Maintenance with Rock Sill Training Structure Alternative (Figure 4-5).

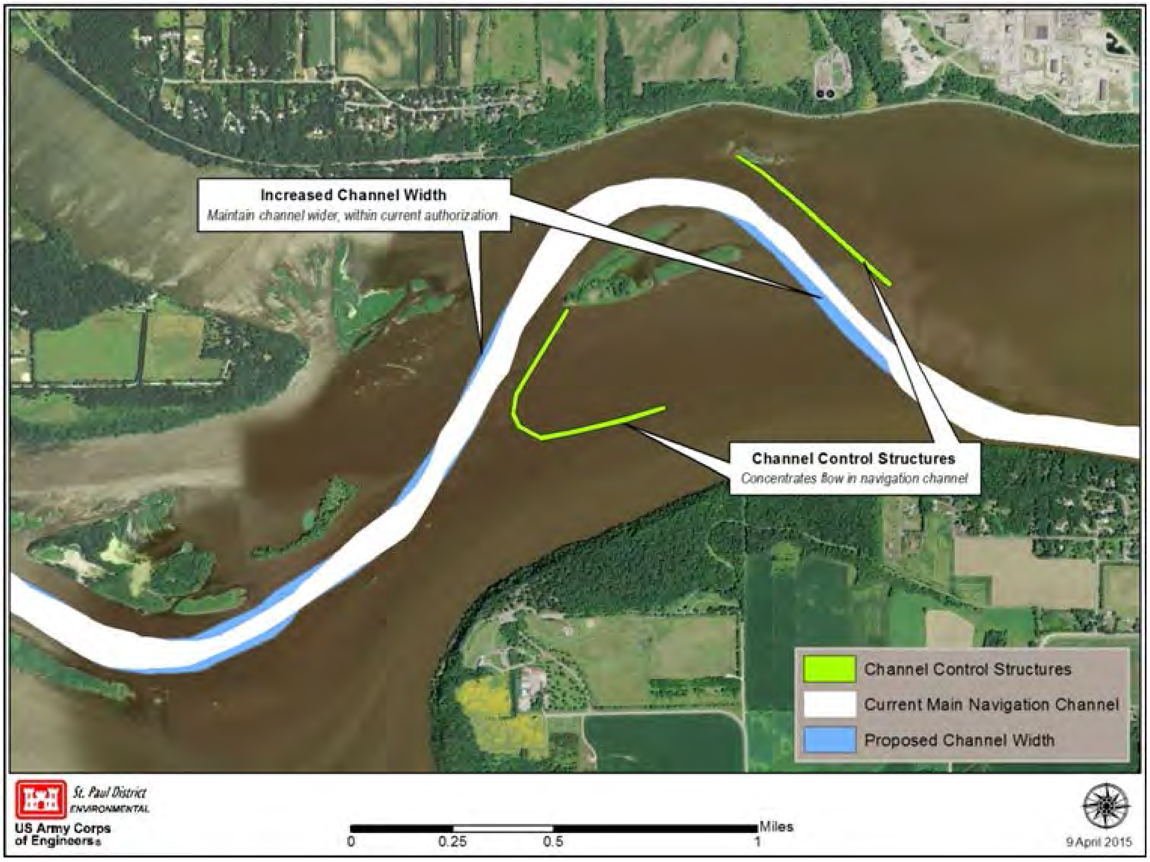


**Figure 4-5 Alternative 6 Increase Channel Maintenance with Training Structure**

#### *Effectiveness*

Based on hydraulic modeling, this alternative combining a widened channel along with both rock sill training structures reduces breakout flow problems, improves the curvature alignments of tows through these tight bends and maintains velocity in the navigation channel. The plan should also improve the dredging problem with the very narrow channel from River Mile 818.3-818.6.

Overall, the effectiveness of the Increased Channel Maintenance with Rock Sill Training Structures alternative is considered to be high.

#### *Environmental Effects*

Construction of project features would disturb an estimated 15 acres of main channel border habitat and approximately 6 acres of impounded floodplain habitat. Any benthic organisms currently living in the project footprint would likely be killed by dredging or material placement. However, the majority of main channel border habitat is unstable, shifting sand that does not provide suitable habitat for benthic organisms. The 6 acres of impounded habitat where the channel control structures would be constructed provides mediocre habitat for freshwater mussels, and it is estimated that construction of these features would impact approximately 85,200 ± 25,800 mussels, including some rare species.

The effects of ongoing, semi-annual maintenance dredging would be similar to the without project condition, but turbidity caused by groundings would be decreased.

Overall, the potential environmental effects of the Increased Channel Maintenance with Control Structures alternative are considered to be moderate adverse.

#### *Socioeconomic Effects*

This alternative would improve public safety by reducing the hazard associated with groundings. The project would also decrease costs to the navigation industry by allowing the more efficient transit of 15-barge tows and reducing the number of trips into and out of the St. Paul harbor. The Coast Guard would also realize cost savings in the form of reduced maintenance of navigation aids.

Overall the socioeconomic effects of this alternative are considered to be high positive.

#### *Implementability*

A close eye was kept on the impacts to the 1 percent (100 year) flood profile throughout the consideration of features for this alternative. Impacts to flood stages are a study constraint which cannot be violated. Combinations of project features were balanced in order to avoid flood stage impacts. The alternative is a combination of channel excavation which lowers flood stages and the construction of rock sill training structures which tends to increase stages. The proposed rock sill river training structures combined with the increased channel dimensions are designed to be effective in concentrating river flows while not impacting flood stages. Overall, the implementability of the Increased Channel Maintenance with Rock Sill Training Structures alternative is considered to be high.

***Cost***

The construction cost of this alternative is estimated to be $9,000,000.

The mitigation cost for this alternative is estimated to be $300,000.

The Interest During Construction is estimated to be $122,000.

The above 3 costs, when amortized over 40 years at 2.875% interest equals an average annual cost of $399,000.

With this project in place, the annual maintenance costs (dredging and unloading) will increase from $2,418,800 to $2,419,600.

The total annual cost for this alternative is $399,000 + $2,419,600 = $2,818,600 compared to the No Action Alternative of $2,418,800. This is an increase of $399,800.

Overall, the cost of the Increased Channel Maintenance with Rock Sill Training Structures alternative is considered to be moderate.

***Risk***

It is likely that material not deposited in the main channel in the project area would result in increased dredging at another location. There is also the risk that the structures would not convey sediment or maintain the channel as well as predicted.

Overall, the risk associated with the increased channel maintenance with rock sill training structures alternative is considered to be moderate.

***Conclusion***

This alternative meets the primary objectives of the project and appears to be feasible. This alternative has been carried forward for detailed evaluation.

## 4.7 Final Array of Alternatives Carried Forward for Further Development

Following alternative plan evaluation and screening, the final array of alternatives carried forward are the No Action alternative, the Boulanger Slough Channel Realignment alternative, and the increased Channel Maintenance with Rock Sill Channel Training Structures alternative. The Alternative Screening Matrix (Table 7) summarizes the final screening criteria for each alternative.

**Table 8 Alternative Screening Matrix**

| **Criteria** | **Alternatives** | | | | | |
|---|---|---|---|---|---|---|
| | ***No Action*** | ***Channel Control Structure*** | ***Nininger Slough Realignment*** | ***Increased Channel Maintenance*** | ***Boulanger Slough Realignment*** | ***Increased Channel Maintenance with Rock Sill Training Structures*** |
| **Effectiveness** | Low | Low | High | Moderate | High | High |
| **Environmental (Acceptability)** | Low Adverse | Moderate Adverse | High Adverse | Low Adverse | High Adverse | Moderate Adverse |
| **Socioeconomic (Acceptability)** | Moderate Adverse | Moderate Positive | High Positive | High Positive | High Positive | High Positive |
| **Implementable (Completeness)** | High | Low | Moderate | Low | Moderate | High |
| **Cost (Efficiency)** | Moderate | NA | High | Moderate | High | Moderate |
| **Risk** | High | Moderate | Moderate | High | Low | Moderate |
| **Recommendation** | Retain | Eliminate | Eliminate | Eliminate | Retain | Retain |

CHAPTER 5.

# Alternative Plan Selection

This chapter describes the development and comparison of the final array of alternatives and the alternative plan selection.

## 5.1 Alternative 1 - No Action Alternative

The No Action Alternative is the plan in which none of the measures or combinations thereof would be constructed. There would be no cost to the No Action Alternative. This alternative required no further development. Refer to chapter 4.1 for a description of this alternative.

## 5.2 Alternative 5 - Boulanger Slough Channel Realignment

Figure 5-1 shows the proposed project features for the Boulanger Slough Channel Realignment Alternative.

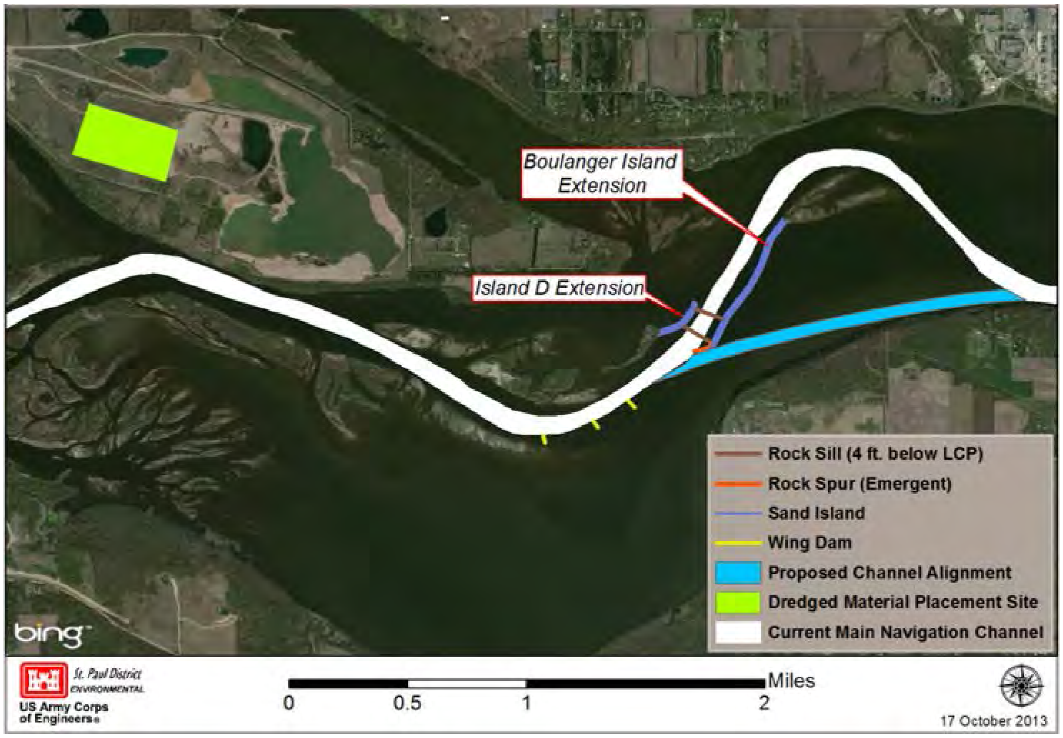



**Figure 5-1 Boulanger Slough Channel Realignment Alternative Features**

The main feature of this alternative is the excavation of a channel approximately 12 feet deep, 330 feet wide, and 8,000 feet long through the area known as Boulanger Slough. Approximately 298,000 cubic yards of dredged material would be removed from Boulanger Slough.

In addition to the channel excavation, this alternative requires several features to be constructed, including islands, submerged weirs, a rock spur, and several wing dams (depicted on Figure 5-1). These features are required to manage the hydraulic functioning of the area. The following paragraphs describe each of the proposed features.

The Boulanger Island Extension will extend approximately 3,500 feet from Boulanger Island upstream towards the head of the new channel cut. The purpose of this island would be to reduce break-out flows from the channel which in turn keeps higher velocity in the upper end of the proposed excavated channel. The Island D Extension would extend approximately 1,100 feet from Island D towards the northeast. The purpose of this island would be to provide a point to anchor the submerged weirs on the western side of the abandoned channel. The islands would be constructed primarily from sand. The island crests would be at an elevation of 688.8 (1912 datum), about two feet above Low Control Pool water surface (686.7 feet (1912 datum).

The Rock Spur is a rock dike that would rise 1.6 feet above low control pool elevation (LCP+1.6=688.3ft (1912)). Its primary function is to improve the alignment of flow into the new channel as well as increase the percentage of flow entering the new channel cut.

Two submerged rock sills would be placed across the old navigation channel, below the inlet to the new channel. The submerged rock sills would tie into the Island D extension on the left bank and the Boulanger Island extension on the right bank.

## 5.3 Alternative 6 – Increased Channel Maintenance and Rock Sill Training Structures

Figure 5-2 shows the proposed project features for the Increased Channel Maintenance and Rock Sill Channel Training Structures.

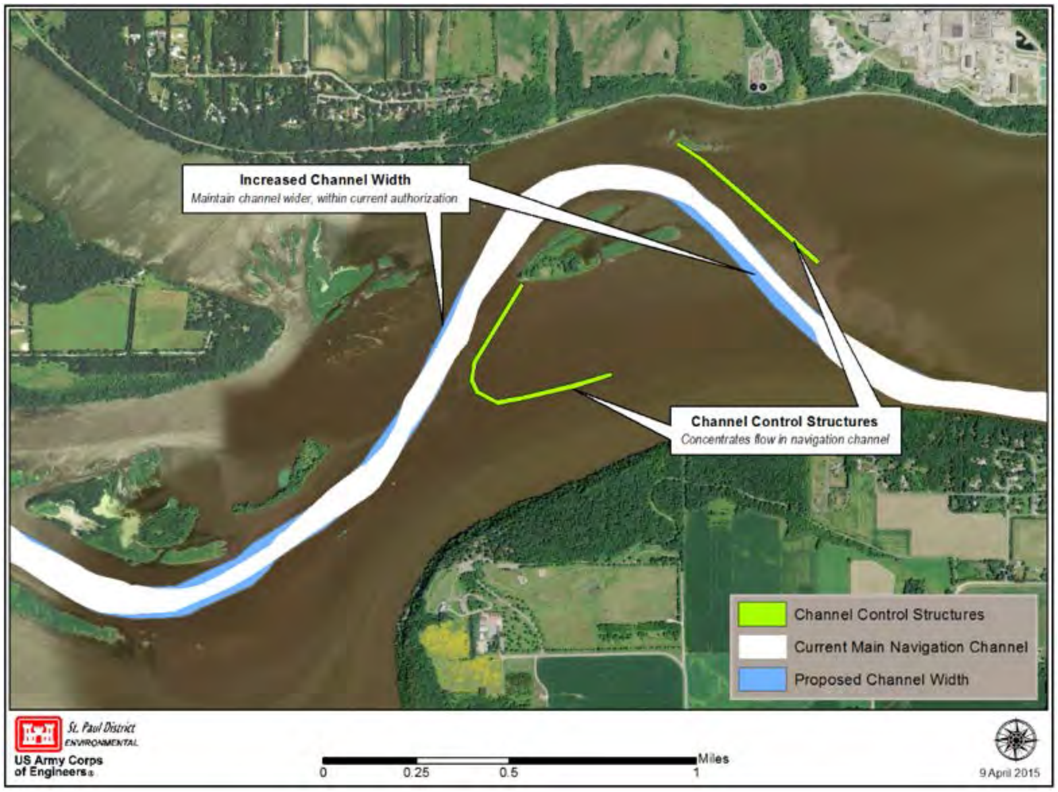



**Figure 5-2 Alternative 6 Increased Channel Maintenance and Rock Sill Channel Training Structures**

The primary features of this alterative include channel excavation and construction of two new rock sill training structures. This plan would include excavation and maintenance of a wider channel that is still within authorized dimensions and placement of two new training structures (rock sills): one on the right descending bank from River Mile 819.5 to 819.8 and one on the left descending bank from River Mile 818.4 to 818.9. It is estimated that 306,000 cubic yards would be dredged during the initial event to bring the channel to this condition. The dredged material would be placed in an inactive mining pit in Lower Grey Cloud Island (See Figure 5-3). These features would improve navigability, safety and reduce channel maintenance requirements.

Various training structure alignments and shapes were considered in an attempt to formulate an alternative that would a) keep velocities at least as high as existing conditions within the navigation channel, b) reduce dredging volume, and c) reduce breakout flow to improve maneuverability of tows. The structure east of Freeborn Island would generally parallel the navigation channel and blocks the breakout flows. It would keep much of the channel discharge in the main navigation channel and keep the movement of water in the same direction as the navigation channel. The 'horseshoe' shaped island to the south of Freeborn Island would reduce breakout flows upstream of Freeborn Island. A simple island, parallel to the navigation channel, was considered first. This would have some effect but flow from the navigation channel would continue to breakout further upstream and fill the conveyant area south of the existing Freeborn Island. By adding the eastward running portion of the island, it was possible to make the sheltered area non-conveyant during most low and moderate flow conditions. The benefit of producing this non-conveyant region is that the navigation channel and other areas experience increased discharge that is no longer flowing across this submerged bend. The result is that the widened channel would experience higher velocities, it would be less depositional leading to reduced dredging volumes, and there would be reduced breakout flows which would improve navigability by tows.


**Figure 5-3 Proposed Dredged Material Placement Site for Alternative 6**

The rock mound type of 'island' was the chosen design for this feature. The dimensions of the rock mound island were adjusted from the standard design found in the Environmental Design Handbook (COE, December 2012). The 10' foot top width has been shown to provide enough mass to withstand the forces that expanding and moving ice would exert on the structure. The crest of the rock mound islands would be at 687.4 feet (1912 datum).

The island crests would only be about 0.8 feet above the Low Control Pool (LCP) elevation in this portion of the river. The islands would be 0.8 feet above the water surface at low flows, and 1.1 feet above water at the 25% duration discharge. The water surface would reach the island crest for the 2 year flood. Because this island would be in the lower end of Pool 2, it would be subject to the pool drawdown at the dam. Figure 5-4d shows the Operating Curves for Pool 2.

The pool is drawn down at the dam to 686.5 between 10,000 and 60,000 cfs. These boundary conditions are coded into the ADH models. LCP in the project area is 686.6 feet (1912 Datum). The rock crest is at 687.4. The islands would overtop until discharges reach the 43,000 cfs (2 Year discharge).

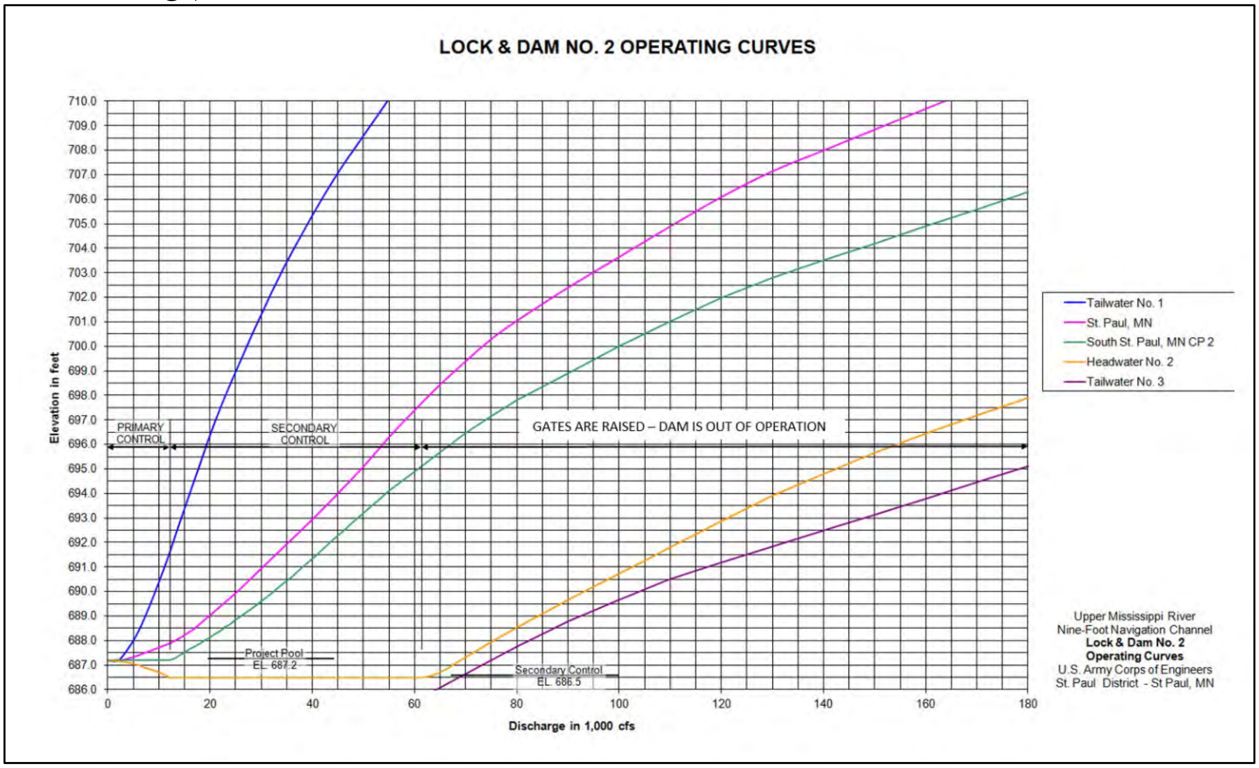



**Figure 5-4 Pool 2 Operating Curves**

The top two vertical feet of the island would have side slopes of 5H:1V to allow ice to ramp over the rock without pushing the structure over. The 5H:1V slope has been successful when used at a problem location on the Trempealeau National Wildlife EMP project. The “Ice Action on Riprap” (Sodhi, Borland and Stanley, CRREL 1996) also recommends that D100 should be twice the ice thickness for shallow slopes. For elevations below 685.4 (2 feet below crest), the slope would be steepened to 1.5H:1V. The Minnesota DNR is particularly concerned with disturbance to mussels in this pool. This alternative would have the minimum footprint size and would require relocation of the fewest mussels without giving too little consideration to stability during ice events. The rock mound cross section is shown in Figure 5-4.

An ongoing question is if the incorporation of occasional field stone boulders (4ft diameter) would aid or hinder safety, or have no benefit. The primary reason to embed the stones within the island is for visibility. The purpose of the boulders is to indicate the hazard of the alignment of the islands when they are shallowly inundated. The boulders could also help break sheet ice as it rides over the rock sill. The boulders would be embedded in the island rock matrix about 3 feet. The tops of the boulders would extend about 1 feet higher than the island crest. The boulders would be spaced at approximately 250 foot intervals. Ten boulders would be incorporated into the NE island and about 15 boulders would be incorporated into the SW island.

This should not affect flood levels since it is such an insignificant in relation to the islands impacts. Additional discussion is included in Appendix D Hydraulics and Hydrology.

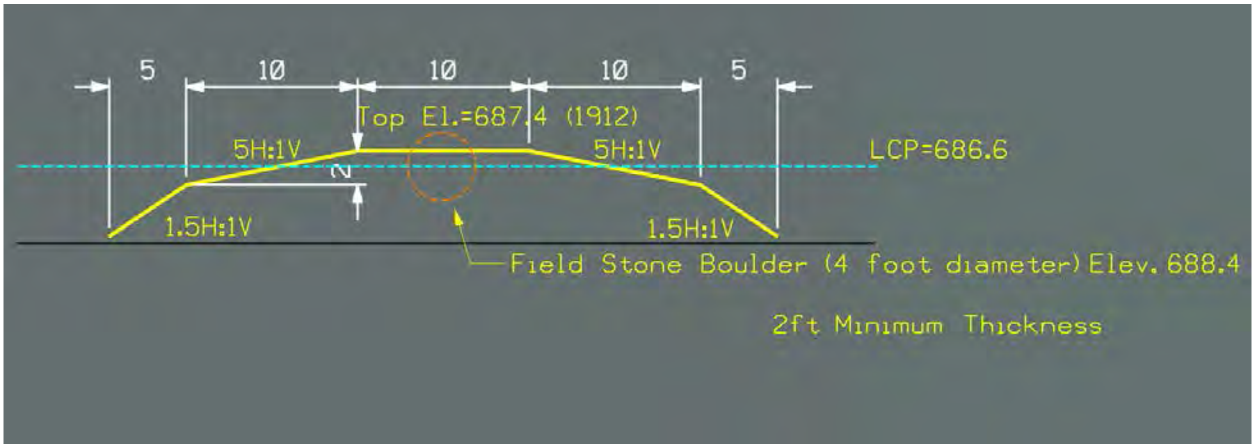



**Figure 5-5 Rock Mound Cross Section**

## 5.4 Comparison of Final Array of Alternatives

The channel improvement project in Pool 2 will generate benefits of three types: savings to the barge industry of tow operating costs, cost savings to the Corps for maintenance dredging, and savings to the Coast Guard of costs to maintain aids to navigation. Benefits represent the reduction in costs as a result of the project compared with those under existing conditions (No Action alternative).

**Table 9 Benefit – Benefit - Cost Summary**

| Category | Boulanger Cut-off | Increased Channel Maint with Structure |
|---|---|---|
| Annual Benefits | - | |
| Tow Costs | 1,220,000 | 910,000 |
| Maintenance Dredging | (111,000) | (1,000) |
| Navigation Aids (USCG) | 79,000 | 37,000 |
| Total | 1,188,000 | 946,000 |
| | | |
| Costs | | |
| First Cost | 14,000,000 | 9,000,000 |
| LERRD (pipeline relocation) | 18,000,000 | NA |
| Mitigation | 2,600,000 | 300,000 |
| Interest During Construction | 454,000 | 122,000 |
| Total Costs | 35,054,000 | 9,422,000 |
| | | |
| Average Annual | | |
| Int & Amort factor (40 yrs @ 2.875%) | 0.04239 | 0.04239 |
| Int & Amort cost | 1,486,000 | 399,000 |
| | | |
| BCR | 0.80 | 2.37 |
| Net Benefits | (298,000) | 547,000 |

NOTES:
1. Mitigation costs for this alternative are based on $2,600,000 to move all mussels from a 60 acre impacted area.
2. Mitigation costs of $300,000 for this alternative are based on mussel mitigation. This alternative would impact 6 acres, where an estimated 85,200 ± 25,800 freshwater mussels currently reside. Mussels would be translocated to a nearby area.

3. Utility relocation costs. For the Boulanger Cut-off alternative there are two Northern Natural Gas pipelines one 24 inch and the other 30 inches buried under the channel including Boulanger Slough. In order to maintain a 12 foot navigation channel depth, excavation would come within a few feet of the 30 inch gas line for at least half the length of the gas line and then taper down for the rest of the channel width. There is a concern with 1) safely excavating over the pipe line and 2) the buoyancy of the pipeline once the work is done and the line is placed back in operation. Per NNG they would like 15 feet of fill over their lines to counteract the buoyancy and provide protection from marine vessels. NNG estimates it would cost $36 million to relocate both pipelines. These are large diameter pipelines and would require horizontal directional drilling (HDD) to route new pipelines 1-1/4 miles each under the Mississippi River. Utility relocations are part of the total project costs and included in Lands, Easements, Right-of-ways, Relocations and Disposals (LERRD's). The cost to relocate even one line is significant enough that this alternative is not economically justified compared to the Channel Maintenance with Structure alternative.
4. Utility relocation costs. For the Channel Maintenance with Structure alternative, there is a single 4-foot diameter HDPE Sewer outfall pipe buried approximately 10 feet under the rock sill alignment. This pipe discharges treated water from the Eagle Point Sewage treatment plant directly into the navigation channel. Presently, it is assumed that this pipe will not need to be relocated.

Increased Channel Maintenance with Rock Sill Training Structure is the plan with the highest net benefits and the highest benefit to cost ratio. Corps planning guidance defines the National Economic Development plan as the plan that maximizes net benefits. Alternative Six Increased Channel Maintenance with Rock Sill Training Structure is identified as the Lower Pool 2 Channel Management Study NED Plan.

## 5.5 Plan Selection

The Tentatively Selected Plan (TSP) is the NED Plan Alternative 6 Increased Channel Maintenance with Rock Sill Training Structures (ICMS). The TSP is shown in Plates 6 and 7.

### 5.5.1 Summary of Accounts for the National Economic Development Plan

- The national economic development (NED) account displays changes in the economic value of the national output of goods and services
- The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources
- The regional economic development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan.
- The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

The Federal objective is to determine the project alternative with the maximum net benefits while protecting or minimizing impacts to the environment. Under the National Economic Development (NED) account, which measures benefits of the recommended plan, the increased channel maintenance with rock sill river training structures demonstrates the highest net benefits of $547,000 and a Benefit to Cost ratio of 2.37.

The features of the increased channel maintenance with river training structures alternative were designed to minimize environmental impacts under the EQ account. Environmental effects are more fully described in Chapter 6.

Under the RED account, the area will most likely experience regional economic benefits during implementation of the project.

The OSE account includes public safety, which will be improved by reducing the hazard associated with groundings and improving navigability of the channel. The channel would also provide a greater area of suitable depth for recreational traffic. Navigation outside the marked channel in Lower Pool 2 can be dangerous due to shifting sediments and significant stump fields.

## 5.6 Tentatively Selected Plan

This section discusses the details of the TSP, which was determined by the plan formulation process described in Chapters 4 and 5. The recommended plan is to excavate a wider channel that is still within authorized dimensions and place two new training structures (rock sills) one on the right descending bank River Mile 819.5 to 819.8 and one on the left descending bank from River Mile 818.4 to

818.9. The widened channel and restriction of breakout flow and outdraft conditions should significantly improve navigation in this reach of Lower Pool 2.

### 5.6.1 Plan Features

The TSP consists of the two rock sill structures and tie-in to existing islands. The navigation channel will also be widened. The plan is described in detail in Section 5.3 as Alternative 6.

The plan consists of:

A. Enhanced Channel Maintenance plan where a defined corridor will be excavated and maintained to a depth of 12 feet. This will make the bends easier to navigate and improve some of the difficult dredging locations.
B. Rock Sill River Training Structures. A rock structure would be constructed upstream of Freeborn Island. The structure is horseshoe shaped and is parallel the navigation channel and to Boulanger Slough. The structure ties into Freeborn Island at its terminus. Another rock sill structure will be constructed to the left side of the navigation channel downstream of Freeborn Island. This structure will parallel the navigation channel.
C. There will need to be some riprap features (riprap/rock trench/offshore rock mound) included to tie the rock sills into existing island. These relatively minor features are required to minimize negative impacts from erosion on the existing islands.

### 5.6.2 Design Considerations

The Project has been developed to a feasibility level of design. Design details are included in the technical appendices and plates. As with all feasibility level studies, these details will be refined in the Plans and Specifications (P&S) Stage.

A consolidation settlement analysis was performed to determine a reasonable range of expected settlement of the rock sill structures on top of the existing clay foundation. Beneath the alignment of the proposed structures, the clay layer ranges from 10 feet to 30 feet thick. Since existing borings have not been tested, consolidation test data from soil boring 86-24M at Lock and Dam 2 were used in the settlement analysis. Boring 86-24M was initiated for the foundation investigation for construction of the Central Control Station for Lock and Dam 2, which is just upstream of the Boulanger Bend project. Standard Penetration Test N-values for the Lock and Dam 2 sample are similar to those recorded at the Boulanger Bend project. The change in stress after construction of the rock sill structures were computed using surface loads on a semi-infinite mass. The change in stress is based on the additional load that the foundation would experience with the construction of the rock sill structures.

Because consolidation test data are unavailable at the project site and the clay layer thicknesses vary from 10 to 30 feet, there is a high level of uncertainty in the estimated range of expected settlement. Once additional borings are advanced and more consolidation tests are performed, the settlement analysis will be updated.

Settlement calculations reveal that roughly 7 to 12 inches of settlement can be expected over the lifetime of the project. Observable settlement is expected to take several years. Typically, settlement has been taken into account by overbuilding the structure, but an impact on the one-percent flood profile has been identified as a constraint. While the excavation of the channel increases conveyance and drops the water surface about 0.05 feet, the construction of the rock sill training structures decreases conveyance-subsequently raising the water surface. Stage increases higher than 0.005 feet are unacceptable. To avoid increased flood stages, the rock sill structure top elevation should not exceed 0.8 feet above low control pool (+ or - 0.3 feet). Overall the average elevation of the rock sills should be within (+ or - 0.1 feet). Boulders may be included in the design and may rise about 1 foot above the crest of rock sill. They would be spaced infrequently (250 foot spacing is expected). These boulders should have no additional effect on flood stages.

The constraint of avoiding flooding stage impacts prevents overbuilding of the rock sill structures to mitigate consolidation settlement. If the rock structures settle below the pool surface, their intended performance is compromised. Since there is a high level of uncertainty associated with the current estimate settlement range, settlement monitoring and mitigation plans will be determined after more sampling and testing has been performed.

### 5.6.3 ENVIRONMENTAL MITIGATION

Freshwater mussel surveys conducted in the proposed project footprint were used to estimate that project construction would kill approximately 85,200 ± 25,800 individual mussels, including individuals representing four species of conservation concern in the State of Minnesota (survey and estimate details in Appendix G). Freshwater mussels fill important ecological roles including nutrient cycling, substrate stabilization, and as a food source for fish and mammals. In accordance with Corps' planning guidance[1] and CMMP guidance,[2] the Corps has incorporated mitigation measures that would ensure that the project does not have more than a negligible adverse effect on this ecological resource. Project effects were first minimized by selecting narrow rock mounds for the channel training structures to reduce the project footprint. Unavoidable impacts of the selected TSP would be offset by relocating the mussels currently within the

[1] USACE Planning Guidance Notebook, Engineering Regulation 1105-2-100, C-3.e.(1)
[2] CMMP EIS Paragraph 5.2.2; Appendix G (IV.B.4)

footprint of the proposed structures prior to project construction. This would involve divers collecting as many mussels from the footprints as possible, and moving the mussels to a location or locations that would augment nearby existing populations. The Mussel Mitigation Plan in included in Appendix G.

### 5.6.4 CONSTRUCTION CONSIDERATIONS

#### *5.6.4.1 ROCK SILLTRAINING STRUCTURES*

Rock sill training structure would be placed along the right descending bank from River Mile 819.5 to 819.8 and one on the left descending bank from River Mile 818.4 to 818.9. These structures will parallel the navigation channel. The purpose of using these types of structures is to keep velocities as high as existing conditions, reduce dredging volume over the project life, and reduce breakout flow and improve maneuverability of tows. Typical designs for the rock mound are shown in Sheet C-105 of the civil drawings. Construction of the rock measures would likely be a combination of marine plant (backhoe on barges and push boats) and land based equipment (trucks and dozers). The equipment used to place the rock would likely be hydraulic backhoe on a barge. No site preparation work would be necessary from the work area. Rock material delivery/staging would be at LD 2 as noted on Sheet C-101. All areas used for rock loading and equipment staging at LD2 must be restored to pre-project conditions

#### *5.6.4.2 CHANNEL EXCAVATION*

As part of the recommended plan, the channel will be excavated and maintained at wider dimensions as it has been maintained in the past and that is still within authorized dimensions. The Tentatively Selected Plan proposes to increase maintenance dredging where needed to improve navigation efficiency and safety; not necessarily to the maximum authorized in the study area. It is estimated that 306,000 cubic yards would be dredged during the initial event to bring the channel to this condition. The granular material would be placed on Lower Grey Cloud Island which is an approved permanent disposal site noted in the Channel Maintenance Management Plan and Dredged Material Placement Plan. The material could be unloaded either mechanically or hydraulically (note: over 1.3 million yards was hydraulically unloaded onto this site in 1999-2000. Mechanical excavation would require a hydraulic backhoe typically using a 3 or 5 cubic yard bucket. The granular material would be placed on barges and unloaded at the existing ramp that has used before for unloading. The barges would be unloaded unto trucks and placed at specific locations in or around the current gravel pit. If excavated hydraulically, a contractor would mobilize a hydraulic dredge and install a floating pipeline that would end at the disposal location. The pipeline would follow an alignment parallel to the navigation channel and exit on land near the loading ramp. The pipeline will be submerged at the navigation channel and is required to be marked for boater safety. Material would be pumped onto the site and dozers would push the sand to its final location. Because of the depth of existing mining pit and existing surrounding sandy soils, an effluent return waterline directly back into the river would not be required.

#### *5.6.4.3 CONSTRUCTION METHODS*

Construction of the rock measures would likely be a combination of marine plant and land based equipment. The equipment used to place the rock would likely be hydraulic backhoe on a barge. No site preparation work would be necessary from the work area. Rock material delivery/staging would be at LD 2 as noted on Sheet C-101.

#### *5.6.4.4 CONSTRUCTION RESTRICTIONS*

Construction restrictions could be applied for any number of reasons. The following are the basic construction restrictions that would likely be applied in the construction of the rock mounds.

a) Commercial navigation. The work is taking place at two locations adjacent to the navigation channel during the navigation season.
b) Access dredging is not anticipated and will not be allowed to construct the project.
c) Utilities – There are two underground natural gas pipelines owned by Northern Natural Gas (NNG). There is also a 4 –foot diameter sewage outfall pipe that is owned by Metropolitan Council. Caution needs to be exercised when accessing these areas and if barges are going to be spudded in place.

#### *5.6.3.5 SOURCES OF ROCK MATERIAL*

The rock would come from an approved local quarry from surrounding counties. The loading site would most likely be at LD 2 loading dock. Some quarries used in the past for Pool 2 projects are listed below.

Draft list for the Lower Pool 2 (will need inspection prior to use)

| QUARRY NAME AND OPERATOR | QUARRY LOCATION | NOTES |
|---|---|---|
| Larson Plant<br>Aggregate Industries<br>2915 Waters Road<br>Eagan, MN 55121<br>(651) 683-0600 | NE1/4, Sec.26, T27N, R22W<br>Washington County, Minnesota | 1, 2 |

| | | |
|---|---|---|
| Luhman Quarry<br>Luhman Construction<br>Rural Route 2, P.O. Box 20<br>Welch, MN 55089<br>(651) 388-3086 | S 1/2 Sec. 13 T113N, R16W<br>Goodhue County, Minnesota | 1, 2 |
| Ninninger Quarry<br>Solberg Aggregate Co.<br>Hastings, MN<br>(651) 437-6672 | NW1/4, SE1/4 Sec. 31, T115N, R17W<br>Dakota County, Minnesota | 1, 2 |
| Prescott Quarry<br>Prescott Stone LLC<br>N6589 Dorwins Mill Road<br>Durand, WI 54736<br>(715) 672-4666 | Sec.12 T26N, R20W NW1/4,<br>Pierce County, Wisconsin | 1, 2 |
| Trimbelle Quarry<br>Aggregate Industries<br>2915 Waters Road<br>Eagan, MN 55121<br>(651) 683-0600 | SE ¼, Sec 21, T26N, R18W<br>Goodhue County, Minnesota | 1, 2 |
| Svec Quarry<br>Kraemer Co.<br>820 Wacher Ave.<br>Plain, WI 53577<br>(608)546-2255 | SE ¼, Sec 17, T26N, R18W<br>Pierce County, Wisconsin | 1, 2 |
| V V Rock Stock Pile<br>Pierce County Hwy Department<br>Box 780<br>Ellsworth, WI 54001<br>715- 273-0596 | NW ¼, Sec. 35, T25N, R18W<br>Pierce County, Wisconsin | 1, 2, 3 |
| Carlson Quarry<br>Bruning Rock Products<br>325 Washington Street<br>Decorah, Iowa 52101<br>563-382-2933 | NW ¼ Sec. 10 T112N, R16W<br>Goodhue County, Minnesota | 1, 2, 3 |

NOTES:

1. Systematic blasting shall be performed in order to minimize deleterious cracks in the final product.
2. Processing riprap with a vibrating grizzly is a minimum requirement.
3. Source of material shall be limited to Oneota Formation.

#### *5.6.3.6 CONSTRUCTION SCHEDULE*

The optimum approach would be to construct the project under one construction contract since it only involves two rock structures and would require no more than one year of construction. Because of the location and nature of the construction, nearly all the work would require use of marine equipment. Construction of this type is limited to the open water season on the Upper Mississippi River. Construction in certain years can begin in April, but May is more typical for beginning construction due to the constraints associated with spring high water. At the other end of the spectrum, late November is the end of the construction season due to winter freeze-up.

Based on current funding it is estimated that a two separate contracts would be required. One contract would be awarded in summer of 2017 for construction of the rock structures with a construction start and completion in 2018, and one contract would be awarded in summer of 2018 for the increased channel dredging to be completed in 2019.

### 5.6.5 Lands, Easements, Rights-of Way, Relocations, and Disposal Site Considerations

All of the land for project construction lies within the 9-Foot Mississippi River Project, and is subject to navigational servitude. Staging will take place on U.S. Government property located at Lock and Dam 2 and placement of any dredged material will be placed on an approved dredge placement site.

### 5.6.6 Real Estate Considerations

No acquisitions are anticipated since all lands necessary for project construction are within the navigational servitude or on lands owned by the Government. Real Estate considerations are further described in Appendix L Real Estate Plan.

### 5.6.7 Operation, Maintenance, Repair, Rehabilitation and Replacement

All maintenance to project structures would be conducted by the Corps; however, based on experiences with previous projects, little or no maintenance would be expected to be necessary for the proposed features.

### 5.6.8 Construction Cost Estimate

The construction of the TSP alternative is considered as the first cost. The first cost is estimated to be $9,300,000 and when amortized over 40 years at 2.875% interest equals an average annual cost of $381,510. Costs are summarized in Table 9.

**Table 10 Project Cost Summary (2016 price level)**

| **Phase 1** | | |
|---|---|---|
| **Item** | **Description** | **Amount** |
| 1 | Bonds (Performance and Payment) | $20,000 |
| 2 | Mobilization and Demobilization | $165,000 |
| 3 | Rock Sills | $3,280,000 |
| 4 | Boulders | $25,000 |
| | **Subtotal Construction Phase 1** | **$3,490,000** |
| | | |
| **Phase 2** | | |
| **Item** | **Description** | **Amount** |
| 1 | Bonds (Performance and Payment) | $50,000 |
| 2 | Mobilization and Demobilization | $500,000 |
| 3 | Channel Excavation | $2,754,000 |
| 4 | Placement on Grey Cloud Island | $551,000 |
| 5 | Grey Cloud Topsoil Stripping | $70,000 |
| 6 | Grey Cloud Topsoil Respread | $68,000 |
| 7 | Turf Establishment- Grey Cloud Island | $72,000 |
| | **Subtotal Construction Phase 2** | **$4,065,000** |
| | | |
| | **Total Construction** | **$7,555,000** |
| | 10% Contingencies | $756,000 |
| | PED/CM | $1,000,000 |
| | **Total Project Cost** | **$9,311,000** |

CHAPTER 6.

# Evaluation of Environmental Effects

An environmental analysis has been conducted for the proposed action, and a discussion of the impacts is presented in the following paragraphs. Because fill would be placed into waters of the United States as a part of the proposed action, a Clean Water Act Section 404(b)(1) evaluation was prepared (Appendix B). Water quality certification as required by Section 401 of the Clean Water Act would be obtained prior to construction.

The effects of the no-action alternative are those expected to occur in the near-term and into the future without the proposed alternative. The no-action alternative serves as the base condition against which the proposed alternative is compared for evaluating effects. The effects of the proposed alternative are the results of the expected differences in conditions short-term and into the future between the no-action and the proposed alternative. The environmental effect of the no-action and proposed alternative are summarized in Table 4 in Chapter 6.

## 6.1 Socioeconomic Effects

### 6.1.1 COMMERCIAL NAVIGATION

Under the No-Action alternative, there would be minor adverse impacts to commercial navigation due to the time lost during groundings and by necessitating reduced tow sizes to fit through the channel.

The primary socioeconomic effect of the proposed project is the improved efficiency of the local navigation system between Red Wing and St. Paul. Improved efficiency is realized by the ability to group barges into 15-barge tows rather than 12-barge tows as current channel conditions allow. The related savings in operating costs to the towing industry is an economic benefit of the project.

Other economic benefits include costs savings to (1) the Corps of Engineers related to reduced maintenance dredging and (2) the Coast Guard related to reduced maintenance of aids to navigation (buoys and lights).

### 6.1.2 RECREATION

Under the No-Action alternative, there would be no impacts to recreation.

Under the proposed alternative, there would be both minor adverse and minor positive effects on recreation safety. The proposed rock sills would increase safety of recreational boaters by helping to maintain a wider and more reliable navigation channel. However, the structures themselves would also present a navigation hazard. This would be similar to other rock channel training structures in place throughout the river system. Boulders would be installed along the rock sills to help boaters notice the structures under medium-high discharge conditions.

### 6.1.3 AESTHETICS

The No-Action alternative would have no impact on aesthetics.

The proposed alternative would have a minor adverse effect on local aesthetics. The channel training structures would be constructed of rock riprap and would be viewed as appearing unnatural to most. This would mostly be limited to river users, but would also affect shoreline users in some areas; for example, users of the scenic overlook at Schaar's Bluff Vista at Spring Lake Regional Park would likely be able to see the structures. These structures would be apparent at most discharges: at discharges lower than the 50-percent annual exceedance probability flood (i.e., "2-year flood"), the channel control structures would be above the water surface and would be visible to those on the vista or by river users near the structures. When the Pool is at the lowest-controlled elevation, the top of the channel control structures would be approximately 0.8 feet (10 inches) inches above the water. At river discharges higher than the 50-percent annual exceedance probability, the structures would become submerged.

### 6.1.4 NOISE

The No-Action alternative would have no impact on noise.

The proposed alternative would have a temporary minor adverse increase in noise in the project vicinity. Construction would require heavy equipment to operate in the area, such as towboats, barges, dredges, excavators, and dozers, and these machines would generate noise during construction. This effect would be minor and would disappear upon construction completion.

### 6.1.5 EXISTING/POTENTIAL LAND USE

The no-action alternative would not have any effect on land use.

No conflicts between the proposed project and existing local land uses or land use plans have been identified. The following interactions were considered.

Placement of sand from the channel onto Lower Grey Cloud Island is in keeping with the current approved Reclamation Plan that Aggregate Industries has developed as part of their permit. In addition, in the recently published Mississippi River Corridor Critical Area District Map, Lower Grey Cloud Island is designated as a Rural & Open Space District (CA-ROS). Filling in portions of the gravel pit with sand, placing top soil and plantings of native grasses and trees is in keeping with this designation.

Dakota County's Comprehensive Land Use Plan provides a Land Use Forecast for the Year 2030. This plan identifies the upland shoreline area along Shaar's Bluff and the area south of Spring Lake as Park and Recreational area, and the shoreline area to the east of Schaar's Bluff as Rural Residential. These uses are commensurate with the current land uses.

Washington County's Comprehensive Plan discusses Grey Cloud Island Township. The shoreland area of Grey Cloud Island Township is zoned as parkland and rural residential, and is part of the Mississippi Critical Area. Washington County adopted the Critical Area Plan by reference (Reference Mississippi Critical Area Act of 1973 and Executive Order No. 79-19). Open space is to be provided in the open river valley lands for public use and the protection of unique natural and scenic resources. All local governments in the river corridor are required to have a plan that meets the Critical Area Act requirements. Grey Cloud Island and Denmark townships are within the Critical Area and are classified as a rural open space district; Washington County has land use authority in these townships. The Grey Cloud Island Township 2030 Land Use Plan states that, "The goal of the Grey Cloud Island Township Plan is to protect its semi-rural nature and preclude the premature demand for municipal services. The minimum residential lot size is 2.5 acres. Continuation of the limestone mining is encouraged. Grey Cloud Island Township consists of portions of two islands; most of the lower island is in Cottage Grove. The township has a significant amount of floodplain and shoreline, including many small islands, peninsulas, and backwaters on the Mississippi River. The township is in the Mississippi River Critical Area. No land use changes are proposed." However, Washington County does identify Lower Grey Cloud Island as an opportunity for preservation and recreation, and discusses potential future plans to create a large regional park. A master plan for the park was adopted in 1994. 1,336 acres of land acquisition on the island are proposed. The Comprehensive Plan states that the implementation strategy is to, "Monitor and respond to acquisition opportunities as they become available on a willing seller basis."

## 6.2 Natural Resource Effects

### 6.2.1 PHYSICAL SETTING

This section summarizes the results of analyses conducted to determine the effects of the proposed project on physical characteristics of the project area such as sediment transport and hydrology. Further details of the analyses can be found in Appendix D: Hydrology and Hydraulics.

#### *6.2.1.1 Geomorphology*

Under the No-Action Alternative, there would be no impacts to geomorphology.

Under the proposed alternative, the geomorphology of the river in the immediate project area would be modified by consistently maintaining the channel to its authorized dimensions and by constructing the channel control structures to maintain velocities within the channel. These geomorphological changes would alter local bed material sediment deposition patterns. The consistent maintenance of the navigation channel would tend towards an increase sediment deposition within the channel by increasing the trap efficiency, while the channel control structures would reduce the sediment deposition by increasing the flow velocity. Modeling of the sedimentation patterns indicated that these two opposing factors would nearly cancel each other out, and showed no significant overall reduction in dredging quantities for this stretch of river over a 5-year modeling period.

#### *6.2.1.2 Hydrology & Hydraulics*

The No-Action Alternative would not have any impacts on local hydrology or hydraulics.

The proposed project would not negatively impact the one-percent flood profile. The proposed project is a combination of channel excavation, which lowers flood stages, and construction of control structures, which increases stages. Hydraulic modeling indicates that structures identified in the area would experience stage increases of less than 0.005 feet at the 1% annual chance exceedance event (or the 100-year flood). Further discussion and maps depicting the localized stage changes can be found in Appendix D: Hydrology and Hydraulics.

Stream velocity in the immediate project area would be altered by the construction of the proposed project. The magnitude of change in current velocity is dependent upon the discharge conditions being considered. Four different discharge conditions were evaluated during hydraulic modeling: a low-discharge condition (flows exceeded 75% of the time); a medium discharge condition (flows exceeded 25% of the time); a high discharge condition (the 2-year flood condition); and an extreme discharge condition (the 100-year flood condition). The medium flow condition (20,560 cubic feet per second) is used in this evaluation to represent the magnitude of the general changes to current velocity due to the project because it is a common condition experienced in the area.

Figures 6-1 and 6-2 show the velocity (meters per second) magnitude and vectors for the medium flow condition under existing conditions and project conditions, respectively. (Both figures show where the proposed rock sill structures would be constructed). Inspection of the figures shows how the breakout flows are contained, particularly east of Freeborn Island, and how the orientations of the directional flow vectors are altered by the project. The color contour shading shows how velocity compares between existing and project conditions. In general, channel velocities are higher in the in the navigation channel for project conditions. Velocities are much lower in the area downstream of the horseshoe-shaped rock sill, although not eliminated as the model is not able to incorporate the water that would seep through the pores in the riprap of the sills or the eddy flows that would form behind the rock sill.

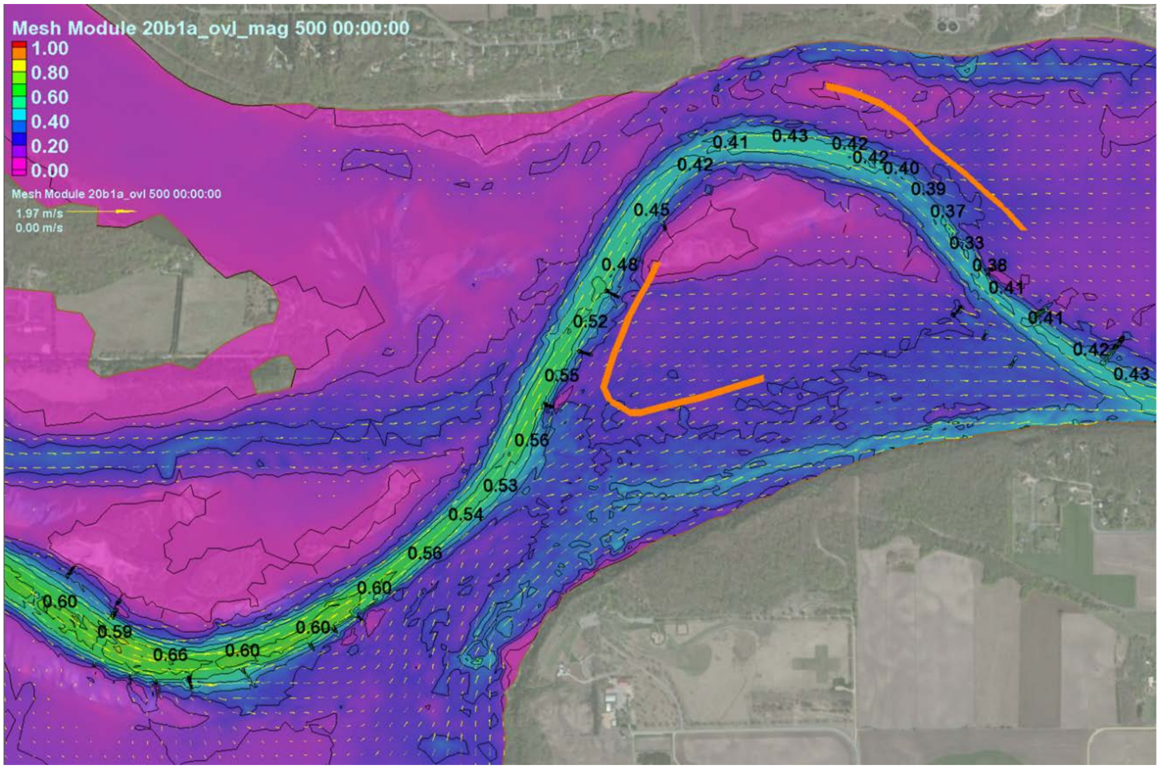



**Figure 6-1 Existing Condition Velocity (meters per second at 20,560 cfs)**

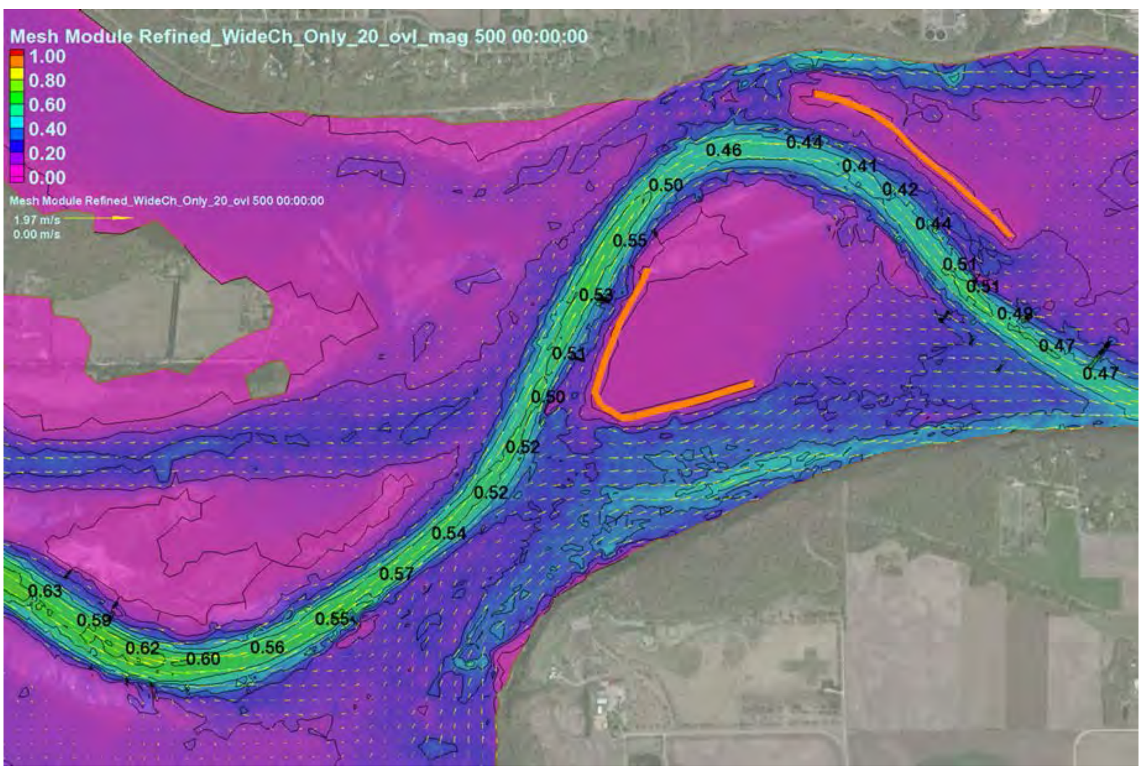



**Figure 6-2 Project Condition Velocity (meters per second at 20,560 cfs)**

### 6.2.2 AQUATIC HABITAT

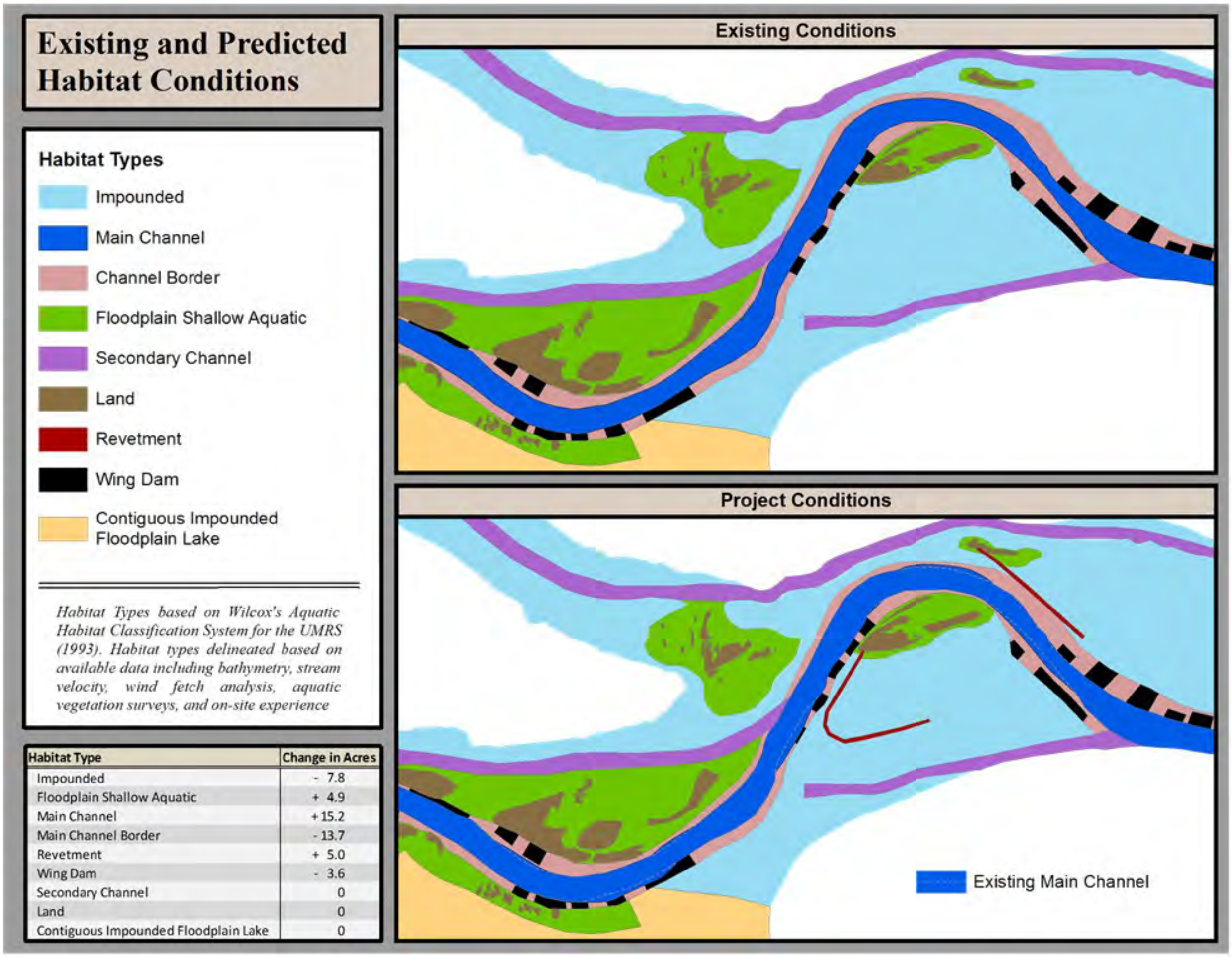
Under the No-Action alternative, there would be minor adverse, recurring impacts to aquatic habitat and biological productivity due to the nearly annual dredging events required to maintain the existing channel and the turbidity caused by the grounding and un-grounding of tows.

To visualize and assess the changes in aquatic habitat that would occur under project conditions, geomorphological, hydrological, and biotic characteristics were used to delineate regions that provide similar habitat for aquatic organisms. The Aquatic Habitat Classification System for the Upper Mississippi River System developed by Wilcox (1993) was used as the basis for delineating, mapping, and naming aquatic habitat areas. Data used to determine the habitat types included bathymetry, stream velocity, wind fetch analysis, vegetation surveys, and professional on-site visual surveys. Once the aquatic areas were mapped, Geographic Information System (GIS) software was used to calculate the change in area between the existing and project conditions. Figure 6-3 shows the aquatic areas mapped for the existing and project conditions, as well as the predicted change in acreage.

The changes under project conditions would be decreases in main channel border habitat (-13.7 acres), impounded aquatic (-7.8 acres), and wing dam habitat (-3.6 acres), although the wing dams are mapped from historic data and many of the wing dams no longer exist. Project conditions would increase main channel areas (+15.2 acres), revetment (+5 acres), and floodplain shallow aquatic habitat (+4.9 acres). Descriptions of the types of habitat found in Lower Pool 2 can be found at the beginning of chapter 2.2.2.

Overall, these changes would not have a net negative impact on the value of the habitat in Lower Pool 2. The habitat types that would be lost – main channel border, impounded aquatic, and wing dam habitats – are abundant in Lower Pool 2 near the project area. No special habitat characteristics or values have been identified in the project footprint or affected areas that would be unique to the area. The channel control structures may increase habitat diversity in Lower Pool 2 by reducing wind and wave action in the shallow area between Boulanger Slough and the current main navigation channel, which could serve to protect and stabilize the areas near them and promote aquatic vegetation growth.

The dredged material would be placed in the waterlogged mining pit created by recent aggregate mining on Lower Grey Cloud Island. The pit is a water-filled depression created by excavating in a previously upland area, and is therefore excluded from consideration as a Water of the United States for purposes of jurisdiction under the Clean Water Act. The pit is very deep and has an estimated capacity of over 10 Million cubic yards, so the estimated 309,000 cubic yards generated by the proposed project would not significantly change the nature of the lake. The pit is currently being used for placement of tailings (sand) generated by the ongoing adjacent mining operation. Filling the pit with sand is part of the approved mining reclamation plan, and the addition of sand from the project would aid in restoring the mining pit. Therefore, the proposed sand placement would not have any negative effects on aquatic habitat.




| Habitat Type | Change in Acres |
|---|---|
| Impounded | - 7.8 |
| Floodplain Shallow Aquatic | + 4.9 |
| Main Channel | +15.2 |
| Main Channel Border | - 13.7 |
| Revetment | + 5.0 |
| Wing Dam | - 3.6 |
| Secondary Channel | 0 |
| Land | 0 |
| Contiguous Impounded Floodplain Lake | 0 |

**Figure 6-3 Existing and Predicted Habitat Conditions**

### 6.2.3 FISHERIES

The No-Action Alternative would not have any impacts on fisheries.

The proposed alternative would alter the local aquatic habitat types as noted above in section 6.2.2. This would lead to different habitat types available for fish in the area. Studies of fish assemblages on the UMR have noted that some species appear to exhibit preferences for localized types of habitat (e.g. Madejczyk, Mundahl, & Lehtinen 1998; Barko, Herzog, & Hrabik 2004). Both of these studies noted that certain species assemblages tended to be associated with sampling conducted near artificial rocky structure. The channel side of the control structures that would be exposed to current would likely continue to provide habitat characteristics preferred by species such as walleye, sauger, and flathead catfish. The downstream side of the channel control structures would be better-suited to species seeking refuge from current.

### 6.2.4 AQUATIC INVERTEBRATES

The No-Action Alternative would not have any impacts on aquatic invertebrates.

The proposed project would have minor adverse effects on the biological productivity of macroinvertebrates including freshwater mussels. A mussel relocation effort planned in the footprint of the proposed training structures would reduce this adverse effect, but a small number of mussels would still be expected to be killed as a result of the proposed project.

Mussel surveys were conducted in and around the study area to quantify the mussel resources within the project footprint. A survey was conducted in and around the footprints of the channel training structures that would be constructed under the proposed plan. Another survey focused on the area that would be disturbed by the Boulanger Slough Channel alternative. Timed searches were conducted in the current main navigation channel and main navigation channel border areas. Several searches were also conducted in Lower Spring Lake, although no currently proposed project features would extend into that area. Figure 6-4 shows all of the points surveyed as a part of the planning process for this project.

Within the proposed training structure footprints, about half (16) of the species known to be living in the pool were present. Four of these species are listed for state protection. No federally listed species were present. A full report detailing the survey's findings can be found in Appendix G. Density was relatively low ($3.34/m^2 \pm 1.01$) compared to high-quality mussel areas in Pool 2. Davis (2007) reported native mussel density about three times greater, $9.02/m^2 \pm 1.29$ in upper Pool 2 at Hidden Falls County Park. Similarly, across the navigation channel from the study area adjacent to Lower Grey Cloud Island in Pool 2 (River Mile 822 to 820), Kelner and Davis (2002) reported average mussel density of $9.8/m^2 \pm 0.8$. Conversely, the current study area does appear to support a slightly more abundant mussel community than the other areas surveyed as a part of the Lower Pool 2 Channel Management Study: In the nearby Boulanger Slough area, average native mussel densities were $2.41 \pm 0.6$ mussels/$m^2$ (Kelner 2012), and in the main channel, main channel border, and Nininger Slough areas surveyed by the MDNR, average mussel densities were 1.03 mussels/ mussels/$m^2$ (Davis 2012).

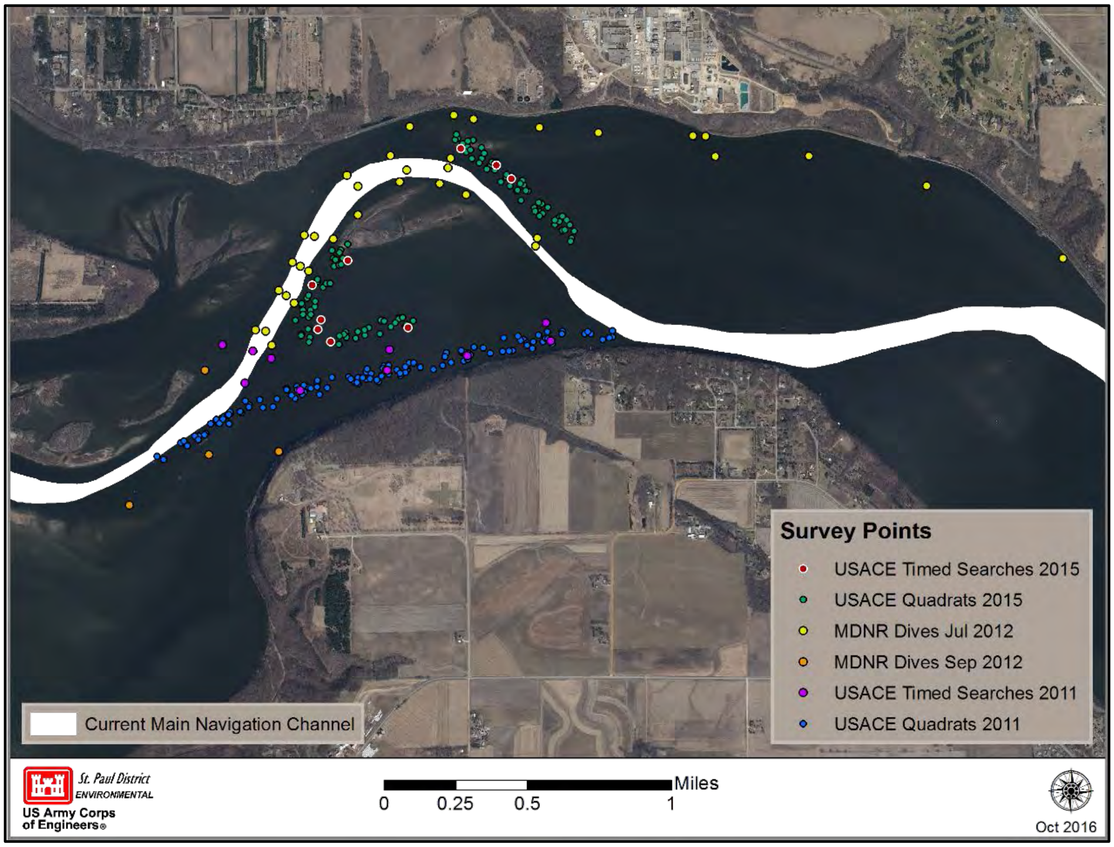



**Figure 6-4 Project-Funded Mussel Surveys**

Some of the surveys conducted in the main channel and main channel border areas were qualitative timed searches, so densities were not obtained. However, abundance can be compared using the 'Catch per Unit Effort' (CPUE), which represents the number of mussels found by collectors during a period of time. In the main channel, mussels were absent or not abundant. In the main channel border, mussels were more abundant with the CPUE between 0 and 1.7 mussels per minute, and an average of 0.6 mussels per minute. This is a bit lower than the average CPUE found near the proposed channel cut of 0.9 mussels per minute. In comparison, Lower Pool 2 sites considered to be "high-quality" by Kelner and Davis (2002) had CPUEs that ranged between 0.9 and 8.5 mussels per minute. With the exception of the sites closest to the existing islands, the substrate and habitat conditions in the channel border areas generally consisted of shifting sand, hardpan clay, or flocculent silt, none of which are considered good habitat for mussels.

Any macroinvertebrates living in the areas within the footprint of the project features (the dredge cuts and training structures) would be directly impacted during project construction. Those within the dredge cuts would be removed from the substrate and placed on land by the dredging process. Impacts to freshwater mussels from dredging would be minimal, as mussel surveys in the main channel and main channel border areas showed low-density, little diversity, and consisted of common species. These results are to be expected because the same conditions that tend to precipitate channel maintenance problems (i.e., dynamic, shifting sediment) make these areas poor habitat for mussels.

Mussels within the footprints of the rock training structures would be buried and killed. Because mussel surveys of these footprints revealed moderate mussel density which included several rare species, mitigation measures are being incorporated into the project to minimize the project's effects. Divers would be tasked with searching the footprints of the proposed training structures and collecting as many freshwater mussels as they can find. These mussels would be relocated to other nearby areas in order to augment the mussel communities. Past studies on mussel relocation efforts have shown that a high percentage of the mussels can be collected (90% or greater), and that survival following relocation is good. Appendix G describes the methodologies and protocols that would be used during the mussel relocation.

Mussels could also be impacted by indirect effects of the project. There are two primary potential impacts outside of the footprints: flow and deposition. Flow behind the structures is anticipated to be reduced, but not eliminated. The project would be expected to change the habitat in the area slowly over time. This may impact colonization of new mussels, but would not be expected to negatively affect the mussels that currently exist in the area. Deposition rates will likely also change, but as shown on Figures 28 & 29 in the H&H appendix (Appendix D), the largest changes in deposition predicted by the ADH model were ~0.6 feet over the course of approximately 5 years (476 total days were modeled, and the model assumes 100 days of active sediment movement per year. Appendix D describes this further). Mussels would not be negatively impacted by that level of sediment deposition. Therefore, the Corps does not believe the project would cause measurable indirect effects to mussels, and does not propose to relocate these mussels. Nonetheless, surveys to monitor changes in the area will be performed during the relocation effort pre-project and by the Corps 5-years post-project to verify that impacts are absent or negligible.

### 6.2.5 THREATENED AND ENDANGERED SPECIES

***Federally-Listed Species***

The proposed action would not affect any Federally-listed threatened or endangered species. Mussel surveys conducted in and around the project area (as described in Chapter 6.2.4) recovered no Federally-listed species. Surveys that were conducted nearby for unrelated purposes were also reviewed, including surveys conducted by the Minnesota DNR and Ecological Specialists, Inc. There has been one recent collection (2010) of a single, live individual Federally-listed endangered Higgins eye pearlymussel approximately one-tenth of a mile upstream from the proposed project, located off of the main channel behind a small rock island. However, it is unlikely that the species occurs within the area that would be disturbed by the project given the marginal habitat conditions identified during the surveys, as Higgins' eye are typically associated with dense, high-quality mussel beds. Substrate conditions in the project area are less than ideal for the Higgins eye, consisting of a loose, 'mucky' mixture of silt, clay, and sand, but with pockets of homogenous sand and hardpan clay. Furthermore, it is highly unlikely that any other species of Federally-listed endangered mussels inhabit the project area. The snuffbox was recently re-introduced in upper Pool 2, but has not otherwise been recently collected in Pool 2. The sheepnose is not known to be extant in Pool 2 of the Upper Mississippi River.

The northern long-eared bat, prairie bush clover, and rusty patched bumblebee are largely terrestrial species, not closely associated with the riverine environment. No habitat suitable for these species, as described in Chapter 2.2.5, would be disturbed by the proposed project.

If any upland disturbance is proposed as part of the dredged material placement, this determination will be reviewed prior to construction.

#### *Species of Local Significance*

Nine State-listed mussel species are known to exist in Lower Pool 2 that could be affected by the proposed project. The effects on individuals of these species would be the same as those discussed for other freshwater mussel species in Chapter 6.2.4 – Aquatic Invertebrates. Effects to these species would be negligible due to the mussel relocation mitigation that has been incorporated into the project plan.

Of the nine, five State-listed mussel species were collected in surveys conducted within the proposed project footprint - the pistolgrip (*Tritogonia verrucosa*), listed as endangered in Minnesota, the wartyback (*Quadrula nodulata*) and the butterfly (*Ellipsaria lineolata*), listed as threatened in Minnesota, the black sandshell (*Ligumia recta*), listed as a species of special concern in Minnesota, and the hickorynut (*Obovaria olivaria*), a 'watchlist' species.

The wartyback is listed as Threatened by the state of Minnesota, and was found during quantitative sampling throughout the two structure footprints at a relative abundance of nearly 9%. Based on the sampled density, it is estimated that approximately 1,340 ± 890 wartyback are present per acre within the project area, and therefore approximately 5,340 ± 3,560 are estimated to exist within the footprint of the proposed channel control structures. Although the wartyback is rare throughout the state including other locations within the UMR, the species has healthy populations in Pool 2. Studies of the mussel community in Pool 2 reflect the good health of the wartyback species in the area.

Two individuals of the state-endangered pistolgrip, one individual of the state-threatened butterfly, and eight individuals of the state-special concern black sandshell were found in qualitative timed-searches. A population estimate cannot be calculated based on survey data for these species because they were only found in qualitative searches. It is reasonable to assume that a small number of individuals of each of these species exist within the project footprint.

The remaining four species were not collected during the mussel surveys conducted in the project footprint, but have been previously found live in other areas of Lower Pool 2. These are the Higgins' eye (*Lampsilis higginsii*), which is listed as endangered both federally and by Minnesota (and discussed at length earlier in this section), the washboard (*Megalonaias nervosa*), which is listed as endangered in Minnesota, the monkeyface (*Quadrula metanevra*) and the fawnsfoot (*Truncilla donaciformis*), listed as threatened in Minnesota. It is possible that individuals of these species occur within the project area, but based on their absence in the project surveys it is not likely that the project area includes significant portions of their populations and therefore, the proposed project would have no effect on these species or their state status.

The paddlefish (*Polydon spathula*) is a large and long-lived planktivorous fish species that has been historically observed in Pool 2, (last documented Pool 2 observation in 2003 (Schmidt & Proulx 2009)). Paddlefish are listed as threatened in Minnesota and Wisconsin. It is not known if paddlefish use the project area, and surveys for paddlefish were not conducted because the rarity of the fish makes it extremely difficult to detect their presence using standardized sampling methods (Schmidt 2004). However, if any paddlefish are present in the project area, the project would not be likely to directly impact them since fish present in the construction areas would be expected to vacate when the area is disturbed. The habitat changes that would follow due to the project could impact paddlefish, but it is unclear whether the effect would be positive or negative. During the majority of the year, studies have associated paddlefish with deeper water (usually >3m) and generally low current velocities (Zigler et al. 2003). During spawning, paddlefish use gravel substrates or hard surfaces with enough current to keep eggs free of silt (Jennings & Zigler 2000). Neither of these habitats are present in the project footprint, and no such areas would be impacted by proposed project actions.

Kitten-tails (*Besseya bullii*) is an upland perennial herb that primarily inhabits oak savanna communities, and less frequently, other dry prairies woodlands. Many of Minnesota's populations of kitten-tails occur on the bluffs and terraces of the Mississippi River valley. No suitable habitat for kitten-tails would be impacted by the proposed project.

The loggerhead shrike (*Lanius ludovicianus*) generally inhabits upland grassland and agricultural areas, and is not strongly associated with riverine habitats. Therefore, the proposed project would not have any effect on loggerhead shrike.

Seven additional species listed as "Species of Special Concern" and on the "watchlist" have been documented near the project area. This includes two fish: the American eel (*Anguilla rostrata*) and pirate perch (*Aphredoderus sayanus*); three terrestrial vascular plants: American ginseng (*Panax quinquefolius*), Laurentian bladder fern (*Cystopteris laurentiana*), and long-bearded hawkweed (*Hieracium longipilum*); one bird: the peregrine falcon (*Falco perigrinus*); and one reptile: western foxsnake (*Pantherophis ramspotti*). The fish, snake, and bird are mobile species and would avoid the project area during construction. Wild ginseng favors deep shade in dense deciduous forests, and no such habitat would be disturbed by the proposed project. The Laurentian bladder fern is found on wet limestone cliffs which also would not be disturbed by the proposed project. Long-bearded hawkweed is found on high-quality dry prairies. The proposed project would not adversely affect habitat for any of these species.

Seven terrestrial communities were identified as existing within a mile of the project area, as listed in Table 5 in Chapter 2.2.5. No habitat of these types would be impacted by the proposed project.

### 6.2.6 AQUATIC VEGETATION

The U.S. Army Corps of Engineers Environmental Laboratory's 1987 Wetland Delineation Manual defines and describes three parameters that must be present to define an area as a wetland: "hydrophytic vegetation, hydric soils, and wetland hydrology." A wetland delineation has not been completed at the site. However, no vegetation (submergent or emergent) has been identified within the project footprints during numerous other site visits, including mussel sampling (which includes activities such as diving and substrate extraction). The lack of vegetation in the project area is likely due to site conditions that are not conducive to vegetative growth. Project features are located near the main channel where the substrate is often unstable and where wind and wave action are high.

### 6.2.7 BIRDS

Neither the No-Action or proposed alternatives are expected to affect birds.

### 6.2.8 WATER QUALITY

Under the No-Action alternative, there would be minor adverse effects on water quality associated with the disturbance of the sediments caused by the frequent dredging events required to maintain the existing navigation channel.

The proposed project would have temporary and minor adverse effects on water quality from the disruption and displacement of sediments during project construction, both during the dredging of the channel and the construction of project features. The proposed alternative would also have periodic minor adverse effects on water quality associated with maintenance dredging events similar to the No-Action alternative.

Dredging re-suspends bottom sediments, increasing turbidity. These increases in are generally local and short term. Anticipated impacts on water quality are generally related to the type of equipment used to complete a dredging job. Hydraulic dredging equipment tends to have a lesser impact on water quality at the dredge cut site than mechanical equipment. Conversely, mechanical dredging equipment tends to have a lesser impact on water quality at the placement site; because there is no carriage water to manage either on- or off-site. However, regardless of these minor differences, both methods of dredging can be conducted using best management practices that minimize effects to water quality, resulting in negligible impacts to water quality.

***Sediment Quality***

The No-Action alternative would cause disturbances of the sediments caused by the frequent dredging events required to maintain the existing navigation channel. However, based on the sediment testing results presented in Chapter 2.2.8 and in Appendix H, the sediments within the navigational channel present only a low risk of affecting benthic invertebrates due to slight exceedances of MPCA’s SQT Level I concentrations for a few PAHs and metals.

The proposed project would present temporary and minor adverse effects on adjacent and downstream suspended sediment and surficial sediment from the disruption and displacement of sediments during project construction, both during the dredging of the channel and the construction of project features. The widening of the channel would also expose more sediment to disruption, but this material only showed slight SQT Level I exceedances. The bigger concern is the substrate quality in the footprints of the training structures. The 2015 testing showed several parameters with SQT Level II and MPCA’s SRV Recreational/Residential exceedances in these areas (See Appendix H for full sampling details). However, following the construction, these sediments would effectively be capped from further movement under normal circumstances. And through coordination with the MPCA, there may be certain BMPs employed during construction that could also reduce disturbance.

### 6.2.9 TERRESTRIAL HABITAT

The placement site for the material dredged from the navigation channel would be the only upland area that would be disturbed by the proposed project. The site(s) that will be used for this purpose would be the same sites used for routine channel maintenance, and have been or will be addressed in separate planning and environmental documentation.

### 6.2.10 AIR QUALITY

Under the No-Action alternative, there would be minor adverse impacts on air quality due to the frequent dredging events required for maintaining the existing navigation channel.

The proposed project is being assessed for air quality effects on several levels: compliance with the rules provided by the Federal Clean Air Act, analysis of greenhouse gas emissions and potential effects on climate change, and impacts to local receptors.

The 1990 Federal Clean Air Act Amendments directed the Environmental Protection Agency (EPA) to develop Federal conformity rules. Those rules (promulgated as 40 CFR parts 51 and 93) are designed to ensure that Federal actions do not cause, or contribute to, air quality violations in areas that do not meet the National Ambient Air Quality Standards (NAAQS). The EPA has developed NAAQS for six principal air quality pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter, and sulfur dioxide. The final rule dictates that a conformity review be performed when a Federal action generates air pollutants in a region that has been designated a non-attainment area for one or more of the six NAAQS criteria pollutants.

Washington County is in “attainment” of the NAAQS for each of the criteria pollutants, so no conformity review is required. Dakota County is listed as a nonattainment region for Lead under the 2008 standard. However, because no lead would be emitted during the construction of or as a result of this project, the action would be exempt from the Federal conformity rules. Therefore, no conformity analysis is required for the proposed project.

Greenhouse gas emissions and their effect on climate change are global issues resulting from numerous and varied sources, with each source making a relatively small addition to global atmospheric greenhouse gas concentrations. Additionally, the ability to accurately predict the localized or short-term effects of changes in greenhouse gas emissions is extremely limited. Nevertheless, it is imperative for agencies to identify the potential emissions from project alternatives when it may inform the agency's decision-making.

The proposed project would be expected to produce greenhouse gasses during construction in the form of exhaust from various types of machinery used for dredging, material transport, and material placement. The proposed project would also have recurring minor adverse impacts on air quality from dredging events required for maintaining the navigation channel at approximately the same level as the No-Action alternative.

The Council on Environmental Quality (CEQ) released draft NEPA guidance for consideration of the effects of climate change and greenhouse gas emissions in February, 2010. The guidance proposed a level of 25,000 metric tons or more of $CO_2$-equivalent GHG emissions annually as an indicator that detailed assessment of greenhouse gasses may be meaningful to decision makers and the public. Using estimates of fuel usage and production quantities for mechanical dredging, it was estimated that dredging and associated placement would result in a release of approximately 1,000 metric tons of $CO_2$-equivalent greenhouse gas emissions. Although more difficult to estimate the emissions related to the construction of the training structures, the level of effort is anticipated to be similar to that of the dredging, and would utilize similar construction equipment. Based on these initial estimates, it does not appear that a detailed assessment of GHG emissions is warranted for this project.

At a local scale, the nearest sensitive receptor is Spring Lake Regional Park, which is located on top of the bluff, a little over 1,000 feet south of the upstream proposed training structure. Several residential properties lie to the east of the park, also on top of the bluff, and would be approximately 2,000 feet away from the tip of one of the proposed training structures. No other receptor sites have been identified within 2,000 feet of any proposed construction. During project construction, the project would have a temporary, minor, and localized adverse effect on air quality due to emissions produced by construction equipment. This would be short-lived and would disappear upon project completion. Construction activities are expected to produce very little dust because the materials to be handled would be either wet (dredged material) or larger materials than are generally mobilized by wind (large rocks for training structure construction).

## 6.3 Cultural Resource Effects

A variety of Project features have the potential to affect identified and unidentified cultural resources. These include direct and indirect impacts to islands and high potential landforms that are now submerged. Cultural resources investigations included pedestrian surveys along island shorelines and interiors and execution of a submerged sediment boring program to detect inundated and deeply buried sites. No cultural resources were identified. In general, a combination of navigation channel maintenance activities and post 1930s fluvial processes appear to have dramatically altered, severely degraded or otherwise destroyed much of the pre-lock and dam landforms in the Project Area. The potential for the Project Area to contain intact, significant cultural resources is remote. The Corps has determined that the Project would have no potential to effect historic properties. A synopsis of the cultural resources investigations for the Project follows.

### 6.3.1 Wing Dams

Collectively, Wing Dams are considered eligible for listing on the NRHP (Pearson 2003). Between RM 821 and RM 815.2 at Lock and Dam 2, 46 wing dams were placed along the main channel between 1875 and 1924. Many of these were modified several times during the $20^{th}$ century (e.g., lengths reduced) or subsequently removed or otherwise destroyed during channel dredging with the eastward or downstream drift of the main channel. No wing dams or training structures remain in the areas proposed for revetment construction. Thus, the project has no potential to effect wing dams or their allies.

### 6.3.2 Boulanger Island Remnant

The island along the right descending bank near RM 819.5 is a remnant of the greater Boulanger Island, also known as Island no. 16. It has been enhanced with dredged material. The main channel side of the island likely hosted a natural levee, with the back side lower in elevation and grading into wetlands. A proposed revetment for the project would tie into the western portion of the existing island. The island was subjected to a surface reconnaissance in August 2013. The island has received extensive deposits from historic side casting of dredged material. The remnants of a wing dam are present at the head of the island. However, the project would not impact this relic.

Because proposed project features would not involve disturbing sub-surface sediments, no deep site testing was completed. Other than the wing dam residuum, no cultural resources were identified. As above, the Project has no potential to effect historic properties.

### 6.3.3 SUBMERGED HIGH PROBABILITY LANDFORMS

Prior to its inundation after 1930, the Pool 2 floodplain contained a suite of landforms. Principal among these are natural levees, areas within the floodplain that often remained above water during minor floods, are well drained and therefore attractive areas for a variety of human activities. A number of cultural resource sites have been identified on natural levees in the UMR and these landforms are considered to have a high potential to contain cultural resources (e.g., Benn and Lee 2005; Kolb and Boszhardt 2004; Perkl 2005; Hudak et al 2002). Within the Project Area, natural levees were evident along both sides of the main channel.

An analysis of the pre-inundation landforms in the Project Area uses the MRC 1895 chart as a proxy for elevations. Low-lying areas average approximately 680 feet above mean sea level (amsl). Areas thought to coincide with natural levees approach elevations of approximately 690 feet amsl. Pool 2 is currently maintained with a water surface elevation of approximately 687 ft amsl, equating to a water level rise of approximately seven feet since 1930. By 1937, much of the floodplain was inundated, although narrow islands along the main channel-the tops of natural levees-remained. By 1953 these features were absent. Recent bathymetry indicates that the depth of the river bottom ranges between approximately less than one foot to three feet over natural levees and from approximately three to nine feet in lower areas. The main navigation channel is nine feet or deeper. From this information, it appears that approximately a minimum four feet of the natural levees have eroded across the area. While some of the pre-1930 topography can be detected, in many low-lying areas sedimentation has occurred in the range of three to four feet of overburden. Despite the apparent degradation of natural levees in the Project Area, deeply buried cultural resources may exist in these landforms (e.g., Florin and Lindbeck 2008; Stoltman 2005). Therefore, these features warranted cultural resources investigations.

The method of choice for detecting submerged cultural resources was through a boring program that is informed from sediment cores and adapts geotechnical boreholes to recover cultural material (Perkl 2007). This program uses equipment mounted on a pontoon barge. River bottom sediments and stratigraphy are initially examined using a 3-inch split-spoon core sampler. Important characteristics of the sediment column that may indicate cultural phenomena include buried surfaces, freshwater shell concentrations and artifacts. This is followed by an adjacent borehole ‘drilled’ using a jerk-line apparatus. A 4-inch casing is set at intervals of several vertical feet to depth and the matrix flushed out with a water-bentonite mix using a 3-inch chopper head. The slurry is passed through 1/8 inch hardware cloth and the contents examined for cultural material.

This method can reach depths sufficient to penetrate pre-inundated river bottom surfaces well below near-surface to detect deeply-buried cultural deposits.

Three episodes of boring activities have been completed in the Project Area, in August 2011, November 2012, and June 2013. A total of 41 bore holes were placed in three areas: along Boulanger Slough (n=21) and Boulanger Island south (n=12) and north (n=8) of the slough's head. On average, bore holes penetrated 15 feet below the bottom surface of the river. Sediments varied across the area from silts, sands, and clays and contained various inclusions, such as shell, bark and wood fragments. Typically, organic matter was encountered at the top of the bores denoting the river bottom. No deeply buried soil horizons were detected. None of the bore holes were positive for cultural material.

Results of the boring program reveal extensive scouring and sedimentation across the area, as predicted in the review of historical information. No remnants of the natural levee were detected in the area along the main channel below the slough's head (ca. RM 819.5-820.1). In this area, it appears that the main channel has obliterated the natural levee as it shifts downstream and to the east. Likewise, between RM 819.5 and 818.3 the natural levee residing along the left descending bank has been removed by channel migration. The proposed revetments in this area will be placed on elevations below 690 ft amsl. In fact, borings along this stretch reveal wetland sediments (i.e., gley soils) prior to 1930s river improvements with inundation of the floodplain. If the natural levees in the area once harbored cultural deposits, they have been destroyed or extensively disturbed from fluvial processes. Based on extensive investigations of submerged land forms in the Project Area with negative results, the Project has no potential to effect historic properties in such areas.

### 6.3.4 PROXIMAL RECORDED CULTURAL RESOURCES

Anticipated indirect effects to identified cultural resources proximal to the Project Area are restricted to visual impacts. However, visual impacts from the project should not be detrimental as those sites that are visible from the project area would not be significantly altered by visual changes, such as vegetation removal or construction of river training structures.

### 6.3.5 COORDINATION

The proposed project has no effect on historic properties; as such, additional coordination is not required.

## 6.4 Cumulative Effects

### 6.4.1 Scope of Cumulative Effects Analysis

Cumulative effects are defined by the Council on Environmental Quality as, "[T]he impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

The time frame considered for the scoping of potential future cumulative impacts was bounded by the project life considered during other analyses, which was 40 years. This is the life-span for project costs, benefits, and effects that is normally considered during the planning of Corps projects. Although this life-span is somewhat arbitrary, no reasonably foreseeable future actions were identified beyond this time scale.

The environmental analysis for the proposed project did not identify significant effects outside of the direct project area. Therefore, the geographic scale analyzed for cumulative impacts was limited to potential actions that have or would have effects in the immediate project area. However, this does not mean that only activities with footprints overlapping the proposed project were considered - this is because the proposed project is a part of a large river system, which necessitates considering if actions upstream or downstream could also impact this particular reach of the river.

### 6.4.2 Actions Identified Within the Project Impact Zone

The following past, present, and reasonably foreseeable future actions were identified as having the potential to interact with or have impacts related to those of the proposed project.

***Past Actions:***

*Modifications to the Upper Mississippi River for Navigation*

The floodplain geomorphology, stream hydraulics, and water levels of the Upper Mississippi River have been modified by impoundment and other navigation features since the 1820s. The most relevant navigation improvement actions within the project impact area are likely the construction of hundreds of channel training structures placed between 1866 and 1907 as part of the 4-foot, 4.5-foot, and 6-foot navigation channel projects. Following the construction of these structures was the construction of Lock and Dam Number 2 in 1930, which raised water levels by several feet in the immediate project area and allowed for a 9-foot-deep navigation channel. The cumulative effect of these actions has played a large role in the development of the habitat that currently exists in the project area.

*Closure of Upper St. Anthony Falls Lock and Dam to Navigation*

Due to concerns regarding the spread of invasive Asian carp, Section 2010 of the Water Resources Reform and Development Act of 2014 (WRRDA 2014) directed the Secretary of the Army to close the Upper St. Anthony Falls lock to navigation within one year after enactment. The WRRDA 2014 was signed into law on June 10, 2014. The WRRDA 2014 allows the lock to continue to be operated for emergency flood control. The lock was closed to navigation on June 9, 2015. The WRRDA 2014 did not direct further disposition of the lock.

***Concurrent and Ongoing Actions:***

*Lake Pepin Eutrophication Total Maximum Daily Load (TMDL) Study and South Metro Mississippi River Total Suspended Solids TMDL Study*

The Minnesota Pollution Control Agency has identified the Mississippi River from Lock and Dam 1 to the head of Lake Pepin to be impaired for phosphorus and total suspended solids (TSS). Ongoing TMDL studies are being undertaken to identify the maximum quantities of these pollutants that can be allowed to enter the water body without exceeding water quality standards. The proposed project would have a minor effect on TSS and turbidity levels. Turbidity in this reach of the river began increasing in the early 1920s as the Twin Cities metropolitan area grew and agricultural use of the Minnesota River Basin increased. Sediment cores from Lake Pepin have shown that the sediment load to Lake Pepin doubled between the 1930s and the 1960s and has stabilized at that level, although the source of the sediment has shifted from farm fields to increased erosion of stream banks and bluffs.

*Pool 2 DMMP*

A dredged material management plan (DMMP) is being prepared for Pool 2 to identify long term placement of channel maintenance dredged material. The DMMP will identify a “base plan” for managing dredged material over the next 40 years. The base plan is the least costly and environmentally acceptable method of managing dredged material. The Pool 2 DMMP will be completed in 2017 and material dredged as a part of the TSP and future material dredged as part of ongoing channel maintenance will be placed in the site identified in the DMMP.

***Reasonably Foreseeable Future Actions:***

*Proposed Nelson Mine Expansion*

There is an ongoing mining operation utilizing an area of Grey Cloud Island, adjacent to the proposed project area. The mining company, Aggregate Industries, has produced a Draft Environmental Impact Statement for a proposed expansion of the mining activities. Mining operations would be expanded into 230 acres of privately-owned backwaters in order to access approximately twenty-one million tons of aggregate material. The project would extend the useful life of the equipment currently being used for mining on the island, and would be estimated to proceed for approximately twenty years.

*Dakota County Park Expansion*

Dakota County has expressed interest in expanding Spring Lake Park Reserve in the future. Plans may include development along the shore of Spring Lake for recreational boat launching or day-use areas.

*Grey Cloud Island Slough Restoration*

Grey Cloud Island is located adjacent to and slightly upstream of the project area. The upper end of the slough is located at approximately River Mile 827.5, and the lower end of the slough is located in the northwest of Freeborn Bend, at approximately River Mile 819.5. The slough once conveyed flow, but the connectivity has been severed since approximately 1965 when flooding provoked an emergency raise of the bridge during which the bridge culverts were filled. Since 1965, the ecological condition of the two disconnected ends of the slough has degraded. A number of potential alternative projects are being considered that would restore connectivity and flow to the slough, resulting in a diversion of an estimated 1-5% of the total Mississippi River flow through this slough.

### 6.4.3 Environmental Consequences of Cumulative Effects

The environmental consequences outlined below are organized by resource categories, in the same order the resources are discussed in Chapters 2 and 6. Refer to Chapter 2 for detailed descriptions of the affected environment or to the respective sections of Chapter 6 for detailed descriptions of environmental effects.

***Recreation***

Recreational opportunities would not be adversely affected by the proposed project. Any expansion of river access within Spring Lake Regional Park would be expected to further improve the recreational opportunities.

***Aesthetic Values***

The proposed project would have minor adverse effects on aesthetic values by introducing two low, rock training structures into the viewshed that would be visible from locations such as the scenic overlook at Schaar's Bluff in Spring Lake Regional Park. The proposed Nelson Mine Expansion project also has the potential to cause minor impacts to this scenic overlook: construction and mining equipment may be visible and several berms are proposed for temporary use (years) during active mining.

***Hydrology, Hydraulics, and Sediment Transport***

The proposed Nelson Mine Expansion project may include the construction of a berm that would reduce or eliminate flows entering the side channel where mining is proposed. This would have the effect of increasing flows in the main channel upstream of the project area. Any sediment that under current conditions would have been be deposited in the slough would instead continue downstream.

The proposed Grey Cloud Island Slough Restoration would have minor effects on the hydraulic function of the area, by redirecting 1-5% of the Mississippi River's flows through the slough. This minor change is not expected to impact the sediment capacity of the navigation channel.

The closure of Upper Saint Anthony Falls Lock could have an impact on dredging quantities in Pool 2, however this depends on future dredging practices in the Upper St. Anthony Falls (USAF) Pool and Pool 1. If dredging in just the USAF Pool was eliminated, the increase in dredging in Pool 2 would be minimal, as long as dredging in Pool 1 was increased to account for the additional sediment load from the USAF Pool. If dredging in both the USAF pool and Pool 1 were eliminated, the increase in dredging in Pool 2 could be substantial. Sediment budget analysis indicates that annual dredging volumes could increase by as much as 40-percent, however an unknown is the amount of time for the increase in Pool 2 dredging to occur. Observation from other river reaches where large changes in sediment transport capacity or dredging volumes have occurred suggest that it could be a decade or more before increased dredging occurs in lower pool 2.

***Mussels***

According to the draft EIS, the proposed Nelson Mine Expansion project would destroy all of the mussels currently found within the mining area, totaling approximately 230 acres. Depending on reclamation strategies following mining, much of the 230 acres may remain unsuitable habitat for mussels after project completion. There may also be effects on downstream mussel communities due to degraded water quality during the period of project operation. Mitigation to offset these effects has been proposed as part of the project and is currently under evaluation. Without a definite long-term plan, it is difficult to further assess the long-term impacts of the proposed project on freshwater mussels.

The proposed project would not be expected to have long-term negative impacts on mussel populations due to the incorporation of relocation of the mussels.

#### *Water Quality*

The proposed Nelson Mine Expansion Project would cause increases in suspended sediment load downstream of the project area during periods of high flow. The Draft EIS for the proposed project estimates that over the 20-year life of the project, a total of approximately 60,000 tons of sediment (an average of 3,000 tons per year) would be introduced to Lower Pool 2.

The project would cause minor increases in turbidity during dredging and construction of project features, which would be temporary and would disappear upon project completion.

## 6.5 Summary of Environmental Effects

Table 10 provides a summary of the environmental consequences of the No-Action alternative and the potential effects of the proposed project. The No-Action alternative is considered to be the base condition, and includes those actions expected to be undertaken in the future in the absence of an additional project, including channel maintenance actions that have previously been authorized. Therefore, the impacts to each of the resource categories under the No-Action alternative are in general a continuation of those that have been caused by current channel maintenance practices. The impacts listed under the proposed alternative are those discussed in detail within Chapter 6. Temporary impacts, denoted in the table by the letter “T,” represent short-term effects, which are usually related to one-time construction efforts.

In general, the No-Action Alternative would have minor adverse impacts on commercial navigation; and temporary minor adverse effects on noise levels, air quality, aquatic habitat, biological productivity, and surface water quality. In comparison, the proposed project would have similar temporary minor adverse impacts on noise levels, air quality, biological productivity, and surface water quality, and would have additional minor adverse impacts on aesthetic values, public safety, and aquatic habitat; substantial beneficial effects on commercial navigation; and minor beneficial effects on public safety.

**Table 11 Environmental Assessment Matrix**

| | No Action` Alternative | | | | | | | Proposed Alternative | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BENEFICIAL | | | | ADVERSE | | | BENEFICIAL | | | | ADVERSE | | |
| PARAMETER | SIGNIFICANT | SUBSTANTIAL | MINOR | NO EFFECT | MINOR | SUBSTANTIAL | SIGNIFICANT | SIGNIFICANT | SUBSTANTIAL | MINOR | NO EFFECT | MINOR | SUBSTANTIAL | SIGNIFICANT |
| **A. Social Effects** | | | | | | | | | | | | | | |
| 1. Noise Levels | | | | | T | | | | | | | T | | |
| 2. Aesthetic Values | | | | X | | | | | | | | X | | |
| 3. Recreational Opportunities | | | | X | | | | | | | X | | | |
| 4. Transportation | | | | X | | | | | | | X | | | |
| 5. Public Health and Safety | | | | X | | | | | | X | | X | | |
| 6. Community Cohesion (Sense of Unity) | | | | X | | | | | | | X | | | |
| 7. Community Growth and Development | | | | X | | | | | | | X | | | |
| 8. Business and Home Relocations | | | | X | | | | | | | X | | | |
| 9. Existing/Potential Land Use | | | | X | | | | | | | X | | | |
| 10. Controversy | | | | X | | | | | | | X | | | |
| **B. Economic Effects** | | | | | | | | | | | | | | |
| 1. Property Values | | | | X | | | | | | | X | | | |
| 2. Tax Revenue | | | | X | | | | | | | X | | | |
| 3. Public Facilities and Services | | | | X | | | | | | | X | | | |
| 4. Regional Growth | | | | X | | | | | | | X | | | |
| 5. Employment | | | | X | | | | | | | X | | | |
| 6. Business Activity | | | | X | | | | | | | X | | | |
| 7. Farmland/Food Supply | | | | X | | | | | | | X | | | |
| 8. Commercial Navigation | | | | | X | | | | X | | | | | |
| 9. Flooding Effects | | | | X | | | | | | | X | | | |
| 10. Energy Needs and Resources | | | | X | | | | | | | X | | | |
| **C. Natural Resource Effects** | | | | | | | | | | | | | | |
| 1. Air Quality | | | | | T | | | | | | | T | | |
| 2. Terrestrial Habitat | | | | X | | | | | | | X | | | |
| 3. Wetlands | | | | X | | | | | | | X | | | |
| 4. Aquatic Habitat | | | | | T | | | | | | | X | | |
| 5. Habitat Diversity and Interspersion | | | | X | | | | | | | X | | | |
| 6. Biological Productivity | | | | | T | | | | | | | T | | |
| 7. Surface Water Quality | | | | | T | | | | | | | T | | |
| 8. Water Supply | | | | X | | | | | | | X | | | |
| 9. Groundwater | | | | X | | | | | | | X | | | |
| 10. Soils | | | | X | | | | | | | X | | | |
| 11. Threatened or Endangered Species | | | | X | | | | | | | X | | | |
| **D. Cultural Resource Effects** | | | | | | | | | | | | | | |
| 1. Historic Architectural Values | | | | X | | | | | | | X | | | |
| 2. Prehistoric & Historic Archeological Values | | | | X | | | | | | | X | | | |

T= Temporary Effect

CHAPTER 7.

# Environmental Compliance and Review

## 7.1 Applicable Environmental Laws and Executive Orders

The proposed action would comply with federal environmental laws, Executive Orders and policies, and applicable state and local laws including but not limited to the Clean Air Act, as amended; the Clean Water Act, as amended; the Endangered Species Act of 1973, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; the Land and Water Conservation Fund Act of 1965, as amended; the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969, as amended; Executive Order 11990 - Protection of Wetlands; Executive Order 12898 - Environmental Justice; the Farmland Protection Policy Act of 1981 (the proposed action would not result in the conversion of farmland, as defined by the Farmland Policy Act, to non-agricultural uses); and Executive Order 11988 - Floodplain Management.

## 7.2 Public Involvement

A public notice of availability of the Draft Report was published on June 26, 2017, on the Corps website. A public meeting will be held if requested and the results of the meeting would be documented in this section, and in the Coordination & Correspondence Appendix A following the finalization of this report. Comments received will be documented in the Coordination and Correspondence section as well.

The draft report has also been concurrently published for a 30-day review and public comment period by the Minnesota DNR, in fulfilment of state requirements of the Minnesota Environmental Protection Act. The Minnesota DNR has adopted this Draft Federal Environmental Assessment for use as a Minnesota State Environmental Assessment Worksheet (EAW). Appendix I has been prepared to help reviewers of the state publication to find the information typically included in an EAW.

## 7.3 Coordination

Planning for the overall project has been coordinated with the public, state and federal agencies, and other interested parties. Several coordination meetings were held in and around Hastings, MN to discuss alternatives and their potential effects with members of interested agencies and stakeholders. The views expressed by the public and agencies have been considered throughout project planning. In addition to the meetings, informal coordination took place on an as-needed basis to address specific problems, issues, and ideas. Table 11 lists applicable environmental regulations and guidelines and provides their current review status. Detailed descriptions of compliance efforts for certain regulations follow.

### 7.3.1 CLEAN WATER ACT

The dredging and fill activities associated with training structure construction would have effects on water quality. The Corps has completed a 404(b)(1) analysis which describes these effects (Appendix B). The Corps will also apply for 401 Water Quality Certification from the Minnesota Pollution Control Agency based on final estimates of quantities of materials determined as part of the Plans and Specifications phase.

### 7.3.2 FISH AND WILDLIFE COORDINATION ACT, ENDANGERED SPECIES ACT

In compliance with the FWCA, project plans have been coordinated with the USFWS and the Minnesota DNR.

### 7.3.3 MINNESOTA STATE ENVIRONMENTAL REVIEW AND PERMITS

The Corps will submit an application to the Minnesota DNR for a Public Waters Work Permit, out of comity. The project as planned would exceed the threshold requiring preparation of a Minnesota EAW, as defined in Minnesota Rules, part 4410.4300, subpart 27, item A. The Corps has worked with the Responsible Government Unit (the Minnesota DNR) to ensure that the federal EA will fulfill the requirements of the EAW. A supplement has been prepared to assist reviewers in locating sections which pertain to EAW requirements (see Appendix I).

### 7.3.4 CULTURAL RESOURCES AND TRIBAL COORDINATION

Consultation with Native American groups and the Minnesota State Historic Preservation Office (SHPO) is in progress.

### 7.3.5 ADDITIONAL ENVIRONMENTAL REVIEW

Some additional permits and environmental planning may fall under the responsibility of the contractor conducting the proposed work. The contractor would be responsible for obtaining construction permits as necessary, such as a National Pollutant Discharge

Elimination System permit. These responsibilities would be detailed in the Specifications provided to the Contractor.

## 7.4 Distribution of Draft Environmental Assessment

This environmental assessment has been provided via computer on the St. Paul District's public website and a press release was published. The following agencies were notified directly regarding the availability of the report:

***Federal***

U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. National Park Service
U.S. Coast Guard

***State of Minnesota***

Department of Natural Resources
Pollution Control Agency
Department of Transportation
Metropolitan Council

***Tribes***

Ho-Chunk Nation
Lower Sioux Indian Community
Prairie Island Indian Community
Shakopee Sioux Community
Upper Sioux Indian Community

***Others***

Dakota County
Washington County
Navigation Industry Representatives
Friends of Pool 2
American Rivers

## 7.5 Comments on the Environmental Assessment

We request and welcome written comments on environmental assessment. **Please provide written comments by July 26, 2017,** to the St. Paul District, U.S. Army Corps of Engineers, ATTN: Mr. Aaron McFarlane, CEMVP-PD-E, 180 Fifth Street East, Suite 701, St. Paul, Minnesota 55101, or by email to: Aaron.M.McFarlane@usace.army.mil.

**Table 12 Compliance review with all applicable Federal environmental regulations and guidelines**

| Environmental Requirement | Compliance[1] |
|---|---|
| *Federal Statutes* | |
| Archaeological and Historic Preservation Act | Partial |
| Bald and Golden Eagle Protection Act of 1940, as amended | Partial[4] |
| Clean Air Act, as amended | Full |
| Clean Water Act, as amended | Partial[2] |
| Coastal Zone Management Act, as amended | N/A |
| Endangered Species Act of 1973, as amended | Full |
| Federal Water Project Recreation Act, as amended | Full |
| Fish and Wildlife Coordination Act, as amended | Full |
| Land and Water Conservation Fund Act of 1965, as amended | Full |
| Migratory Bird Treaty Act of 1918, as amended | Full |
| National Environmental Policy Act of 1969, as amended | Partial[3] |
| National Historic Preservation Act of 1966, as amended | Full |
| National Wildlife Refuge Administration Act of 1966 | Full |
| Noise Pollution and Abatement Act of 1972 | Full |
| Watershed Protection and Flood Prevention Act | N/A |
| Wild and Scenic Rivers Act of 1968, as amended | N/A |
| Farmland Protection Policy Act of 1981 | N/A |
| | |
| *Executive Orders, Memoranda* | |
| Floodplain Management (EO.. 11988) | Full |
| Protection and Enhancement of Environmental Quality (E.O. 11514) | Full |
| Protection and Enhancement of the Cultural Environment (E.O. 11593) | Full |
| Protection of Wetlands (E.O. 11990) | Full |
| Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 30 August 1976) | Full |

[1] The compliance categories used in this table were assigned according to the following definitions:

a. Full - All requirements of the statute, E.O., or other policy and related regulations have been met for the current stage of planning.
b. Partial - Some requirements of the statute, E.O., or other policy and related regulations remain to be met for the current stage of planning.
c. Noncompliance (NC) - Violation of a requirement of the statute, E.O., or other policy and related regulations.
d. Not Applicable (N/A) - Statute, E.O., or other policy and related regulations not applicable for the current stage of planning.

[2] 401 water quality certification required.
[3] Full compliance to be achieved with the District Engineer's signing of the Finding of No Significant Impact.
[4] Bald eagle non-purposeful take permits may be obtained.

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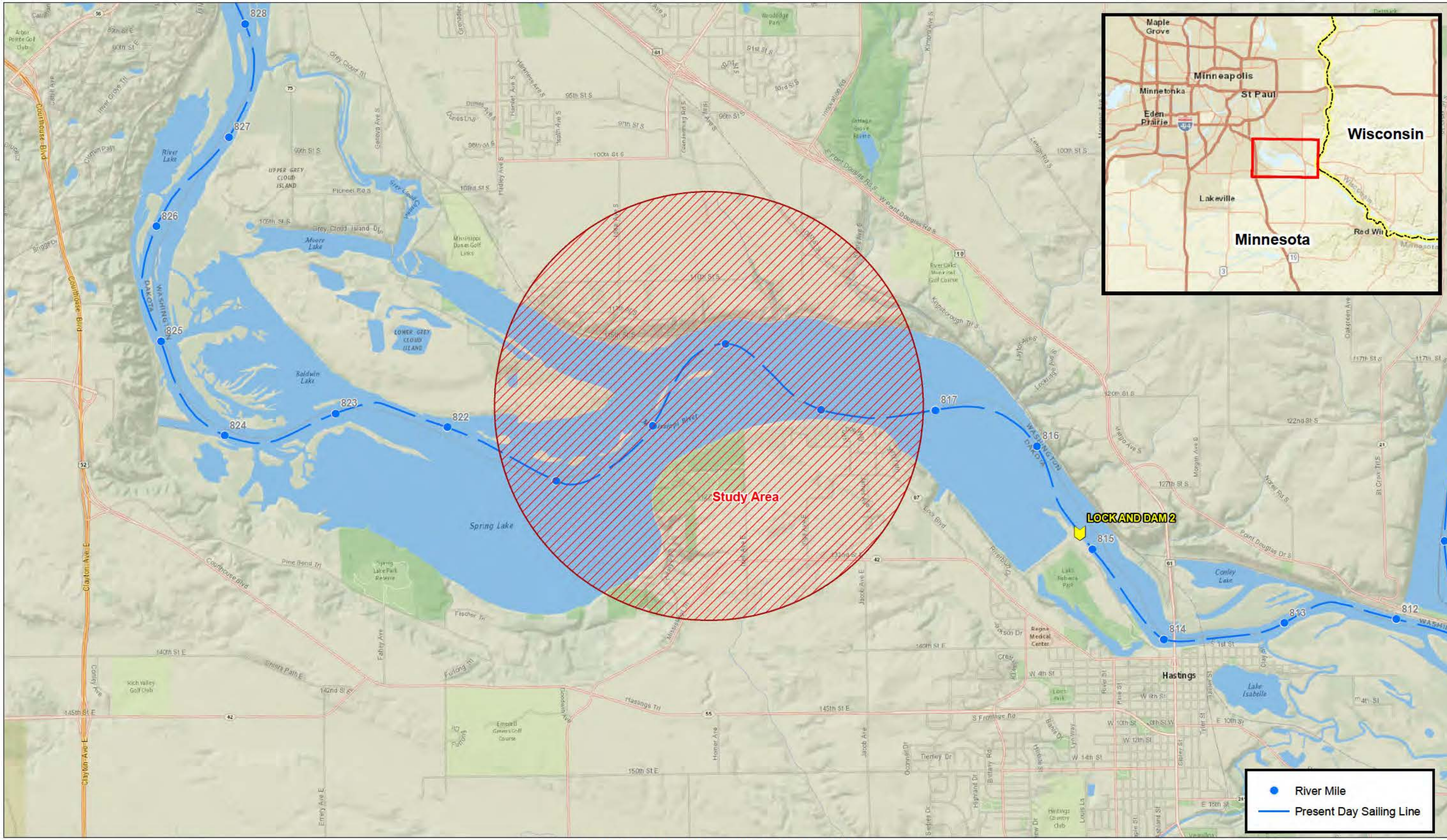


**Pool 2 - Site Plan - Mississippi River**

Base Image: National Geographic World Map

0 4,000 8,000 Feet

N

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**Plate 1: LP2-CMS**

\Pool 02\LP2 CMS Boulanger to LD2 2013\10 GIS Support\MXD\Plate1 Boulanger SitePlan.mxd MRW 20161205


## Pool 2 - Historic Channel - Mississippi River

Base Image: USACE 1927

0 2,000 4,000 Feet

N

**Plate 2: LP2-CMS**

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\Pool_02\LP2_CMS_Boulanger_to_LD2_2013\10_GIS_Support\MXD\Plate2_Boulanger_HistoricChannel_1927.mxd MRW 20161205


Pool 2 - Bathymetry 2014/15 - Mississippi River

Base Image: 2015 NAIP

0 2,000 4,000 Feet

Plate 3: LP2-CMS

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\Pool_02\LP2_CMS_Boulanger_to_LD2_2013\10_GIS_Support\MXD\Plate3_Boulanger_Bathymetry.mxd MRW 20161205


# Pool 2 - Channel Width - Mississippi River

Base Image: 2015 NAIP

2,000 0 2,000 Feet

**Plate 4: LP2-CMS**

ICM dredging dimensions:
818.0-820.5 - 350'
820.5-821.0 - 450'

Authorized dredging dimensions:
817.8-820.3 - 400'
820.3-821.5 - 500'

N

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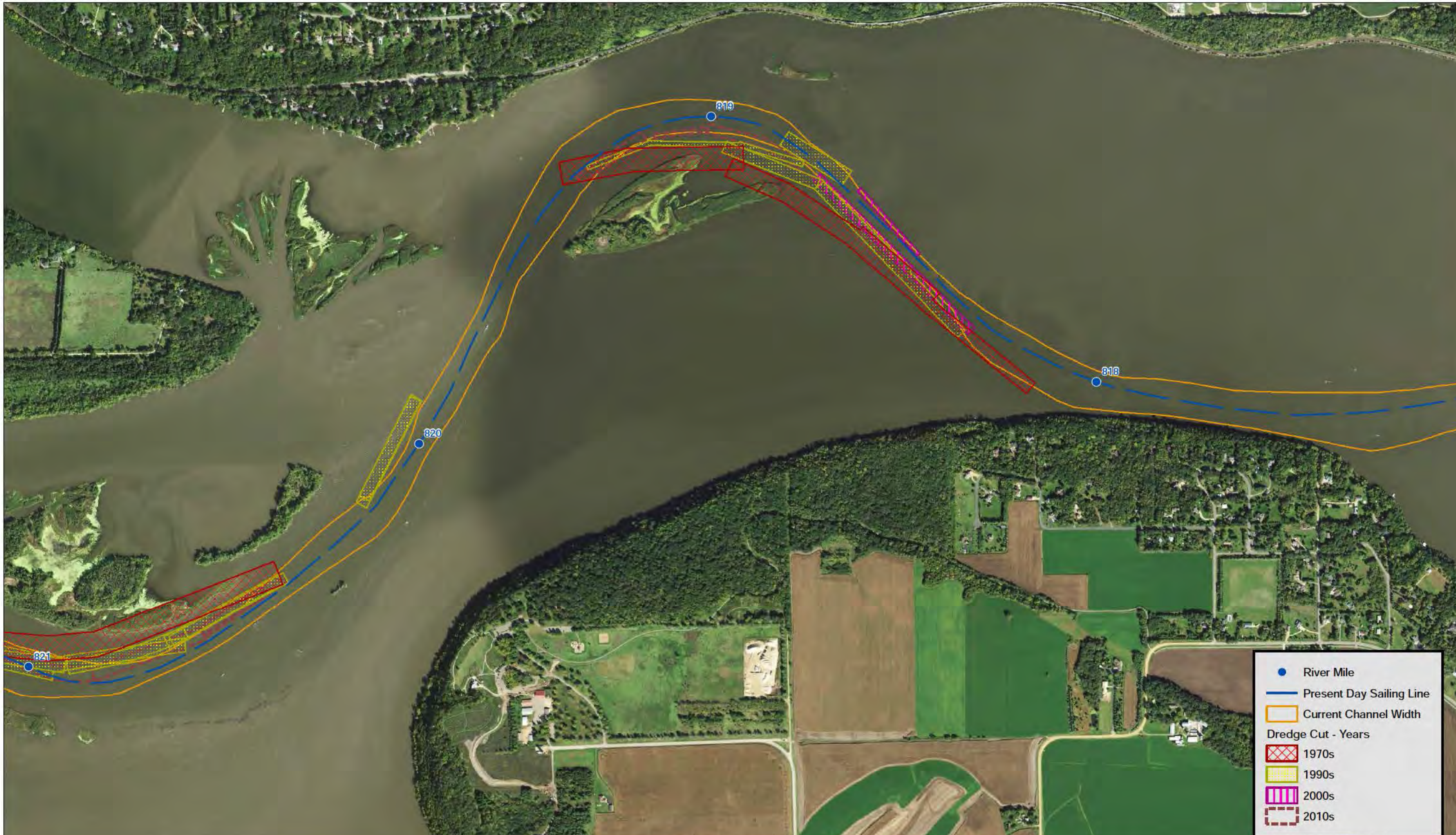


Pool 2 - Dredge Cuts - Mississippi River

Base Image: 2015 NAIP

2,000 0 2,000 Feet

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Plate 5: LP2-CMS

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\Pool_02\LP2_CMS_Boulanger_to_LD2_2013\10_GIS_Support\MXD\Plate5_Boulanger_DredgeCuts.mxd MRW 20161205


# Pool 2 - Current TSP - Mississippi River

Increase Channel Mainenance with Structures (ICMS)

Base Image: 2015 NAIP

2,000 0 2,000 Feet

N

**Plate 6: LP2-CMS**

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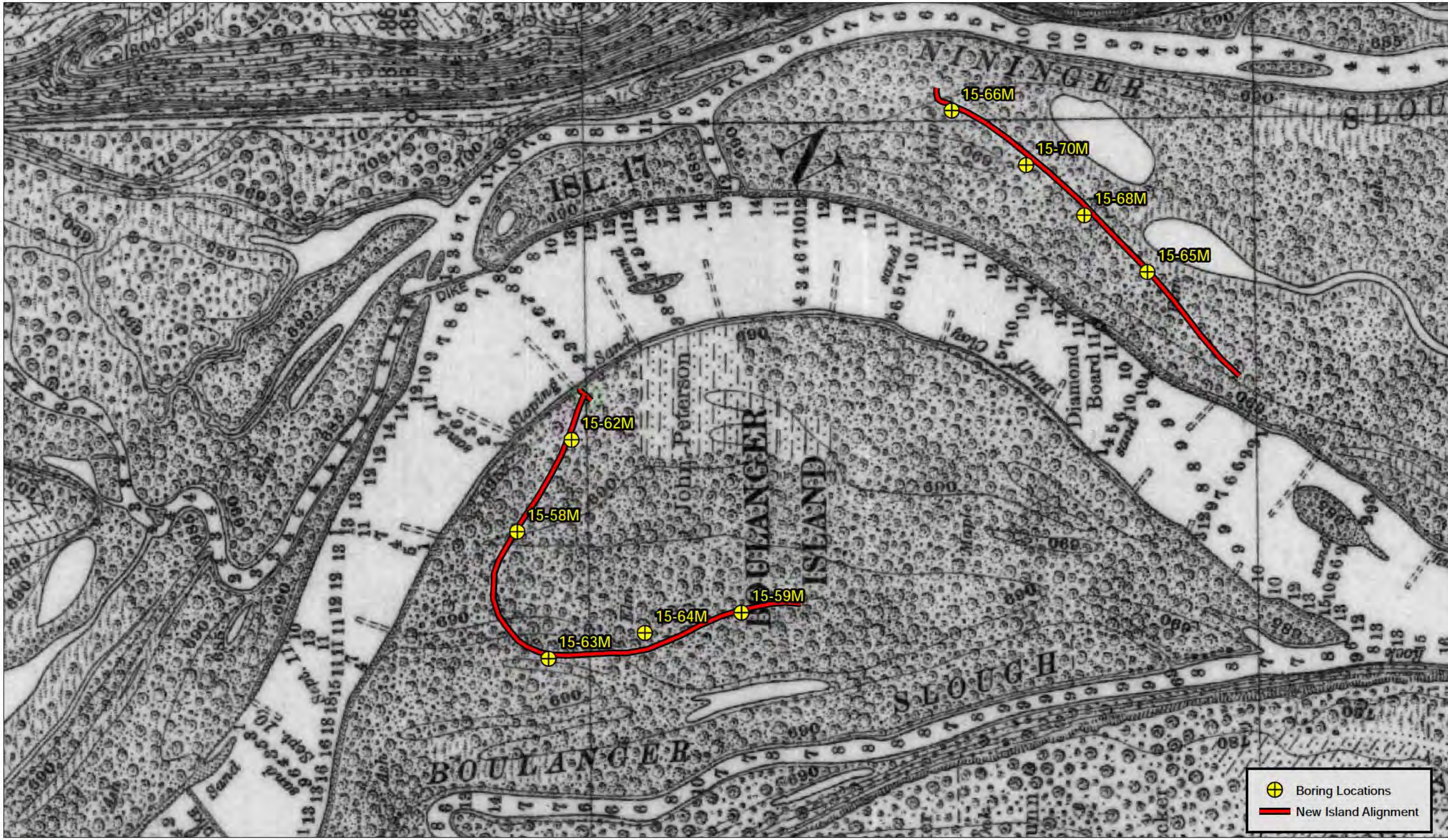
\Pool_02\LP2_CMS_Boulanger_to_LD2_2013\10_GIS_Support\MXD\Plate6_Boulanger_TSP_ICMS.mxd MRW 20161206




Pool 2 - Historic Channel - Mississippi River

Base Image: 1890 Brown Survey

600 0 600 1,200 Feet

Plate 7: LP2-CMS

St. Paul District GIS CENTER

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\Pool_02\LP2_CMS_Boulanger_to_LD2_2013\10_GIS_Support\MXD \Plate7_Boulanger_RockMound_1890_BrownSurvey.mxd MRW 20161220

# Attachment B

January 2017 Comments of the National Wildlife Federation, American Rivers, Missouri Coalition for the Environment, and Prairie Rivers Network on the Regulating Works Project Draft Supplemental Environmental Impact Statement

Comments on the
Regulating Works Project
Draft Supplemental Environmental Impact Statement
November 2016

Submitted by

National Wildlife Federation
American Rivers
Missouri Coalition for the Environment
Prairie Rivers Network

January 18, 2017

Submitted by email to: RegWorksSEIS@usace.army.mil

# Table of Contents

The National Wildlife Federation, American Rivers, Missouri Coalition for the Environment, and Prairie Rivers Network (collectively, the Conservation Organizations) appreciate the opportunity to submit these comments on the Regulating Works Project Draft Supplemental Environmental Impact Statement (November 2016) (the "DSEIS"). The Conservation Organizations strongly oppose the preferred alternative in the DSEIS and urge the Corps of Engineers to develop and select an alternative that will protect communities and the ecological health of the Middle Mississippi River.

The National Wildlife Federation (NWF) is the nation's largest conservation education and advocacy organization. NWF has almost six million members and supporters and conservation affiliate organizations in forty-nine states and territories. NWF has a long history of advocating for the protection, restoration, and ecologically sound management of the Mississippi River. NWF also has a long history of working to modernize federal water resources planning to protect the nation's rivers, wetlands, floodplains, and coasts and the fish and wildlife that depend on those vital resources.

American Rivers protects wild rivers, restores damaged rivers, and conserves clean water for people and nature. Since 1973, American Rivers has protected and restored more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and an annual America's Most Endangered Rivers® campaign. Headquartered in Washington, DC, American Rivers has offices across the country and more than 200,000 members, supporters, and volunteers. The Upper Mississippi River is one of 11 priority river basins where American Rivers is concentrating and integrating our work to protect and restore rivers over the next 5 years.

The Missouri Coalition for the Environment works to protect and restore the environment through education, public engagement, and legal action.

Prairie Rivers Network (PRN) is Illinois' advocate for clean water and healthy rivers. PRN champions clean, healthy rivers and lakes and safe drinking water to benefit the people and wildlife of Illinois. Drawing upon sound science and working cooperatively with others, PRN advocates public policies and cultural values that sustain the ecological health and biological diversity of water resources and aquatic ecosystems.

## General Comments

The Regulating Works Project is a massive, ongoing federal civil works project that imposes enormous financial costs on federal taxpayers, significantly increases flood risks for communities, and destroys vital fish and wildlife habitat and the free services that habitat provides to all of us.

The National Environmental Policy Act (NEPA) provides an important framework for developing and selecting alternatives that would reduce these significant burdens. However, rather than taking advantage of NEPA to do this, the DSEIS appears to have been formulated to justify continuation of the status quo. As discussed in detail in these comments, the DSEIS: fails to comply with longstanding legal requirements; fails to evaluate a host of highly reasonable alternatives; fails to evaluate the project's adverse impacts to a wide range of fish and wildlife species and vital habitats; and is scientifically unsound.

The end result of this flawed study is the selection of a preferred alternative that is bad for both people and wildlife. The preferred alternative will significantly increase flood risks and the associated costs of flood insurance payments; federal emergency assistance; and state, local, and private recovery efforts. The preferred alternative will cause wide-spread, highly significant harm to the Middle Mississippi River and the fish and wildlife that rely on that vital resource. The preferred alternative will also undermine extensive taxpayer investments in flood risk reduction and habitat protection and restoration.

NEPA and its public participation process provide a much needed framework to ensure that federal investments are both environmentally sound and cost-effective. To achieve these goals, and ensure the highest level of protection to the public, the Conservation Organizations once again urge the Corps to:

1. Initiate a National Academy of Sciences study on the effect of river training structures on flood heights to inform development of the SEIS. A National Academy of Sciences review is critical for ensuring that: (a) the SEIS is based on the best possible scientific understanding of the role of river training structures on increasing flood heights; (b) the SEIS produces recommendations that will provide the highest possible protection to the public; and (c) the public will have confidence in this aspect of the evaluation and recommendations contained in the final SEIS.

2. Impose a moratorium on the construction of new river training structures pending completion of the National Academy of Sciences Study and the SEIS. As discussed in these comments, extensive peer-reviewed science demonstrates that river training structures have increased flood levels by up to 15 feet in some locations and 10 feet in broad stretches of the Mississippi River where these structures are prevalent. In light of these findings, it is critical that additional river training structures not be built unless, and until, the National Academy of Sciences study and comprehensive SEIS establish that such construction will not contribute to increased flood risks to communities.

3. Fully evaluate the impacts of all reasonable alternatives—including those alternatives outlined in these comments—and select an alternative that protects people and wildlife. To comply with longstanding Congressional directives, including the National Water Resources Policy, the SEIS must ultimately select an alternative that will protect and restore the natural functions of the Mississippi River system and mitigate any unavoidable damage.

4. Appoint a new and fully independent external peer review panel to evaluate the adequacy and appropriateness of the models, science, and methodology used in the SEIS and to evaluate whether the selected alternative will in fact protect communities and protect and restore the natural functions of the Mississippi River system.

5. Expand the SEIS to evaluate the full suite of operations and maintenance activities for the Upper Mississippi River – Illinois Waterway (IWR-IWW) navigation system. As the Corps is well aware, the Regulating Works Project is just one of a number of activities carried out by the Corps to maintain navigation on the UMR-IWW. Other activities include water level regulation; operation and maintenance of the system's 37 locks and dams; and dredging, dredged spoil disposal, and construction of revetment in other portions of the UMR-IWW. Since all of these activities are designed to maintain a single navigation project, individual activities may not be evaluated in isolation, but should instead be evaluated in a single environmental impact statement.

## Specific Comments

## I. The Corps Should Develop and Select a New Alternative that Will Protect People, Wildlife, and the Environment

The Conservation Organizations strongly oppose the preferred alternative because it will lead to increased flooding and will further degrade the ecological conditions in the Mississippi River. The flood risks created by the preferred alternative's continuation of river training structure are discussed in Section II.C.4 of these comments. The DSEIS recognizes that the preferred alternative will cause significant environmental harm, and as outlined throughout these comments, the Conservation Organizations believe that the adverse impacts will be far greater than acknowledged in the DSEIS.

The preferred alternative is also at odds with longstanding federal policy directing the protection of the nation's rivers, floodplains, and wetlands, including the National Water Resources Planning Policy established by Congress in 2007:

> "It is the policy of the United States that all water resources projects" are to, among other things, "protect[] and restor[e] the functions of natural systems and mitigat[e] any unavoidable damage to natural systems."[1]

The preferred alternative violates this policy because it would harm, not protect and restore, the functions of the Middle Mississippi River and its floodplain.

To comply with NEPA, the DSEIS should be substantially revised to fully consider the alternatives outlined below in light of an appropriate project purpose, a clear demonstration of project need, and a comprehensive and meaningful assessment of potential impacts that is directed by a National Academy of Sciences study on the effect of river training structures on flood heights and flooding:[2]

(1) The No New Construction Alternative, which should be reexamined in light of an appropriate project purpose, a clear demonstration of need, and a comprehensive and meaningful assessment of potential impacts.

(2) An alternative that includes removing and/or modifying existing river training structures in the Project area to restore backwater, side channel, and braided river habitat; and reduce flood risks.

    Importantly, the DSEIS acknowledges that such actions can be carried out without adversely affecting navigation. According to the DSEIS (pages 157-158):

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[1] 42 USC § 1962–3.

[2] These alternatives, and the critical need for a National Academy of Sciences study, were also identified in the Scoping Comments for the Supplemental Environmental Impact Statement for the Middle Mississippi River Regulating Works Project, Public Notice 2013-744, submitted by the National Wildlife Federation, American Rivers, Great Rivers Environmental Law Center, Missouri Coalition for the Environment, Prairie Rivers Network, River Alliance of Wisconsin (February 14, 2014).

"Removal, shortening, notching, etc. of existing river training structures would facilitate the replacement of lost function with a similar amount of habitat function. This could be accomplished by restoring the amount of unstructured main channel border habitat that is lost by future placement of river training structures. An evaluation of current channel bathymetry on the MMR reveals opportunities where existing river training structures could be removed, shortened, and/or notched without adversely affecting the current dredging requirements of the adjacent navigation channel."

***

"The result of extending existing dikes is that the structure spacing is no longer optimized, resulting in structures that have little or no effect on maintaining navigation channel depths."

"In addition, many of the structures on the MMR were designed by engineers without the assistance of modern numerical and physical model studies that are now used to optimize structure locations, configurations, spacing, etc. Adaptive management was used in cases when there was a need for additional constriction from what was initially designed; however, in cases where constructed projects deepened the navigation channel by more than what was needed or expected, structures were not normally removed."

"These factors have created a situation where opportunities now exist within the MMR to remove, shorten, notch, or otherwise alter the configuration of existing river training structures without adversely affecting the adjacent navigation channel to compensate for the 1,100 acres of main channel border habitat estimated to be impacted."

(3) An alternative that minimizes the use of new river training structures, including by placing restrictions on the number and/or types of structures that can be utilized in a given reach based on a robust scientific assessment of the cumulative impacts of the various types of river training structures.

(4) An alternative that maintains the authorized navigation channel through other approaches, including such things as alternative upstream water level management regimes, alternative dredging and dredged spoil disposal activities, and the development of new, innovative techniques.

(5) An alternative that evaluates restoration activities that would improve the ecological health and resiliency of the Mississippi River and its floodplain and the fish and wildlife species that rely on those resources. This alternative should include formally adopting restoration, and fish and wildlife conservation, as authorized Project Purposes.[3]

To comply with the National Water Resources Planning Policy, and to protect communities and taxpayers, the final SEIS should select an alternative that will reduce flood risks to communities, and protect and restore the Mississippi River.

[3] That restoration activities can be carried out under other authorities does not obviate the need for developing, evaluating, and selecting an alternative that would improve the health and resiliency of the Mississippi River.

## II. The DSEIS Fails to Comply with the National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires that an environmental impact statement identify the full scope of direct, indirect, and cumulative impacts of a proposed action and determine whether there are less environmentally damaging ways to achieve the project purpose. As discussed throughout these comments, the DSEIS is inadequate as a matter of law because it fails to satisfy these fundamental requirements.

### A. The DSEIS Purpose and Need Statement Fails to Comply with NEPA

The DSEIS utilizes the following statement of Purpose and Need:

> "As authorized by Congress, the Regulating Works 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 Regulating Works 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. Therefore, pursuant to the Congressionally authorized purpose of the Project, the District continually identifies and monitors areas of the MMR that require frequent and costly dredging to determine if a long-term sustainable solution through regulating works is reasonable. The District also monitors bank stabilization areas to determine if additional work or re-enforcement of existing work is needed to ensure the dependability of the navigation channel." DSEIS at ES-1.

This DSEIS Purpose and Need statement violates NEPA because it: (1) is drawn so narrowly that it effectively limits the analysis of alternatives to only those that will continue the status quo approach to carrying out the Regulating Works project; (2) fails to account for a host of Congressional directives that require and/or promote the protection and restoration of the nation's water resources; and (3) fails to establish an actual need for the Project, including the need to construct new river training structures. The problems created by this legally inadequate Purpose and Need statement are compounded by the Corps' explicit refusal to evaluate alternatives that may require additional or changed Congressional authorization, in direct violation of NEPA.[4] *See* DSEIS at ES-1.

To correct these failings, the Conservation Organizations urge the Corps to adopt the following, legally appropriate, Project and Need statement that would help ensure consideration of important and fully reasonable alternatives:

> **The purpose of the Project is to maintain navigation in the Middle Mississippi River while protecting and restoring the ecological health of the river and its floodplain and minimizing flood risks to communities.**
>
> The need for this Project includes, the critical need to:

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[4] 42 C.F.R. § 1502.14, §1506.2(d); CEQ, Forty Most Asked Questions Concerning CEQ's NEPA Regulations (reasonable alternatives that are outside the legal jurisdiction of the lead agency or outside the scope of what Congress has approved or funded must be analyzed).

(1) Improve the degraded conditions of the Middle Mississippi River;
(2) Protect and restore important and diverse in-stream, channel border, and side channel habitats;
(3) Restore as much of the natural functions of the Middle Mississippi River as possible;
(4) Conserve and restore populations of fish and wildlife species affected by the Project;
(5) Reduce the risks of flooding created by the extensive construction of river training structures;
(6) Maintain a viable navigation system; and
(7) Ensure full compliance with Federal laws and policies.

### 1. The Purpose and Need Statement Improperly Limits the Alternatives Analysis

An appropriate statement of Purpose and Need is crucially important to the adequacy of the DSEIS because the Purpose and Need statement "delimit[s] the universe of the action's reasonable alternatives."[5] This is because "[o]nly alternatives that accomplish the purposes of the proposed action are considered reasonable, and only reasonable alternatives require detailed study. . . ."[6]

As the Courts have long acknowledged:

> "One obvious way for an agency to slip past the strictures of NEPA is to contrive a purpose so slender as to define competing "reasonable alternatives" out of consideration (and even out of existence). . . . If the agency constricts the definition of the project's purpose and thereby excludes what truly are reasonable alternatives, the EIS cannot fulfill its role. Nor can the agency satisfy the Act. 42 U.S.C. § 4332(2)(E)."[7]

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[5] *Citizens Against Burlington v. Busey*, 938 F.2d 190, 195 (D.C. Cir. 1991). *See also Wyoming v. U.S. Dep't of Agric.*, 661 F.3d 1209, 1244 (10th Cir. 2011) ("how the agency defines the purpose of the proposed action sets the contours for its exploration of available alternatives."); *Sierra Club v. U.S. Dep't of Transp.*, 310 F.Supp.2d 1168, 1192 (D. Nev. 2004) (citing *City of Carmel-By-The-Sea v. U.S. Dep't of Transp.*, 123 F.3d 1142, 1155 (9th Cir. 1997)).
[6] Webster v. U.S. Department of Agriculture, 685 F.3d 411, 422 (4th Cir. 2012); Methow Valley Citizens Council v. Regional Forester, 833 F.2d 810, 815-16 (9th Cir. 1987).
[7] *Simmons v. United States Army Corps of Eng'rs*, 120 F.3d 664, 666 (7th Cir. 1997). *See also City of Bridgeton v. FAA*, 212 F.3d 448, 458 (8th Cir. 2000); *City of Carmel-by-the-Sea v. United States Dep't of Transp.*, 123 F.3d 1142, 1155 (9th Cir. 1997) ("an agency cannot define its objectives in unreasonably narrow terms"); *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 195-96 (D.C. Cir. 1991), *cert. denied*, 502 U.S. 994 (1991) ("an agency may not define the objectives of its action in terms so unreasonably narrow that only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action"); *City of New York v. United States Dep't of Transp.*, 715 F.2d 732, 743 (2d Cir. 1983), *cert. denied*, 456 U.S. 1005 (1984) ("an agency will not be permitted to narrow the objective of its action artificially and thereby circumvent the requirement that relevant alternatives be considered"); *Methow Valley Citizens Council v. Regional Forester*, 833 F.2d 810, 815-16 (9th Cir. 1987) (impact statements must consider all reasonable alternatives that accomplish project purpose, but need not consider alternatives not reasonably related to purpose).

Accordingly, the Courts have made it clear that an agency may not define a project so narrowly that it "forecloses a reasonable consideration of alternatives"[8] or makes the final EIS "a foreordained formality."[9]

The DSEIS Purpose and Need statement violates each of these mandates because it is so narrowly drawn that it dictates continuation of the status quo approach to the Project, severely limiting the analysis of alternatives. For example, the DSEIS Purpose and Need statement effectively mandates continuation of river training structure construction to reduce dredging costs regardless of public safety impacts, ecological impacts, or national priorities. The Purpose and Need statement similarly suggests that the Project must also continue to stabilize the river banks with revetment and remove rocks that may affect navigation. As a result, the Purpose and Need statement precludes meaningful consideration of alternatives that do not include each of these features.

Notably, while the DSEIS states repeatedly that Congress has dictated the approach that the Corps must take in carrying out the Project, the DSEIS does not provide the full text of either the legislation or supporting Chief of Engineers' reports that set forth those approaches. As a result, the public is precluded from assessing the accuracy of the Corps' claims with respect to the alleged dictates of the authorizing legislation. The public is also precluded from determining whether the Project authorization included limitations on appropriations or included a Project expiration date. For example:

(a) The DSEIS provides only a one sentence excerpt from the 1881 report that forms the basis of the Regulating Works Project authorization.[10] DSEIS at 3; *see* DSEIS Appendix F at F-9 to F-13. This limited excerpt makes it impossible to evaluate the full suite of actions suggested by the plan and any limitations that the plan may have placed on recommended activities, funding, or length of authorization. The 1881 plan is not readily accessible to the public.

(b) The DSEIS does not provide any text from the Chief of Engineers Report that accompanied the Rivers and Harbors Act of 1910, and provides only a short excerpt from the Chief of

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[8] *Fuel Safe Washington v. Fed. Energy Regulatory Comm'n*, 389 F.3d 1313, 1324 (10th Cir. 2004) (quoting *Davis v. Mineta*, 302 F.3d 1104, 1119 (10th Cir. 2002); *Citizens' Comm. To Save Our Canyons v. U.S. Forest Serv.*, 297 F.3d 1012, 1030 (10th Cir. 2002); *Friends of Southeast's Future v. Morrison*, 153 F.3d 1059, 1066 (9th Cir. 1998) ("An agency may not define the objectives of its action in terms so unreasonably narrow that only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action".); *Simmons v. United States Army Corps of Eng'rs*, 120 F.3d 664, 666 (7th Cir. 1997); *City of New York v. United States Dep't of Transp.*, 715 F.2d 732, 743 (2d Cir. 1983), *cert. denied*, 456 U.S. 1005 (1984) ((holding that "an agency may not narrow the objective of its action artificially and thereby circumvent the requirement that relevant alternatives be considered); *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991), *cert. denied* 502 U.S. 994 (1991).

[9] *City of Bridgeton v. FAA*, 212 F.3d 448, 458 (8th Cir. 2000) (quoting *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991), *cert. denied* 502 U.S. 994 (1991); citing *Simmons v. U.S. Army Corps of Eng'rs*, 120 F.3d 664, 666 (7th Cir. 1997)).

[10] DSEIS at 3 ("the system to be pursued is that of contraction, thus compelling the river to scour out its bed; this process being aided, if necessary by dredging. Wherever the river is causing any serious caving of its banks, the improvement will not be permanent until the bank has been protected and the caving has been stopped" and that "it may be advisable to remove some bowlders [sic] and perhaps to cut off some points of rocks, which at low-water hamper navigation" (Senate Executive Doc. No. 10 (47th Congress, 1st Session) (hereinafter referred to as the 1881 Report))."

Engineers Report that accompanied the Rivers and Harbors Act of 1927.[11] This limited excerpt makes it impossible to evaluate the full suite of actions suggested by the plan and any limitations on the recommended activities, funding, or length of authorization. Neither of these reports are readily accessible to the public.

In addition, the strict limitations on the Project approaches outlined in the DSEIS do not appear to be supported by the limited excerpts from the 1881 plan and the Chief of Engineers Report that accompanied the Rivers and Harbors Act of 1927 provided in the DSEIS. The Corps' own actions also appear to contradict the strict Project approach limitations established by the DSEIS. As set forth in DSEIS Appendix F, the Corps made numerous and significant changes to the techniques it has used to carry out the Project **after** the 1910 and 1927 authorizations. DSEIS Appendix F at F-9 to F-13. Indeed, the significant changes to the Project over time demonstrate that the Corps believes it is readily able to change the methods and techniques used to carry out the Project.

The Corps should provide the full text of the applicable sections of the Rivers and Harbors Acts, and the full text of the sections of the Chief of Engineers' Reports relied on in those Acts so that the public and decision makers can assess: (1) the full extent of any limitations on techniques authorized under those provisions; and (2) whether Congress imposed any limitations on the length of time the Project authorization would remain in effect or imposed a limitation on the amount of appropriations that could be spent on the Project. This information is essential to understanding the full extent of any constraints that may have been established in the authorizing legislation.

The ability to review this information is particularly important given the length of time that has passed since the Project was authorized. While it is of course possible that the Chief of Engineers recommended a Project with no time limitation or appropriations ceiling, or that the Chief of Engineers authorized continuous construction of new river training structures and revetment for well over 100 years, it is far more likely that the Chief of Engineers reports recommend a far more limited scope of construction. Under such a scenario, new Congressional authorization would likely be required to carry out any additional construction of river training structures that might be recommended in the final EIS.[12] This would have important implications for the DSEIS.

The DSEIS should provide the full text of the applicable sections of the Chief of Engineers' reports to assist the public and decision makers in evaluating the precise activities currently authorized (including any limitations on those activities) and whether new authorization would be required.

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[11] DSEIS at 3. ("The Congressionally authorized modification to the Project in the Rivers and Harbors Act of 1927, changing the depth and width of the authorized navigation channel, was based upon the Chief of Engineers' report dated December 17, 1926. This Chief of Engineers report described the current and future status of the Project as follows: "Although great benefits have resulted from the work already done, it is essential that additional regulating works and bank protection be carried to a point where a minimum of dredging is required and a stable channel is available at all times... [The Chief of Engineers also concurred in the District Engineers' recommendation that] the regulating works and revetment be completed and that dredging, which affords only temporary relief, be resorted to only when and to the extent that the needs of navigation then existing require" (House Committee Doc. No. 12 (70th Cong., 1st Session)).")

[12] It is also possible that the numerous river training structure projects currently being proposed by the Corps also exceed the existing authorization, and thus cannot be constructed without new Congressional authorization.

### 2. The Purpose and Need Statement Fails to Account for Clear Congressional Directives

The Purpose and Need statement fails to account for the full suite of laws and policies applicable to Corps projects. A proper statement of Purpose and Need must consider "the views of Congress, expressed, to the extent that an agency can determine them, in the agency's statutory authorization to act, **as well as in other Congressional directives**."[13]

Congress has established a host of post-authorization directives that must be incorporated into the Purpose and Need statement for the Project, including many directives that require and/or promote the protection and restoration of the nation's waters and fish and wildlife resources, and that require the Corps to minimize flood risks. These directives include:

a. The National Water Resources Planning Policy established by Congress in 2007. This policy requires "all water resources projects" to protect and restore the functions of natural systems and to mitigate any unavoidable damage to natural systems. 42 U.S.C. § 1962-3. This policy requires the Corps to operate the Regulating Works Project to protect the Mississippi River and its floodplain.

b. The National Environmental Policy Act enacted in 1970. NEPA directs the "Federal Government to use all practicable means" to, among other things: (i) "fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;" (ii) ensure "safe, healthful, productive" surroundings for all Americans; and (iii) "attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences." 42 U.S.C. § 4331(b). NEPA states explicitly that the policies, regulations and laws of the United States "**shall** be interpreted and administered in accordance with the policies set forth in this Act." 42 U.S.C. § 4332(1) (emphasis added). NEPA also explicitly states that "policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies." 42 U.S.C. § 4335.

c. The many statutory directives to protect the environment and fish and wildlife contained in the Clean Water Act, the Endangered Species Act, the Clean Air Act, the Corps' civil works mitigation requirements (33 U.S.C. § 2283(d)), and the Water Resources Development Act of 1990 that changed the Corps' fundamental mission to "include environmental protection as one of the primary missions of the Corps of Engineers in planning, designing, constructing, operating, and maintaining water resources projects." 33 U.S.C. § 2316.

d. The Fish and Wildlife Coordination Act enacted in 1958. The Fish and Wildlife Coordination Act directs that "wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development," and that water resources development is to prevent loss and damage to fish and wildlife and improve the health of fish and wildlife resources. Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661, 662. *See* Section IV of these comments for a more detailed discussion of the Fish and Wildlife Coordination Act and its applicability to the Project.

Corps regulations in place since 1980 state that:

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[13] *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 196 (D.C. Cir. 1991) (emphasis added).

> "Laws, executive orders, and national policies promulgated in the past decade require that the quality of the environment be protected and, where possible, enhanced as the nation grows. . . . Enhancement of the environment is an objective of Federal water resource programs to be considered in the planning, design, construction, and **operation and maintenance of projects**. Opportunities for enhancement of the environment are sought through each of the above phases of project development. Specific considerations may include, but are not limited to, **actions to preserve or enhance critical habitat for fish and wildlife; maintain or enhance water quality; improve streamflow**; preservation and restoration of certain cultural resources, **and the preservation or creation of wetlands.**"

33 C.F.R. § 236.4 (emphasis added).

The DSEIS fails to incorporate these critically important post-project authorization Congressional directives, and longstanding Corps' policy objectives, into the project purpose as required by law.[14]

### 3. The Purpose and Need Statement Fails to Demonstrate Project Need

The DSEIS Purpose and Need Statement fails to demonstrate Project need, and notably fails to establish that there is in fact a need for new river training structures (*e.g.*, dikes, weirs, chevrons, and revetment) or additional revetment.

New navigation structures are clearly not required to maintain the navigation channel as the current dredging regime has a long history of effectively maintaining navigation in the Middle Mississippi River. To the contrary, the Corps acknowledges that the actual purpose of the river training structures is simply to reduce the costs associated with dredging certain sections of the navigation channel. Notably, however, the DSEIS does not provide any type of meaningful cost information or a benefit-cost assessment that could assist in determining whether new river training structure construction might actually achieve even this limited goal.

Instead of providing meaningful information demonstrating the need for new river training structure construction, the DSEIS contends that new river training structures should be constructed to fend off vague and unsubstantiated risks of barge groundings, channel closures, and lack of sufficient funding for dredging under certain extreme conditions that may (or may not) occur at some point in the future. According to the DSEIS:

> "The Continue Construction Alternative would be expected to reduce average annual dredging quantities from approximately 4 million cubic yards to approximately 2.4 million cubic yards. This anticipated reduction in dredging would be expected to reduce barge grounding rates and result in a safer and more reliable navigation channel.
>
> The reduction in dredging needs would result in increased channel reliability and a decrease in the risk of channel closures due to reduced frequency of groundings and the formation of mid channel sandbars that could impact navigation at low stages. The reduction in need for just-in time dredging would reduce the likelihood of a failure to find problematic locations and get the dredge to the location when needed.

[14] See Citizens Against Burlington, Inc. v. Busey, 938 F.2d 190, 196 (D.C. Cir. 1991).

> The District's ability to respond to extreme dredging situations would also be improved with implementation of the Continue Construction Alternative. During the recent low-water event of 2012/2013, the Corps had to redirect O&M funding from other O&M needs as well as bring on an additional dredge boat to meet dredging demands. The availability of additional funding and dredging resources cannot be assumed for future low-water events. Implementation of the Continue Construction Alternative would be expected to reduce the dredging requirements during any such future events and would increase the likelihood of avoiding adverse effects to navigation."

DSEIS at 161-162.

The Corps' ability to respond to the 2012/2013 low water event further undercuts this already highly tenuous claim. During the extreme conditions in 2012/2013, the Corps was able to mobilize additional dredges and remove rock ledges (pinnacles) to address the severe low water levels on the Middle Mississippi. Moreover, despite the low water conditions, "traffic through the restricted reaches at Thebes, Illinois was largely unchanged between 2011 and 2012."[15]

Indeed, according to one assessment conducted by the Corps' St. Louis District:

> "The entire 2012 low water effort resulted in a navigation channel that remained open for commerce throughout the drought, without any groundings or accidents within the channel, and generally led to a much more reliable channel for shippers."[16]

Moreover, since the proposed project will merely reduce – not eliminate – the need for future dredging in the project area, there is no way to know whether the proposed project would in fact reduce the need for dredging under any future low water conditions. Moreover, the DSEIS fails to provide any estimate of future costs with and without new river training structure construction, and fails to identify those areas likely to require continued dredging even if additional structures are constructed.

As discussed in Section II.C.2 of these comments, the DSEIS also fails to provide critical information on sediment loads and sediment transport in the Middle Mississippi River, making it impossible for the public and decision makers to assess the need for additional river training structures.

Properly demonstrating a need for construction of new river training structures – on the basis of legitimate, scientifically sound, and detailed factual information – is fundamental to an adequate NEPA analysis and is absolutely critical for this Project as the river training structures create a significant risk of increased flooding for river communities and, by the Corps' own acknowledgement, will lead to significant adverse impacts to the environment.

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[15] USACE, Event Study 2012 Low-Water and Mississippi River Lock 27 Closures, August 2013 at 15.

[16] David C. Gordon (Chief, Hydraulic Design Section, U.S. Army Corps of Engineers – St. Louis District) and Michael T. Rodgers (Project Manager, U.S. Army Corps of Engineers – St. Louis District), *Drought, Low Water, And Dredging Of The Middle Mississippi River In 2012* (available at http://acwi.gov/sos/pubs/3rdJFIC/Contents/4C-Gordon.pdf).

## B. The DSEIS Alternatives Analysis Fails to Comply with NEPA

The DSEIS alternatives analysis is inadequate as a matter of law because it: (1) fails to review highly reasonable alternatives, including alternatives that would reduce flood risks and improve the health and resiliency of the Middle Mississippi River; (2) fails to evaluate a reasonable range of alternatives; and (3) fails to provide an informed and meaningful consideration of alternatives. The DSEIS also fails to identify the environmentally preferable alternative. As discussed in Section II.C of these comments, the DSEIS alternatives analysis is also inadequate as a matter of law because it is based on a fundamentally flawed analysis of direct, indirect, and cumulative impacts.

NEPA requires that each EIS "[r]igorously explore and objectively evaluate all reasonable alternatives."[17] This requires a "**thorough consideration of all appropriate methods of accomplishing the aim of the action**" and an "**intense consideration of other more ecologically sound courses of action**."[18] The rigorous and objective evaluation of all reasonable alternatives is the "heart of the environmental impact statement."[19] Importantly, "the discussion of alternatives must be undertaken in good faith; it is not to be employed to justify a decision already reached."[20]

While an EIS need not explore every conceivable alternative, it must rigorously explore all reasonable alternatives that are consistent with its basic policy objective and that are not remote or speculative. A viable but unexamined alternative renders an EIS inadequate.[21] An alternative may not be disregarded merely because it does not offer a complete solution to the problem.[22] Importantly, an alternative also may not be disregarded because it would require additional Congressional authorization. To the contrary, the alternatives analysis must "[i]nclude reasonable alternatives not within the jurisdiction of the lead agency."[23]

Failure to look at an appropriate range of alternatives likewise renders an alternatives analysis inadequate.[24] The range of alternatives that must be considered is determined by the nature and scope of the proposed action. The greater the impacts and scope of the proposed action, the greater the

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[17] 40 C.F.R. § 1502.14.

[18] Environmental Defense Fund, Inc. v. Corps of Engineers of U.S. Army, 492 F.2d 1123, 1135 (5th Cir. 1974) (emphasis added).

[19] 40 C.F.R § 1502.14.

[20] Citizens Against Toxic Sprays, Inc. v. Bergland, 428 F.Supp. 908, 933 (D.Or. 1977).

[21] E.g. Muckleshoot Indian Tribe v. U.S. Forest Service, 177 F.3d 800, 810, 814 (9th Cir. 1999).

[22] Natural Resources Defense Council, Inc. v. Morton, 458 F.2d 827, 836 (D.C. Cir. 1972).

[23] 40 C.F.R. § 1502.14(c); *Natural Resources Defense Council v. Morton*, 458 F.2d 827, 834-36 (D.C. Cir. 1972) (alternative sources of energy had to be discussed, despite federal legislation indicating an urgent need for offshore leasing and mandating import quotas; Department of Interior had to consider reasonable alternatives to offshore oil lease which would reduce or eliminate the need for offshore exploration, such as increased nuclear energy development and changing natural gas pricing, even though that would require Congressional action); *Environmental Defense Fund v. Froehlke*, 473 F.2d 346 (8th Cir. 1974) (acquisition of land to mitigate loss of land from river channel project must be considered even though it would require legislative action).

[24] *E.g. Resources Ltd., Inc. v. Robertson*, 35 F.3d 1300, 1307 (9th Cir. 1993).

range of alternatives that must be considered.[25] The range of alternatives considered is not sufficient if each alternative has the same end result.[26]

In comparing and analyzing potential alternatives, the DSEIS must examine, among other things, the direct, indirect, and cumulative environmental impacts of the flow regimes in the different alternatives, the conservation potential of those alternatives, and the means to mitigate adverse environmental impacts. 40 C.F.R. § 1502.16. A robust analysis of project impacts is essential for determining whether less environmentally damaging alternatives are available.

Direct impacts are caused by the action and occur at the same time and place as the action. Indirect impacts are also caused by the action, but are later in time or farther removed from the location of the action. 40 C.F.R. § 1508.8. Cumulative impacts are:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

40 C.F.R. § 1508.7. A cumulative impact analysis ensures that the agency will not "treat the identified environmental concern in a vacuum."[27]

### 1. The Alternatives Analysis Violates NEPA as a Matter of Law

The DSEIS clearly violates NEPA as a matter of law, because it has explicitly and intentionally failed to evaluate reasonable alternatives to determine whether there are less damaging ways to achieve the project purpose. To the contrary, the DSEIS states that it has not examined any alternatives that the Corps currently deems to be outside of the existing authorization, or that do not specifically track approaches identified by Congress more than 100 years ago. *See* DSEIS at ES-2 and 23.

NEPA requires that the DSEIS "[r]igorously explore and objectively evaluate all reasonable alternatives."[28] This requires a "**thorough consideration of all appropriate methods of accomplishing the aim of the action**" and an "**intense consideration of other more ecologically sound courses of action**."[29] The alternatives analysis must "[i]nclude reasonable alternatives not within the jurisdiction of the lead agency,"[30] which means that an alternative may not be disregarded merely because it would require additional Congressional authorization. An alternative also may not be disregarded merely

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[25] *Alaska Wilderness Recreation and Tourism v. Morrison*, 67 F.3d 723, 729 (9th Cir. 1995); *see Sierra Club v. Espy*, 38 F.3d 792, 803 (5th Cir. 1994) (the range of alternatives that must be considered in an environmental assessment decreases as the environmental impact of the proposed action becomes less and less substantial).
[26] *State of California v. Block*, 690 F.2d 753, 767 (9th Cir. 1982) (holding that an inadequate range of alternatives was considered where the end result of all eight alternatives evaluated was development of a substantial portion of wilderness).
[27] *Grand Canyon Trust v. FAA*, 290 F.3d 339, 346 (D.C. Cir. 2002).
[28] 40 C.F.R. § 1502.14.
[29] Environmental Defense Fund, Inc. v. Corps of Engineers of U.S. Army, 492 F.2d 1123, 1135 (5th Cir. 1974) (emphasis added).
[30] 40 C.F.R. § 1502.14(c).

because it does not offer a complete solution to the problem.[31] A viable but unexamined alternative renders an EIS inadequate.[32]

Despite these well-settled legal requirements, and the fundamental importance of identifying less environmentally damaging alternatives, the DSEIS explicitly and intentionally refuses to examine alternative approaches to achieving the goals of the project. The Corps attempts to justify this untenable position by claiming that it must continue to use the techniques for carrying out the Project that Congress approved 107 years ago based on a Corps studied developed 136 years ago.[33] DSEIS at 3 and Appendix F.

According to the DSEIS:

> "Alternatives. Congress provided the manner in which the navigation channel for the MMR should be obtained and maintained via the original Regulating Works Project authorization in 1910 and a modification to the authorization in 1927. The purpose of this SEIS is not to consider a change to that authorization through reevaluating the need for the Regulating Works Project or the methods to be used to accomplish the goals of the project. Rather, this document analyzes the impacts of the Regulating Works Project as it is currently constructed, operated, and maintained with current information that has become available since the completion of the 1976 EIS." DSEIS at ES-2.

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> "As described in Section 1.2 Purpose of and Need for NEPA Supplement, this SEIS is not a study or re-evaluation of how a project should be carried out, but an updated analysis of the impacts of an already authorized, on-going project; Congress has already provided the manner in which the navigation channel for the MMR is to be obtained and maintained via the Regulating Works Project authorization. Any alternatives outside of this authorization to be considered in detail would require a planning study for either modification of the Project or new authorization from Congress on how to obtain and maintain navigation within the MMR. While alternatives outside of this authorization were not immediately dismissed, the analysis and evaluation of the new information and circumstances during the process of supplementing the 1976 EIS did not lead to a reasonable or feasible alternative that warranted transitioning this SEIS to such a planning document. Therefore, alternatives outside of the scope of this authorization are not evaluated in detail for purposes of this document."[34] DSEIS at 23.

The Corps' explicit refusal to examine any alternatives that the Corps currently deems to be outside of the existing authorization, or that do not specifically track approaches identified by Congress more than 100 years ago, renders the DSEIS inadequate as a matter of law. Common sense and modern science also clearly dictate a fundamentally different approach to evaluating alternatives.

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[31] Natural Resources Defense Council, Inc. v. Morton, 458 F.2d 827, 836 (D.C. Cir. 1972).

[32] E.g. Muckleshoot Indian Tribe v. U.S. Forest Service, 177 F.3d 800, 810, 814 (9th Cir. 1999).

[33] DSEIS at 3 ("In the Rivers and Harbors Act of 1910, Congress authorized obtaining and maintaining the MMR to be carried out in accordance with the plan in 1881.")

[34] The DSEIS states that "[i]n the Rivers and Harbors Act of 1910, Congress authorized obtaining and maintaining the MMR to be carried out in accordance with the plan in 1881." DSEIS at 3.

## 2. The DSEIS Fails to Evaluate Highly Reasonable Alternatives

The DSEIS violates NEPA because it fails to evaluate highly reasonable alternatives, as required by NEPA. *See* discussion above. To comply with NEPA, the DSEIS must rigorously explore and objectively evaluate at least the following alternatives (which are also set forth in Section I of these comments) in light of an appropriate project purpose, a clear demonstration of project need, and a comprehensive and meaningful assessment of potential impacts that is directed by a National Academy of Sciences study on the effect of river training structures on flood heights and flooding:[35]

(6) The No New Construction Alternative, which should be reexamined in light of an appropriate project purpose, a clear demonstration of need, and a comprehensive and meaningful assessment of potential impacts.

(7) An alternative that includes removing and/or modifying existing river training structures in the Project area to restore backwater, side channel, and braided river habitat; and reduce flood risks.

Importantly, the DSEIS acknowledges that such actions can be carried out without adversely affecting navigation. According to the DSEIS (pages 157-158):

> "Removal, shortening, notching, etc. of existing river training structures would facilitate the replacement of lost function with a similar amount of habitat function. This could be accomplished by restoring the amount of unstructured main channel border habitat that is lost by future placement of river training structures. An evaluation of current channel bathymetry on the MMR reveals opportunities where existing river training structures could be removed, shortened, and/or notched without adversely affecting the current dredging requirements of the adjacent navigation channel."
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> "The result of extending existing dikes is that the structure spacing is no longer optimized, resulting in structures that have little or no effect on maintaining navigation channel depths."
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> "In addition, many of the structures on the MMR were designed by engineers without the assistance of modern numerical and physical model studies that are now used to optimize structure locations, configurations, spacing, etc. Adaptive management was used in cases when there was a need for additional constriction from what was initially designed; however, in cases where constructed projects deepened the navigation channel by more than what was needed or expected, structures were not normally removed."

[35] These alternatives, and the critical need for a National Academy of Sciences study, were also identified in the Scoping Comments for the Supplemental Environmental Impact Statement for the Middle Mississippi River Regulating Works Project, Public Notice 2013-744, submitted by the National Wildlife Federation, American Rivers, Great Rivers Environmental Law Center, Missouri Coalition for the Environment, Prairie Rivers Network, River Alliance of Wisconsin (February 14, 2014).

> "These factors have created a situation where opportunities now exist within the MMR to remove, shorten, notch, or otherwise alter the configuration of existing river training structures without adversely affecting the adjacent navigation channel to compensate for the 1,100 acres of main channel border habitat estimated to be impacted."

(8) An alternative that minimizes the use of new river training structures, including by placing restrictions on the number and/or types of structures that can be utilized in a given reach based on a robust scientific assessment of the cumulative impacts of the various types of river training structures.

(9) An alternative that maintains the authorized navigation channel through other approaches, including such things as alternative upstream water level management regimes, alternative dredging and dredged spoil disposal activities, and the development of new, innovative techniques.

An alternative that evaluates restoration activities that would improve the ecological health and resiliency of the Mississippi River and its floodplain and the fish and wildlife species that rely on those resources. This alternative should include formally adopting restoration, and fish and wildlife conservation, as authorized Project Purposes.[36]

### 3. The DSEIS Fails to Evaluate an Appropriate Range of Alternatives

The DSEIS examines only two alternatives, the Continue Construction Alternative and the No New Construction alternative. This cannot satisfy NEPA's requirement to evaluate an appropriate range of alternatives for at least three reasons.

*First*, as discussed above, there are other highly reasonable alternatives that must be examined.

*Second*, the scope and impacts of the Project mandate evaluation of a much broader range of alternatives.[37] The range of alternatives that must be considered is determined by the nature and scope of the proposed action. The greater the impacts and scope of the proposed action, the greater the range of alternatives that must be considered.[38] Both the scope and the impacts of the Project are enormous. For example:

(a) The Project has caused, and will continue to cause, direct, indirect, and cumulative impacts to 195 miles of the Mississippi River and its floodplain, and the hundreds of species that rely on those vital resources.

(b) The Project is well documented as causing significant adverse impacts to the Middle Mississippi River, including as documented in the 2000 Biological Opinion and in the numerous studies incorporated by reference in the DSEIS cumulative impact analysis. The DSEIS also

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[36] That these types of activities could be carried out under other authorities does not obviate the need for this approach.

[37] *E.g. Resources Ltd., Inc. v. Robertson*, 35 F.3d 1300, 1307 (9th Cir. 1993).

[38] *Alaska Wilderness Recreation and Tourism v. Morrison*, 67 F.3d 723, 729 (9th Cir. 1995); *see Sierra Club v. Espy*, 38 F.3d 792, 803 (5th Cir. 1994) (the range of alternatives that must be considered in an environmental assessment decreases as the environmental impact of the proposed action becomes less and less substantial).

acknowledges that the Corps' preferred alternative will cause significant adverse impacts through the destruction of at least an additional 1,100 acres of vitally important main channel border habitat.

(c) Independent scientists, conservation organizations, and river communities remain deeply concerned about the Project's impacts to flood stages. Extensive peer-reviewed science demonstrates that river training structures have caused significant increases in flood heights in broad stretches of the Mississippi River, and a 2016 peer-reviewed study demonstrates that the excessive constriction caused by river training structures (and to a lesser extent, levees) has led to fundamental changes in the way the Middle Mississippi River responds to flood events. *See* Section II.C.4 of these comments.

(d) The DSEIS states that preferred alternative will result in "constructing future river training structures that equate to approximately 4.4 million tons of rock" and continued dredging of an average of approximately 2.4 million cubic yards per year.[39]

This Project's significant scope and extensive impacts require the Corps to evaluate a far greater range of alternatives that the two evaluated in the DSEIS, including at least those additional alternatives identified in these comments.

*Third*, Federal courts have routinely found that NEPA "prevents federal agencies from effectively reducing the discussion of environmentally sound alternatives to a binary choice between granting and denying an application."[40] The DSEIS provides just such an improper binary choice; one alternative would continue construction of river training structures along with all other current Regulating Works activities, while the second alternative would stop construction of river training structures while still carrying out all other current Regulating Works activities.

To satisfy NEPA, the DSEIS must evaluate a full range of alternatives, including the alternatives outlined above that will improve ecological conditions and/or reduce flood risks.

### 4. The DSEIS Fails to Provide an Informed and Meaningful Consideration of Alternatives

NEPA requires an "informed and meaningful" consideration of alternatives:

> "NEPA's requirement that alternatives be studied, developed, and described both guides the substance of environmental decisionmaking and provides evidence that the mandated decisionmaking process has actually taken place. "Informed and meaningful consideration of

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[39] DSEIS at 32.

[40] *Save Our Cumberland Mountains v. Kempthorne*, 453 F. 3d 334, 345 (6th Cir. 2006), *citing Davis v. Mineta,* 302 F.3d 1104, 1122 (10th Cir.2002) ("[O]nly two alternatives were studied in detail: the no build alternative, and the preferred alternative. [The agency] acted arbitrarily and capriciously in approving an [environmental assessment] that does not provide an adequate discussion of [p]roject alternatives."); *Colo. Envtl. Coal. v. Dombeck,* 185 F.3d 1162, 1174 (10th Cir.1999) ("[T]he National Environmental Policy Act and Council on Environmental Quality Regulations require [an agency] to study in detail all `reasonable' alternatives [in an environmental impact statement].... [Courts] have interpreted this requirement to preclude agencies from defining the objectives of their actions in terms so unreasonably narrow they can be accomplished by only one alternative.").

alternatives – including the no action alternative – is . . . an integral part of the statutory scheme.[41]

As documented throughout these comments, the DSEIS fails to satisfy this requirement because it fails to properly evaluate impacts, fails to analyze highly reasonable alternatives, and fails to analyze an appropriate range of reasonable alternatives.

The DSEIS also fails to satisfy the "informed and meaningful" review requirement for the two alternatives that it does evaluate because it fails to provide meaningful information on the actions that will be carried out under those alternatives. Neither alternative provides criteria for the triggering of future dredging, revetment, or river training structure construction. Neither alternative provides information concerning the likely locations of such future actions. Neither alternative provides any information on the economic costs or impacts of the likely future actions. The Continue Construction Alternative does not provide any information on the types of river training structures that will be used, and does not provide any information on the projected linear feet of river training structures that will be constructed. As discussed in Section II.C.4 of these comments, the total linear feet of river training structures has a significant impact on flood heights.

The Independent Peer Review (IEPR) panel for the Project highlights a number of these failings. The IEPR panel concludes, among other things, that:

1. "It is not clear why impacts of future river training structure construction and the associated compensatory mitigation requirements were not evaluated in more detail with respect to specific locations in the MMR."

2. "The project description for the proposed action does not describe the decision-making process that will be employed for identifying new river training structure construction sites."

3. "The SEIS does not clearly describe the project construction features within the main report such that a link between the project and the level of impacts can be easily compared."[42]

*See* Section II.C.2 of these comments for an additional discussion of the IEPR Panel and its findings.

Because the Corps has been implementing the Project since 1910, the agency should have information on likely future dredging needs and dredged spoil disposal sites, river training structure construction needs, and locations where the Corps contends that new revetment may be needed. Without this type of information it is not possible to meaningfully evaluate the impacts of the proposed alternatives.

The DSEIS also fails to satisfy the "informed and meaningful" review requirement for the two alternatives that it does evaluate because that analysis has been conducted in light of an improperly narrow project purpose. Indeed, this improperly narrow project purpose appears to be the determining

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[41] *Bob Marshall Alliance v Hodel*, 852 F.2d 1223, 1228 (9th Cir. 1988) (internal citations omitted).

[42] Final Independent External Peer Review Report on the Supplemental Environmental Impact Statement (SEIS) for the Mississippi River between the Ohio and Missouri Rivers (Regulating Works), October 13, 2016 ("Final IEPR Report").

factor in the DSEIS selection of the Continue Construction Alternative even though that alternative will, according to the DSEIS, cause far more harm than the No New Construction Alternative.[43]

### 5. The DSEIS Fails to Identify the Environmentally Preferable Alternative

The Record of Decision for the final SEIS must identify the "environmentally preferable" alternative[44] and agencies are encouraged to identify the environmentally preferable alternative in the EIS.[45] The environmentally preferable alternative is "the alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources."[46]

Identification of the environmentally preferable alternative is critical so that the public and decision makers can fully assess the appropriateness of the preferred alternative:

> "Through the identification of the environmentally preferable alternative, the decisionmaker is clearly faced with a choice between that alternative and others, and must consider whether the decision accords with the Congressionally declared policies of the [National Environmental Policy] Act."[47]

On the basis of the information provided in the DSEIS, the No New Construction alternative is clearly the environmentally preferable alternative since the Corps contends that it would not cause a significant loss of channel border habitat and would not otherwise require compensatory mitigation. The Corps should clearly identify the environmentally preferable alternative in the DSEIS.

## C. The DSEIS Fails to Properly Evaluate Project Impacts

The DSEIS fails to properly evaluate project impacts, leading to a dangerously false picture of the potential impacts of the Project.

NEPA requires agencies to analyze all "reasonably foreseeable" direct, indirect and cumulative environmental impacts.[48] "If it is reasonably possible to analyze the environmental consequences in an EIS...the agency is required to perform that analysis."[49] This mandate applies to both site-specific and programmatic NEPA documents.[50]

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[43] Compare DSEIS at 29 (The No New Construction Alternative "Does not achieve Congressionally authorized project objective of reducing federal expenditures by reducing dredging to a minimum") with DSEIS at 32 ("Based on the Project's Congressional authority and the continued benefit of the remaining construction, the Continue Construction Alternative with the described potential compensatory mitigation is the Preferred Alternative.")
[44] 40 C.F.R. § 1505.2.
[45] *Id*.
[46] CEQ Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 Fed. Reg. 18026 (March 23, 1981), as amended, Question 6.
[47] *Id*.
[48] 40 C.F.R. § 1508.8.
[49] *Kern v. U.S. Bureau of Land Mgmt.,* 284 F.3d 1062, 1072 (9t hCir.2002).
[50] See, e.g., Kern v. U.S. Bureau of Land Mgmt., 284 F.3d at 1072.

Where site-specific impacts are "reasonably foreseeable" at the program planning stage, they must be evaluated in the programmatic EIS.[51] The Corps may not evade its obligation to analyze the reasonably foreseeable, site-specific environmental consequences of a larger program merely by saying that those consequences will be analyzed later.[52] Indeed, such procrastination is antithetical to NEPA's basic charge to undertake analysis and integrate it into agency decision making as early as possible.[53]

The DSEIS impacts analysis must be based on, and present, "quantified or detailed information."[54] "General discussion of an environmental problem over a large area" is not sufficient and cannot satisfy NEPA.[55] Unsupported conclusory statements likewise cannot satisfy NEPA:

> "A conclusory statement unsupported by empirical or experimental data, scientific authorities, or explanatory information of any kind not only fails to crystalize the issues, but affords no basis for a comparison of the problems involved with the proposed project and the difficulties involved in the alternatives."[56]

The DSEIS also must be based on "high quality" science and information and the Corps must "insure professional integrity, including scientific integrity, of the discussions and analysis in environmental impact statements."[57] Importantly, if information that is essential for making a reasoned choice among

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[51] *Colorado Environmental Coalition v. Office of Legacy Management*, 819 F. Supp. 2d. 1193, 1209 (D. Colo. 2011), reconsideration granted in part on other grounds, 2012 U.S. Dist. LEXIS 24126 (D. Colo. Feb. 27, 2012) (concluding that future site-specific mining activity was reasonably foreseeable at the lease stage because mining had previously taken place on the same public lands and thus must be reviewed at the programmatic leasing stage.)
[52] Kern v. U.S. Bureau of Land Mgmt., 284 F.3d at 1072.
[53] *See* 40 C.F.R. §§ 1501.2, 1502.5; *Save Our Ecosystems v. Clark*, 747 F.2d 1240, 1246 n. 9 (9th Cir.1984) ("Reasonable forecasting and speculation is . . . implicit in NEPA, and we must reject any attempt by agencies to shirk their responsibilities under NEPA by labeling any and all discussion of future environmental effects as 'crystal ball inquiry,'" *quoting Scientists' Inst. for Pub. Info., Inc. v. Atomic Energy Comm'n*, 481 F.2d 1079, 1092 (D.C. Cir.1973)); *City of Davis v. Coleman*, 521 F.2d 661, 676 (9th Cir. 1975) ("the purpose of an [EIS] is to evaluate the possibilities in light of current and **contemplated** plans and to produce an informed estimate of the environmental consequences. . . . Drafting an [EIS] necessarily involves some degree of forecasting." (emphasis added)).
[54] *Neighbors of Cuddy Mountain v. U. S. Forest Service*, 137 F.3d 1372, 1379 (9th Cir. 1998); *Ecology Center v. Castaneda*, 574 F.3d 652, 666 (9th Cir. 2009) (requiring "quantified or detailed data"); *Natural Resources Defense Council v. Callaway*, 524 F.2d 79, 87 (2d Cir. 1975).
[55] South Fork Band Council v. U.S. Dept. of Interior, 588 F.3d 718 (9th Cir. 2009); Neighbors of Cuddy Mountain v. U.S. Forest Service, 137 F.3d 1372, 1379-80 (9th Cir. 1998).
[56] *Seattle Audubon Society v. Moseley*, 798 F. Supp. 1473, 1479 (W.D. Wash. 1992), *aff'd* 998 F.2d (9th Cir. 1993); *see also, e.g.*, *Klamath-Siskiyou Wildlands Ctr. v. BLM*, 387 F.3d 989,995-996 (9th Cir. 2004) ("generalized or conclusory statements" in cumulative effects analyses do not satisfy NEPA); *Friends of the Earth v. Army Corps of Engineers*, 109 F. Supp. 2d 30, 38 (D.D.C. 2000) (ruling that the Corps must "provide further analysis" to satisfy NEPA because the Corps did not provide "the basis for any" of its claims that the project would have an insignificant impact or that fish and other organisms would simply move to other areas); *Sierra Club v. Norton*, 207 F. Supp. 2d 1310, 1335 (S.D. Ala. 2002) (stating "Defendant's argument in this case would turn NEPA on its head, making ignorance into a powerful factor in favor of immediate action where the agency lacks sufficient data to conclusively show not only that proposed action would harm an endangered species, but that the harm would prove to be 'significant'").
[57] 40 C.F.R. § 1502.24 ("Agencies shall insure professional integrity, including scientific integrity, of the discussions and analysis in environmental impact statements"); *Earth Island Inst. v. U.S. Forest Service*, 442 F.3d 1147, 1159-60 ($9^{th}$ Cir. 2006) (quoting 40 CFR §1502.24).

alternatives is not available, the Corps **must** obtain that information unless the costs of doing so would be "exorbitant."[58]

As discussed throughout these comments, the DSEIS violates these fundamental NEPA requirements, including by relying extensively on unsupported conclusory statements and generalizations, failing to include necessary information, and failing to ensure the scientific integrity of its analyses. Because of the many failings, the DSEIS profoundly understates the adverse impacts of the alternatives assessed in the DSEIS.

At the most fundamental level, key problems with the DSEIS can be traced to its excessive focus on engineering outcomes and acres of physical habitat affected, while ignoring critical biological implications of the Project and the preferred alternative. Moreover, the extremely limited assessments of biological impacts in the DSEIS are poorly tied to the claimed environmental benefits of the Project and the vaguely defined mitigation. The claimed positive environmental actions that may be carried out under the preferred alternative, such as notching dikes, will not result in meaningful ecological benefits. For example, a 2012 study found that single feature restoration projects, such as the placement of weirs to increase habitat heterogeneity, are not effective at achieving biodiversity goals. That study recommends "baseline attributes and historic conditions be assessed and integrated into project design and implementation" to ensure the restoration strategy is truly site appropriate.[59] Similarly, a 2009 study found that almost all restoration projects that focused exclusively on rehabilitated physical habitat failed to restore invertebrate biodiversity.[60] The DSEIS should carefully evaluate these studies.

The Conservation Organizations also note that the DSEIS fails to analyze how the Project may affect the broader restoration goals for, and efforts on, the Middle Mississippi River. The DSEIS should include this evaluation and identify and explain how the Project will affect the Corps' other missions and projects along the Middle Mississippi River, including restoration and flood damage reduction efforts. The Corps should also work with the full array of resource agencies, and the public, to improve management of the Mississippi River, including by implementing a robust monitoring plan to evaluate the effectiveness of those efforts. These efforts would be greatly facilitated through the development of an environmental impact statement for the entire Upper Mississippi River-Illinois Waterway navigation system

### 1. The DSEIS Fails to Examine Reasonably Foreseeable Site-Specific Impacts

The DSEIS violates NEPA because it fails to examine reasonably foreseeable site-specific impacts.

As discussed above, where, site-specific impacts are "reasonably foreseeable" at the program planning stage, they must be evaluated in the programmatic EIS.[61] The Corps may not evade this requirement by saying these impacts will be examined through later environmental reviews.[62]

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**58** 40 C.F.R. § 1502.22.
**59** Salant, NL, JC Schmidt, P Budy, and PR Wilcock. 2012. Unintended consequences of restoration: loss of riffles and gravel substrates following weir installation. *J Environ Manage* 109:154-63.
60 Palmer, MA, HL Minninger, E Bernhardt. 2010. River restoration, habitat heterogeneity and biodiversity: a failure of theory or practice? *Freshwater Biology* 55 (Suppl. 1), 205–222.
**61** *Colorado Environmental Coalition v. Office of Legacy Management*, 819 F. Supp. 2d. 1193, 1209 (D. Colo. 2011), reconsideration granted in part on other grounds, 2012 U.S. Dist. LEXIS 24126 (D. Colo. Feb. 27, 2012) (concluding that future site-specific mining activity was reasonably foreseeable at the lease stage because mining had previously taken place on the same public lands and thus must be reviewed at the programmatic leasing stage.)
**62** Kern v. U.S. Bureau of Land Mgmt., 284 F.3d at 1072.

Site-specific impacts are reasonably foreseeable for the Project because the Corps has seen the impacts of the Project for more than a century. During the past 100 years, the Corps has seen the impacts of: constructing an extensive array of river training structures; repeated and extensive dredging and dredged spoil disposal; and placing revetment on some 60 percent of the banks of the Middle Mississippi River. The Corps also has extensive experience with those areas in the Middle Mississippi River that require repeated dredging. The Corps also has extensive experience with the way in which river training structures can shift the locations where repetitive dredging may be required.

Because site specific impacts of the Project are reasonably foreseeable, the DSEIS is required to analyze those impacts.

### 2. The DSEIS Lacks Scientific Integrity

The DSEIS violates NEPA because it lacks scientific integrity.

"Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA."[63] Accordingly, the DSEIS must be based on "high quality" science and information and the Corps must "insure professional integrity, including scientific integrity, of the discussions and analysis in environmental impact statements."[64] Importantly, if information that is essential for making a reasoned choice among alternatives is not available, the Corps **must** obtain that information unless the costs of doing so would be "exorbitant."[65]

An EIS must utilize "quantified or detailed information" when analyzing impacts.[66] The DSEIS may not rely "on conclusory statements unsupported by data, authorities, or explanatory information."[67] Accordingly, the DSEIS must supply supporting data and authorities, and explain how and why it has drawn the conclusion it has reached.

The Corps must also candidly disclose the risks of its proposed action and respond to adverse opinions held by respected scientists:[68]

> "'Where scientists disagree about possible adverse environmental effect, the EIS must inform decision-makers of the full range of responsible opinion on the environmental effects.' Where the agency fails to acknowledge the opinions held by well respected scientists concerning the hazards of the proposed action, the EIS is fatally deficient."[69]

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[63] 40 C.F.R. § 1500.1(b).
[64] 40 C.F.R. § 1502.24 ("Agencies shall insure professional integrity, including scientific integrity, of the discussions and analysis in environmental impact statements"); *Earth Island Inst. v. U.S. Forest Service*, 442 F.3d 1147, 1159-60 (9th Cir. 2006) (quoting 40 CFR §1502.24).
[65] 40 C.F.R. § 1502.22.
[66] *Neighbors of Cuddy Mountain v. U. S. Forest Service*, 137 F.3d 1372, 1379 (9th Cir. 1998); *Ecology Center v. Castaneda*, 574 F.3d 652, 666 (9th Cir. 2009) (requiring "quantified or detailed data"); *Natural Resources Defense Council v. Callaway*, 524 F.2d 79, 87 (2d Cir. 1975).
[67] *Id*.
[68] *Seattle Audubon Soc'y v. Mosely*, 798 F.Supp. 1473, 1482 (W.D. Wash. 1992) (citing *Friends of the Earth v. Hall*, 693 F.Supp. 904, 934, 937 (W.D.Wash. 1988).
[69] *Friends of the Earth v. Hall*, 693 F. Supp. 904, 934 (W.D. Wash. 1988) (citations omitted).

It is not sufficient to include the statements of independent experts, including the Independent External Peer Review panel, in an Appendix or some other document. The expert comments must be included and appropriately responded to in the impacts section of the DSEIS.[70]

The DSEIS fails to meet these important and longstanding NEPA requirements, including by lacking scientific credibility across the board, as discussed below. The DSEIS also lacks scientific integrity because it fails to evaluate critical information discussed throughout Section II.C of these comments.

#### (a) Flood Heights and Flood Response

As discussed extensively in Section II.C.4 of these comments, the DSEIS' contention that river training structures do not increase flood heights lacks scientific credibility.

#### (b) Sediment Loading, Sediment Transport, Hydrology and Hydraulics

The DSEIS lacks fundamental information on sediment loading, sediment transport, hydrology and hydraulics in the Middle Mississippi River despite the fundamental purpose of the Regulating Works Project. The purpose of the Regulating Works Project is to maintain navigation on the Middle Mississippi River, which historically has been carried out through the sediment management practices of dredging and river training structure construction.

Despite the fact that sediment loads drive the Project, the DSEIS fails to provide sufficient data regarding the sediment load of the Middle Mississippi River or the River's sediment transport capabilities. This failing was identified by the IEPR panel, which concluded that the panel could not "judge whether structures and dredging designs are based on robust science, data and engineering" because the DSEIS does not provide meaningful information on sediment load and transport in the DSEIS.[71] The IEPR Panel recommends that the DSEIS be revised to include the following information:

- "Annual percentages and load from Missouri River and Upper Mississippi River."
- "Sediment properties for both bed load and suspended load – particle size, settling velocity, specific gravity, and fraction distribution within each particle size."
- "Annual volumes entering the MMR, temporarily and permanently deposited in the MMR, and exiting the MMR as compared to annual dredging load."
- "Relationship between channel conveyance, flood hydrographs (i.e., rising leg and falling leg), bed load, suspended sediment load, and sediment transportation."
- "Percentage of total bed load and suspended sediment load that is dredged."[72]

The Conservation Organizations note that there have been significant advancements in the understanding of large river sediment transport and deposition documented in hundreds of published

[70] *Id*.
[71] IEPR Final Report at 9
[72] *Id*.

scientific studies since the 1976 EIS was finalized.[73] This extensive body of science should be evaluated by the Corps and addressed in the DSEIS. As the IEPR panel notes, a "[s]trong working knowledge of sediment characteristics is necessary to design and construct effective regulating structures and conduct annual dredging programs."[74]

The IEPR Report also concluded that "the SEIS has little information on the hydraulic and hydrologic engineering data for the MMR."[75] While the IEPR panel concluded that the 1976 EIS contained sufficient data for this review, this finding is contradicted by the DSEIS and common sense. According to the DSEIS, the hydraulic and hydrology of the Middle Mississippi River has changed significantly since 1976:

> "Generally there has been an increase in cross sectional area, hydraulic depth, conveyance and volume throughout the period of record (Little et al. 2016). The Regulating Works Project has contributed to these changes, although it is uncertain to what extent." DSEIS at 44.

The DSEIS lacks scientific credibility because it fails to include fundamentally important data and information on sediment loading, sediment transport, hydrology, and hydraulics.

#### (c) Main Channel Border Habitat Model

The DSEIS assessment of main channel border habitat is based on an incomplete, and uncertified border habitat model. According to the DSEIS:

> "Actual acreages affected would not be known until the main channel border habitat model is completed and is subsequently used to determine impacts on an ongoing site-by-site basis.[76]

This failing is particularly critical since the DSEIS recognizes that the preferred alternative will cause significant adverse impacts to main channel border habitat, and those impacts will add to the already extremely significant loss of 34.85% of this habitat in the Middle Mississippi River.[77] *See* Section II.C.5 of these comments for an additional discussion of problems with the DSEIS assessment of main channel border habitat.

This model should have been completed, certified, and used to assess impacts before the DSEIS was completed because it is essential for making a reasoned choice among alternatives. As a result, the Corps **must** obtain this information unless the costs of doing so would be "exorbitant."[78]

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[73] E.g., DeHaan, H.C. 1998, *Large River Sediment Transport and Deposition: An Annotated Bibliography,* U.S. Geological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, April 1998, LTRMP 98-T002. 85 pp. (identifying more than 250 scientific studies addressing large river sediment transport and deposition published since 1976): Pierre Y. Julien and Chad W. Vensel, Department of Civil and Environmental Engineering Colorado State University, *Review of Sedimentation Issues on the Mississippi River*, DRAFT Report Presented to the UNESCO: ISI, November 2005 (referencing more than 100 studies published between 1979 and 2005).
[74] IEPR Final Report at 9.
[75] IEPR Final Report at 5.
[76] DSEIS at 56, n.22
[77] *See* DSEIS at 156 (from 1976 to 2014, the amount of unstructured main channel border habitat in the MMR decreased from 19,800 acres to 12,900; "river training structure construction affected approximately 6,900 acres of main channel border habitat from 1976 to 2014).
[78] 40 C.F.R. § 1502.22.

The model also may not be used for planning purposes until it is finalized, independently reviewed, and certified. The Corps' internal guidance clearly requires certification of the new model before it can be used for planning activities. The purpose of model certification is to ensure, among other things, that models used by the Corps are technically and theoretically sound, computationally accurate, transparent, and in compliance with Corps policy:

> "**Use of certified or approved models for all planning activities is mandatory**. This policy is applicable to all planning models currently in use, models under development and new models. District commanders are responsible for delivering high quality, objective, defensible, and consistent planning products. Development of these products requires the appropriate use of tested and defensible models. National certification and approval of planning models results in significant efficiencies in the conduct of planning studies and enhances the capability to produce high quality products. The appropriate PCX will be responsible for implementing the model certification/approval process. The goal of certification/approval is to ensure that Corps planning products are theoretically sound, compliant with Corps policy, computationally accurate, based on reasonable assumptions regarding the availability of data, transparent, and described to address any limitations of the model or its use. The use of a certified/approved model does not constitute technical review of the planning product. The selection and application of the model and the input data is still the responsibility of the users and is subject to Agency Technical Review and Independent External Peer Review (where applicable). Once a model is certified/approved, the PCXs will be responsible for assuring that model documentation and training on the use of the model are available (either from the PCX or the model developers), and for coordinating with model developers to assure the model reflects current procedures and policies. All certification/approval decisions will be in effect for a period specified by the Model Certification HQ Panel, not to exceed seven years."

EC 1105-2-412, Assuring Quality of Planning Models at paragraph 6 (emphasis added). Similarly, the use and application of the new model for individual projects is subject to the requirements of the Corps' peer review process. *See, e.g.*, EC 1105-2-408 and EC-1105-2-410.

### (d) Nineteen Mile Modeled Reach

The DSEIS lacks critical information on both the model used to assess the 19 mile reach of the Middle Mississippi River and on the characteristics of that modeled reach. The DSEIS also does not indicate whether the model has been independently reviewed and certified, as required by the Corps' internal guidelines EC 1105-2-412, EC 1105-2-408, and EC-1105-2-410. The accuracy and reliability of this model is particularly important because it forms the basis for the Corps' entire impacts analysis.

In addition to the potential lack of independent review and model certification, at least the following additional information must be provided in the DSEIS to assist the public and decision makers in assessing the adequacy, and potential accuracy, of the model:

1. The number and types of river training structures that are in the modeled reach.
2. The total length of river training structures in the modeled reach.
3. The height and widths of the river training structures in the modeled reach.
4. The information in 1-3 should also be provided for each different type of river training structure (*e.g.*, wing dike, bendway weir, chevron, other).

5. The linear feet and acreage of natural main channel border habitat in the modeled reach, and the linear feet and acreage of wetlands both in the main channel border habitat and in the adjacent floodplain.
6. The baseline depth data for the modeled reach.
7. The baseline flow patterns in the modeled reach.
8. The locations and areal extent of areas within the modeled reach that require repetitive dredging.
9. The length and width of revetment in the modeled reach.
10. Sufficient details concerning the model used to allow an independent reviewer to assess the adequacy of the model used.

In addition, the DSEIS should document that the length and characteristic of the modeled reach are statistically significant for assessing impacts to the entire Middle Mississippi River (the modeled reach accounts for just 9.75% of the length of the Middle Mississippi River). To properly analyze flood height impacts, the model should also **not be biased** towards shallower flows as river training structures have a greater impact on flood heights during high flow events.

The DSEIS should also provide detailed information on the cost and "time consuming" nature of modeling the full Middle Mississippi or multiple reaches of the Middle Mississppi. Because the modeled information is essential for making a reasoned choice among alternatives, the Corps must obtain the information unless the costs of doing so would be "exorbitant."[79] Without the cost and time data, it is not possible to assess whether the costs of addition modeling would in fact be "exorbitant" and thus, not required.

The DSEIS should also provide evidence demonstrating that this model was certified and independently reviewed pursuant to EC 1105-2-412, EC 1105-2-408, and EC-1105-2-410. These Engineering Regulations are discussed above.

### (e) Independent External Peer Review Panel Comments

The DSEIS fails to include the concerns raised by the Independent External Peer Review Panel (IEPR Panel), and fails to address those concerns. Indeed, the DSEIS does not even mention the existence of the IEPR Panel. It is not sufficient to include the statements of the IEPR Panel in a separate report or Appendix, the expert comments must be included and appropriately responded to in body of the DSEIS.[80] This failure to address the concerns of the IEPR Panel renders the DSEIS "fatally deficient."[81]

The IEPR Panel made the following findings, each of which demonstrates that the DSEIS lacks the most basic and fundamental information needed to assess Project impacts:

1. "It is not clear why impacts of future river training structure construction and the associated compensatory mitigation requirements were not evaluated in more detail with respect to specific locations in the MMR."

[79] 40 C.F.R. § 1502.22.
[80] *Friends of the Earth v. Hall*, 693 F. Supp. 904, 934 (W.D. Wash. 1988) (citations omitted).
[81] *Id*.

2. "The project description for the proposed action does not describe the decision-making process that will be employed for identifying new river training structure construction sites."

3. "The SEIS does not clearly describe the project construction features within the main report such that a link between the project and the level of impacts can be easily compared."

4. "A lack of detailed information on the sediment load entering the MMR limits the understanding of the overall effort needed to achieve the project's stated purpose of providing an economical, regulated, and dredged navigation channel."[82]

### (f) Independent Peer Review Panel Report and Membership

The existence of the IEPR Panel has not ensured the scientific credibility of the DSEIS for at least three reasons. *First*, as noted above, the DSEIS does not address the issues raised by the IEPR Panel.

*Second*, the IEPR Panel conducted only an extremely limited review and was provided with only limited information on the highly controversial issue of the impact of river training structures on flood stages. As a result, the Panel did not meaningfully "assess the 'adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used' (EC 1165-2-214; p. D-4) for the MMR Regulating Works SEIS documents" as required by the Corps' stated Objectives for the IEPR Panel.[83] Contrary to the IEPR Panel charge, the Panel also did not: "identify, explain, and comment upon assumptions that underlie all the analyses"; "evaluate the soundness of models, surveys, investigations, and methods"; or "evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable." The Conservation Organizations also note that the Final IEPR Report contains just five partial pages of substantive results and discussion,[84] and cites only three references.[85]

Critically, the IEPR Panel was only provided with the Corps' views on river training structures and flood stage as set forth in the 30 page Appendix A (Effects of River Training Structures on Flood Levels) of the DSEIS.[86] The IEPR Panel did not receive the extensive array of information on this critical topic that the Conservation Organizations have provided to the Corps over the past 5 years in connection with previous comments on Environmental Assessments for river training structure projects, scoping comments on the DSEIS, and federal litigation. During this period, the Conservation Organizations provided the Corps with a list of scientific references that included approximately 500 pages of scientific research linking river training structures to flood risk in previous comments, copies of a number of those studies, and two critical Affidavits that lay out the scientific case demonstrating that river training structures affect flood heights and that provide a point-by-point rebuttal of the Corps' conclusions on this issue.

Appendix A does not provide a balanced assessment of the science and cannot support a meaningful independent review of the impact of river training structures on river and flood stages. The language in Appendix A is both biased and dismissive of the findings of other respected scientists, and demonstrates a significant degree of animosity between the St. Louis District and independent scientists. While

[82] Final IEPR Report.
[83] Final IEPR Report, Appendix C.
[84] Final IEPR Report at 5-9.
[85] Final IEPR Report at 10.
[86] Final IEPR Report, Appendix C at C-6.

Appendix A contends that the Corps' models and findings have been reviewed by "other external reviewers" Appendix A does not provide the identities or affiliations of these reviewers and does not discuss their qualifications.

*Third*, the IEPR Panel has, at a minimum, a strong appearance of lack of meaningful independence and, at worse, in fact lacks the independence required for a meaningful independent review. The IEPR Panel also included an inappropriately small number of reviewers.

Collectively, the members of the IEPR Panel have worked directly for the Corps for 63 years. Each IEPR Panel members has worked for the Corps for a significant portion of their professional lives: one panel member worked for the Corps for 31 years; one panel member worked for the Corps for 19 years; and one panel member worked for the Corps for 13 years. Each IEPR Panel member has worked on previous IEPR Panel reviews for Corps civil works projects. The Conservation Organizations are extremely concerned that this extensive history of working with and for the Corps biases Panel members towards agreeing with, or minimizing critique of, Corps methodologies, models, and evaluations. This problem is amplified by the fact that there were only three reviewers on the IEPR Panel – despite the significance of the scientific controversies surrounding the Project, the extensive scope of the Project, and the significant impacts of the Project. Such a small panel for such a large project calls into question whether the panel really had the full range of expertise needed to review the DSEIS. By comparison, the IEPR Panel for the St Johns Bayou New Madrid Floodway Project had eight panelists.

As discussed elsewhere in these comments, the Conservation Organizations urge the Corps to initiate a National Academy of Sciences study on river training structures and flood heights. The Corps should also convene a new, larger, and more Independent External Peer Review Panel to evaluate the DSEIS and the Final DSEIS.

### (g) Economic Data and Analyses

The DSEIS provides only the most rudimentary, general, and unsupported analysis of the potential cost of future river training structure construction and mitigation. *See* DSEIS, Appendix C at 9-11. The DSEIS explicitly does not provide any economic analysis of the Regulating Works Project, despite the fact that the preferred alternative recommends extensive new, ongoing construction for at least 17 years:

> "The purpose of this document is to analyze the environmental impacts of the Regulating Works Project in the context of the new circumstances and information that has become available since the 1976 EIS was produced. Accordingly, this SEIS does not include a detailed economic evaluation of the Regulating Works Project. The future economic updates that are performed for the Project will include current information on construction costs, dredging costs, and any mitigation costs. These future economic updates may also result in an updated estimated quantity of construction and mitigation, which will be appropriately evaluated and assessed when completed." DSEIS at 27.

This lack of a meaningful economic analysis is particularly problematic since the DSEIS claims that new river training structure construction is needed to reduce the costs of maintaining the navigation channel. Without a detailed assessment of project costs **and** benefits, it is not possible to determine whether this stated goal would in fact be met. To assess the benefits and costs of the preferred alternative, the DSEIS should assess at least the following information:

(1) The projected future costs of required dredging for each alternative evaluated in the DSEIS, and each of the other highly reasonable alternatives identified in these comments, calculated for the life Project.
(2) The construction and full life cycle maintenance costs of river training structures that would be constructed under the New Construction Alternative;
(3) A meaningful assessment of mitigation costs for each alternative, including the costs associated with monitoring (as required by law), adaptive management and contingency planning should the mitigation not achieve ecological success criteria as required by law;
(4) The costs associated with increased risks of upstream or nearby levee failures should new river training structure construction increase flood heights.
(5) The value of the ecosystem services that will be lost under each alternative.

In addition, due to the extensive construction of new river training structure projects under the preferred alternative, the DSEIS should also include a National Economic Development (NED) analysis to compare alternatives. In this needed analysis, the DSEIS should evaluate the full range of ecosystem services that will be lost due to the construction of the preferred alternative.

The DSEIS lacks scientific credibility because it fails to include basic and necessary economic data.

### 3. The DSEIS Fails to Accurately Establish Baseline Conditions

The DSEIS violates NEPA because it fails to accurately establish and consider baseline conditions. It is well established that:

> "Without establishing the baseline conditions ... there is simply no way to determine what effect the [action] will have on the environment, and consequently, no way to comply with NEPA."[87]

Properly establishing baseline conditions requires accurate and comprehensive data on baseline conditions. Without baseline data, "an agency cannot carefully consider information about significant environment impacts. Thus, the agency fails to consider an important aspect of the problem, resulting in an arbitrary and capricious decision."[88] If information that is essential for making a reasoned choice among alternatives is not available, the Corps must obtain that information unless the costs of doing so would be "exorbitant."[89]

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[87] *Half Moon Bay Fisherman's Mktg. Ass'n. v. Carlucci,* 857 F.2d 505, 510 (9th Cir.1988). As a result, the entire DSEIS is inadequate as a matter of law. *E.g.*, *Friends of Back Bay v. U.S. Army Corps of Engineers*, 681 F.3d 581, 588 (4th Cir. 2012) (an EIS fails to comply with NEPA if it relies on a "material misapprehension of the baseline conditions.")

[88] *N. Plains Res. Council, Inc. v. Surface Transp. Bd.*, 668 F.3d 1067, 1083, 1085 (9th Cir. 2011) (the EIS did "not provide baseline data for many of the species" of concern and thus "did not take a sufficiently 'hard look'" to fulfill its NEPA-imposed obligations at the impacts as to these species).

[89] 40 C.F.R. § 1502.22. *See also*, *Half Moon Bay Fisherman's Mktg. Ass'n.* 857 F.2d 505; N. Plains Res. Council, 668 F.3d 1067; *Gifford Pinchot Task Force v. Perez*, No. 03:13-CV-00810-HZ, 2014 WL 3019165, at *27-29 (D. Or. July 3, 2014), *appeal dismissed* (Dec. 23, 2014), *appeal dismissed* (Dec. 29, 2014); *Idaho Conservation League v. U.S. Forest Serv.,* No. 1: 11 –CV–00341 -EJL, 2012 WL 3758161, at *16 (D.Idaho Aug. 29, 2012) (analyzing an EA, ruling that the agency needed to conduct a baseline study and actual investigation of groundwater before reaching a conclusion regarding the impacts of a mining project on groundwater).

Properly establishing baseline conditions also requires a clear description of "how conditions have changed over time and how they are likely to change in the future without the proposed action" to determine whether additional stresses will push this system over the edge.[90] This is particularly important in situations, like those in the Middle Mississippi River, where the environment has already been greatly modified by human activities because it "is often the case that when a large proportion of a resource is lost, the system nears collapse as the surviving portion is pressed into service to perform more functions."[91]

The DSEIS fails to meet these requirements because the DSEIS:

(a) Lacks fundamental baseline data on flood heights. Notably, the DSEIS improperly dismisses extensive and highly credible information on flood level increases and on fundamental changes to the way the Middle Mississippi River responds to flood events.[92] The Corps' refusal to acknowledge the validity of this information, and account for these changes—and the role of river training structures in creating these dangerous conditions—taints the entire DSEIS.

(a) Lacks fundamental baseline data on sedimentation rates.

(b) Lacks fundamental baseline data on fish and wildlife species, including migratory species, and their critical habitat needs. The DSEIS fails even to identify the vast majority of the many hundreds of individual species that rely on the Middle Mississippi River and its floodplain, including particularly those species that rely on diverse braided river habitats, slow moving river habitats, border channel habitats, and floodplain wetlands. Critically, the DSEIS also fails to provide any information on the various habitats needed throughout the full life cycles of those species, including habitat and flows needed to support breeding (including access to the floodplain), rearing, feeding, and resting.

(c) Lacks fundamental baseline data on plant species, including wetland plant species.

(d) Lacks fundamental baseline data on vitally important habitat types, including main channel border habitat, braided river habitat, wetland habitat, and floodplain habitat. Despite the significant losses of main channel border habitat from the preferred alternative, the DSEIS does not describe the ecological characteristics of this habitat, does not identify the full suite of fish and wildlife species that utilize this habitat, and does not provide information on the direct, indirect, and cumulative effects of the loss of this habitat.

(e) Fails to meaningfully evaluate the potential impacts of channel cutoffs. Channel cut offs can have significant consequences for conditions in the Middle Mississippi River. One location of particular concern is the potential for a channel cut off at Dogtooth Bend. For this location, the DSEIS states only that "[a]nother site that has shown the potential of a channel cutoff is at Dogtooth Bend at river mile 33. A cutoff at Dogtooth Bend would reduce the length of the MMR by approximately 16 – 18 miles. The consequences of a channel cutoff at Dogtooth Bend would be similar to those at Thompson Bend." DESIS at 13. The implications of such a change are

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[90] Council on Environmental Quality, Considering Cumulative Effects Under the National Environmental Policy Act at 41 (January 1997).
[91] *Id*.
[92] *See* Section II.C.4 of these comments.

significant and should be analyzed in far more depth. Important information on this situation is included in a 2016 study by Olson and Morton. A copy of this study is provided at Attachment A. The DSEIs should fully assess the potential implications of a channel cutoff at this and other locations, and develop a comprehensive approach to the problem.

(f) The discussion of baseline conditions fails to discuss and account for the significant decline in the ecological health of the Mississippi River and the role of the Regulating Works Project in that decline. These issues must be addressed in the discussion of baseline conditions; it is not enough to simply incorporate by reference numerous past studies that document this significant decline.[93]

Because of these failings, the DSEIS fails to take the "hard look" at impacts required by NEPA and fails to comply with the Act.

### 4. The DSEIS Fails to Adequately Evaluate Impacts on Flooding

The DSEIS fails to adequately evaluate the impacts of the Regulating Works Project, and particularly the construction of river training structures, on flood heights. The DSEIS instead rejects the extensive body of scientific evidence demonstrating that such structures increase flood heights and that the extensive array of these structures has fundamentally changed the way the Middle Mississippi River responds to flood events.

The Conservation Organizations once again urge the Corps to initiate a National Academy of Sciences (NAS) study to examine the effect of river training structures on flood heights. An NAS review is a common sense approach that is critically important given the overwhelming scientific consensus that river training structures increase flood heights. This consensus directly contradicts the Corps' assertions that river training structures do not affect flood levels. An NAS study would cost far less than a single river training structure, and the costs of the study would be far outweighed by the public benefits of an NAS review. Importantly, an NAS study would increase the public's confidence in the decision making process. There currently is intense public opposition to constructing new river training structures, due to their flood risks.[94]

Science shows that river training structures, constructed by the Corps to reduce navigation dredging costs, have significantly increased flood levels by up to 15 feet in some locations and 8 feet and more in broad stretches of the river where these structures are prevalent.[95] Independent scientists have determined that the more than 40,000 feet of "wing dikes" and "bendway weirs" constructed by the Corps in the Mississippi during the 3 years prior to the great flood of 1993 contributed to record crests in 1993, 1995, 2008, and again in 2011. Even studies commissioned by the St. Louis District and cited in

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[93] *See* DSEIS at 166.

[94] *See, e.g.*, the extensive public scoping comments for this Project, the extensive public comments on this DSEIS, and the strong opposition by local community members to the revised Grand Tower Environmental Assessment expressed at the March 9, 2016 and February 19, 2014 public hearings on the Grand Tower project.

[95] Pinter, N., A.A. Jemberie, J.W.F. Remo, R.A. Heine, and B.A. Ickes, 2010. Empirical modeling of hydrologic response to river engineering, Mississippi and Lower Missouri Rivers. River Research and Applications, 26: 546-571; Remo, J.W.F., N. Pinter, and R.A. Heine, 2009. The use of retro- and scenario- modeling to assess effects of 100+ years river engineering and land cover change on Middle and Lower Mississippi River flood stages. Journal of Hydrology, 376: 403-416.

the DSEIS (*e.g.*, Watson et al., 2013a, DEIS at 40 and Appendix A) find statistically significant increases in water levels for flood flows.

Scientific evidence directly contradicting the Corps' findings on river training structures continues to accumulate. In his comments on the Regulating Works Project Grand Tower Amended Environmental Assessment, Robert E. Criss, Ph.D., a professor in the Department of Earth and Planetary Sciences at Washington University in St. Louis, concludes:

> "The consequences of current management strategy on floodwater levels are clearly shown by data from multiple gauging stations on the Middle Mississippi River (Figures). The Chester and Thebes stations were selected as they are the closest stations to the project area that have long, readily available historical records (USGS, 2016). **These figures conclusively document that floodwater levels have been greatly magnified along the Middle Mississippi River, in the timeframe when most of the in-channel navigational structures were constructed. If these structures are not the cause, then we are left with no explanation for this profound, predictable effect.** That USACE proposes more in-channel construction activities only two months after another "200-year" flood (as defined by USACE, 2004, 2016) occurred in this area proves that their structures and opinions are not beneficial, but harmful."[96]

Dr. Criss adds that measurements at the Mississippi River at St. Louis and the Missouri River at Herman "document similar damaging and incontestable trends for other river reaches managed in the same manner."[97]

A 2016 Journal of Earth Science study co-authored by Dr. Criss ("Criss and Luo 2016") highlights the cumulative impact of the Corps' excessive channelization of the Middle Mississippi River. That study concludes that the Middle Mississippi River has been so constricted by river training structures and levees that it is now exhibiting "the flashy response" to flooding "typical of a much smaller river":[98]

> "Ehlmann and Criss (2006) proved that the lower Missouri and middle Mississippi Rivers are becoming more chaotic and unpredictable in their time of flooding, height of flooding, and magnitude of their daily changes in stage. This chaotic behavior is primarily the result of extreme channelization of the river, and its isolation from its floodplain by levees (e.g., Criss and Shock, 2001; GAO, 1995; Belt, 1975). The channels of the lower Missouri and middle Mississippi Rivers are only half as wide as they were historically, along a combined reach exceeding 1 500 km, as clearly shown by comparison of modern and historical maps (e.g., Funk and Robinson, 1974).

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[96] Comments on Draft Environmental Assessment by Robert E Criss, Washington University, March 3, 2016 (emphasis added).
[97] *Id*.
[98] Robert E. Criss, Mingming Luo, *River Management and Flooding: The Lesson of December 2015–January 2016, Central USA*, Journal of Earth Science, Vol. 27, No. 1, p. 117–122, February 2016 ISSN 1674-487X (DOI: 10.1007/s12583-016-0639-y).

> The aftermath of storm Goliath [which led to the December 2015 floods] provides another example in an accelerating succession of record floods, whose tragic effects have been greatly magnified by man. The heavy rainfall was probably related to El Nino, and possibly intensified by global warming. . . . The Mississippi River flood at St. Louis was the third highest ever, yet it occurred at the wrong time of year, and its brief, 11-day duration was truly anomalous. Basically, this great but highly channelized and leveed river exhibited the flashy response of a small river, and indeed resembled the response of Meramec River, whose watershed is smaller by 160×. Yet, only a few percent of the watershed above St. Louis received truly heavy rainfall during this event; the river rose sharply because the water simply had nowhere else to go.
>
> Further downstream, new record stages on the middle Mississippi River were set. Those record stages would have been even higher, probably by as much as 0.25 m, had levees not failed and been overtopped. The sudden drop of the water level near the flood crest at Thebes clearly demonstrates how levees magnify floodwater levels. In this vein, it is very significant that the water levels on the lower Meramec River were highest, relative to prior floods, proximal to a new levee and other recent developments.
>
> Forthcoming calls for more river management, including higher levees and other structures, must be rejected. Additional “remediations” to this overbuilt system will only aggravate flooding in the middle Mississippi Valley (see Walker, 2016).
>
> ***
>
> In contrast, Goliath’s extraordinary rainfall impacted only a tiny fraction of the huge, 1.8 million km2 Mississippi River Basin above St. Louis, yet flooding occurred which was truly remarkable for the high water level, time of year, and brief duration.
>
> This continental-scale river exhibited the flashy response typical of a much smaller river such as the Meramec. This unnatural response is clearly consistent with the dramatic channelization of the middle Mississippi River and its isolation from its floodplain by levees, as clearly pointed out by Charles Belt more than 40 years ago. It is time for this effect to be accepted and for flood risk and river management to be reassessed.”[99]

A copy of Criss and Luo 2016 is provided at Attachment B.

The critique of Criss and Luo 2016 in Appendix A to the DSEIS is fundamentally flawed. That critique does not address the content of the study, and instead focuses on a single locality (Chester) that was scarcely mentioned in the study. The DSEIS discussion of this single locality (Chester) inappropriately compares the recent winter flood with prior, warm weather floods, and rising limb data with falling limb data.

In addition, the DSEIS critique, does not—and cannot—explain away critical findings in Criss and Luo 2016, including the findings related to:

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[99] Robert E. Criss, Mingming Luo, *River Management and Flooding: The Lesson of December 2015–January 2016, Central USA*, Journal of Earth Science, Vol. 27, No. 1, p. 117–122, February 2016 ISSN 1674-487X (DOI: 10.1007/s12583-016-0639-y).

(1) The record high stages set during this recent flood just downstream at Cape Girardeau and Thebes, which as Criss and Luo point out would have been far higher but for the catastrophic failure of the Len Small levee.
(2) Why the recent peak stage at Chester was nearly 3 feet higher than it was on April 30, 1973, which at that time was the highest water level ever recorded at that site.
(3) The unusual winter timing of this recent flood and its short duration, both of which would not have caused a flood of this magnitude without constriction of the river.
(4) Why the site showing the greatest increase in stage over previous floods occurred adjacent to the Valley Park levee, built by the Corps in 2005.

Moreover, contrary to the assertions in the DSEIS critique, the Criss and Luo 2016 synopsis of weather conditions clearly acknowledges antecedent ground saturation, and all data used by Criss and Luo are identical to values reported by the cited federal agencies at the time of writing. Each of those values remains identical to the values reported today with the single exception that the 1982 stage at Pacific was revised subsequently by the National Weather Service. However, this change has no effect on the Criss and Luo 2016 conclusions.

The Corps' conclusion that river training structures do not affect flood heights has been conclusively disproved by research led by Nicholas Pinter, Ph.D., currently the Shlemon Chair in Applied Geology at the University of California Davis. In a series of exchanges published in the Journal of Hydraulic Engineering, Dr. Pinter has specifically rebutted both the methodology and conclusions in the Watson studies relied on extensively by the Corps. The series of exchanges between Dr. Pinter and Watson are provided at Attachment C. Dr. Pinter has also rebutted the Corps' conclusion in sworn affidavits submitted to the District Court for the Southern District of Illinois. These affidavits are provided at Attachment D.

Critically, Dr. Pinter's research shows that flood stages increase more than 4 inches for each 3,281 feet of wing dike built within 20 river miles downstream. These impacts are cumulative—the more structures placed in the river, the higher the flood increases:

> "[O]ur analyses demonstrate that wing dikes constructed downstream of a location were associated with increases in flood height ("stage"), consistent with backwater effects upstream of these structures. Backwater effects are the rise in surface elevation of flowing water upstream from, and as a result of, an obstruction to water flow. These backwater effects were clearly distinguishable from the effects of upstream dikes, which triggered simultaneous incision and conveyance loss at sites downstream. On the Upper Mississippi River, for example, stages increased more than four inches for each 3,281 feet of wing dike built within 20 RM (river miles) downstream. These values represent parameter estimates and associated uncertainties for relationships significant at the 95 percent confidence level in each reach-scale model. The 95-percent level indicates at least a 95% level of certainty in correlation or other statistical benchmark presented, and is considered by scientists to represent a statistically verified standard. Our study demonstrated that the presence of river training structures can cause large increases in flood stage. For example, at Dubuque, Iowa, roughly 8.7 linear miles of downstream wing dikes were constructed between 1892 and 1928, and were associated with a

nearly five-foot increase in stage. In the area affected by the 2008 Upper Mississippi flood, more than six feet of the flood crest is linked to navigational and flood-control engineering."[100]

The Conservation Organizations urge the Corps to fully consider the information provided by Dr. Pinter in these rebuttals.

The failure to acknowledge and account for the significant increases in flood heights and the fundamental changes to the way the Middle Mississippi River responds to floods caused by river training structures renders the DSEIS fundamentally, and dangerously flawed.

### 5. The DSEIS Fails to Adequately Evaluate Impacts to Main Channel Border Habitat

Despite recognizing that the preferred alternative will result in the loss of at least "1,100 acres (8%) of the remaining unstructured main channel border habitat,"[101] the DSEIS fails to meaningfully evaluate the full extent of main channel border habitat impacts, fails to meaningfully evaluate the ecological implications of those losses, and fails to evaluate the additive implications of those losses in light of the already highly significant losses of main channel border habitat to date

The Conservation Organizations note that based on the information provided in the DSEIS the 1,100 acre loss would actually constitute an 8.53% loss of existing main channel border habitat (1,100 acres of the remaining 12,900 acres), not 8% has indicated in the DSEIS. Given the 34.85% loss of main channel border habitat to date due to river training structures,[102] it is important to accurately state the additional percentage of habitat that might be lost.

The DSEIS fails to provide an accurate assessment of the areal extent and locations of adverse impacts to main channel border habitat for at least the following four reasons:

(1) The DSEIS assessment that 1,100 (8%) of the remaining unstructured main channel border habitat will be lost is based on an incomplete border habitat model. DSEIS at 56, n.22 ("Actual acreages affected would not be known until the main channel border habitat model is completed and is subsequently used to determine impacts on an ongoing site-by-site basis.) This model should have been completed, certified, and used to assess impacts before the DSEIS was completed.

(2) The incomplete main channel border habitat model appears to have been applied to the extremely limited and problematic analysis of the 19 Mile Modeled Reach. *See* Section II.C.2 of these comments for a discussion of problems with the Modeled Reach.

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[100] Reply Declaration of Nicholas Pinter, Ph.D. in Support of Plaintiffs' Motion for Preliminary Injunction, NWF et al v. Corps of Engineers, Case No. 14-00590-DRH-DGW, (S.D. ILL), 2014; Declaration of Nicholas Pinter, Ph.D. in Support of Plaintiffs' Motion for Preliminary Injunction, Case No. 14-00590-DRH-DGW, (S.D. ILL), 2014.
[101] DSEIS at 26.
[102] *See* DSEIS at 156 (from 1976 to 2014, the amount of unstructured main channel border habitat in the MMR decreased from 19,800 acres to 12,900; "river training structure construction affected approximately 6,900 acres of main channel border habitat from 1976 to 2014).

(3) The DSEIS does not meaningfully analyze the additive losses to main channel border habitat that will be caused by the disposal of dredged spoil. According to the DSEIS, "550 acres of main channel and main channel border habitat are impacted by dredged material disposal. These are anticipated to decrease to approximately 330 acres each with the Continue Construction." DSEIS at 136. While the Corps presumably knows the precise locations of its dredged spoil disposal, the DSEIS does not provide information on dredged spoil disposal within the main channel border habitat alone.

Based on the information provided in the DSEIS, in a worse-case scenario, the Middle Mississippi River could be losing 550 acres of main channel border habitat each year from the disposal of dredged spoil alone. Under the preferred alternative, this could eventually drop to 330 acres of impact to main channel border habitat each year at the end of 17 years. Since the Corps appears to contemplate dredging in perpetuity, these losses would also continue into perpetuity. Even using a conservative estimate of 100 acres of side channel habitat impacted by dredged disposal for each of the next 17 years (when the Corps currently estimates an end to river training structure construction), dredged disposal would cause an additional 1,700 acre loss of main channel border habitat during this period, more than doubling the 1,100 acres of border habitat loss estimated from river training structure construction alone. The full extent of direct, indirect, and cumulative impacts to main channel border habitat from all aspects of the Project must be assessed and mitigated.

In addition, DSEIS Appendix C suggests that impacts to main channel border habitat from river training construction alone could be much higher than 1100 acres: "It was calculated that the impact of all construction necessary to achieve the maximum dredging reduction as determined by the Expert Elicitation was 1774 acres of main channel border."[103]

(4) The assessment of impacts is limited to an estimate of acreage losses. While it is important to know the acreage losses, to assess impacts in a river system, it is equally important to know the total linear feet and likely locations of such losses. This information is essential for assessing the true extent of impacts, including assessing whether significant losses will occur in areas that are of particular importance to key species, or assessing whether such losses will occur in areas where natural main channel border habitat has already been significantly compromised.

The DSEIS also fails to meaningfully evaluate the ecological losses that will stem from the significant losses of main channel border habitat. For example:

(1) The DSEIS fails to provide even the most basic information on the ecological characteristics of main channel border habitat. Indeed, the DSEIS states only that main channel border habitat is "defined as areas shallower than LWRP -10 without river training structures." DSEIS at 156. As the St. Louis District has recognized in the past, main channel border habitat has important ecological characteristics. For example, in 1998 the St. Louis District provided this definition of main channel border habitat in the Upper Mississippi River:

> "The zone lines between the 9-foot channel and the main riverbank, islands, or submerged definitions of the old main river channel. The bottom is mostly sand

[103] DSEIS, Appendix C at 3.

> along the main channel border in the upper sections of a pool and silt in the lower. On the MR there are 87,833 acres of main channel border habitat. . . . The main channel border is a primary habitat for freshwater mussels, and the basis for the commercial mussel industry. Furbearers use this area as they do side channels and backwaters for feeding, and the banks occasionally serve as den sites. Shore and wading birds use the shallow waters within the main channel border for feeding. Some waterfowl use can also be noted, mainly by wood ducks and mallards. . . . Main channel border is classified primarily as riverine unconsolidated shore, but may also include riverine aquatic bed and emergent wetlands."[104]

This 1998 definition for the Upper Mississippi River suggests that the loss of a significant portion of the remaining main border habitat would have ecological impacts far beyond benthic organisms and fisheries. *See* DSEIS at 74, 77. The DSEIS should evaluate impacts to the various habitat types located within the main channel border habitat, and assess the impacts to the fish and wildlife species that utilize those various habitats.

(2) The DSEIS also does not identify the vast array of fish and wildlife species that utilize the main channel border, and does not provide a meaningful assessment of the direct, indirect, and cumulative adverse impacts to the full array of fish and wildlife resources from the significant additional losses to main channel border habitat. The DSEIS does not examine any impacts at all to non-fish species that utilize main border channel habitat. While the DSEIS does identify some fish species that prefer main border channel habitat, it provides little information on the impacts to those species. The DSEIS instead focuses its fisheries impact analysis on changes in fish densities surrounding river training structures and impacts of entrainment during dredging.

For example, the DSEIS fails to discuss or reference an important 2004 study which shows that in the Middle Mississippi River, main channel border habitat is a preferred habitat for the federally endangered Pallid sturgeon.[105] A copy of this study is provided at Attachment E to these comments. The DSEIS fails to discuss impacts to reptiles at all, even though a 2016 study shows that "[s]hallow, low-velocity habitat seems most important to turtles" in the Middle Mississippi River and that "smooth softshell turtles used open side channels and unstructured main-channel borders most often."[106]

(3) As discussed in Section II.C.16 of these comments, the DSEIS fails to account for the cumulative impacts of the loss of an additional 8.53% of main channel border habitat on top of the already extremely significant loss of 34.85% of main channel border habitat in the Middle Mississippi River. As a result, the DSEIS cannot satisfy the fundamental requirement

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[104] Draft Environmental Impact Statement, Second Lock at Locks and Dam No. 26 (replacement) Mississippi River, Alton, Illinois and Missouri (St. Louis District) 1986 at DEIS-65.

[105] Hurley, Keith L., Sheehan, Robert J., Heidinger, Roy C., Wills, Paul S. and Clevenstine, Bob. "Habitat Use by Middle Mississippi River Pallid Sturgeon." (Jul 2004), published in Transactions of the American Fisheries Society, Vol. 133, Issue 4 ( July 2004) at doi: 10.1577/T03-042.

[106] Braun, Andrew P., Phelps, Quinton E. "Habitat Use by Five Turtle Species in the Middle Mississippi River." Chelonian Conservation and Biology Jun 2016: Vol. 15, Issue 1, pg(s) 62-68 doi: 10.2744/CCB-1156.1 (available at http://www.bioone.org/doi/abs/10.2744/CCB-1156.1).

> to "determine the magnitude and significance of the environmental consequences" of the preferred alternative in the context of the cumulative effects of other past, present, and future actions.[107]

Notably, however, even the minimal information provided in the DSEIS demonstrates that the Project induced losses are so significant that the Corps should select the No New Construction alternative, or one of the other alternatives recommended for review in these comments. According to the DSEIS:

> "Although these unstructured main channel border habitats are part of a river system that is highly modified compared to its original state, they likely more closely resemble some of the habitats of the historic MMR. The continued conversion to structured habitat is expected to result in the continued functional change of the river from the unconfined, shifting, meandering river that was the historic condition, toward a river dominated by the deep, high velocity habitat of the main channel surrounded by structured main channel border habitat. This analysis also provides insight into the magnitude of the potential adverse effect to fish movement described above. Areas of unstructured main channel border habitat are more likely to provide the necessary movement and migration pathways required by the MMR fish community. Overall, the continued conversion to structured main channel border habitat is expected to have a significant adverse effect on the MMR fish community and the District has concluded that this would warrant compensatory mitigation."

DSEIS at 156-157.

As the DSEIS properly concludes, this level of impact to main channel border habitat is "significant on technical, institutional, and public merits." DSEIS at ES-26. The full suite of adverse impacts from this significant loss of main channel border habitat must be assessed in the DSEIS.

### 6. The DSEIS Fails to Evaluate Key Information Concerning Side Channels

The DSEIS properly recognizes the importance of side channel habitat in the Middle Mississippi River, and provides information on the threat to these important habitats due to greater isolation from the main channel caused in part by the trend toward decreasing stages at low to moderate river discharges. See DSEIS at 171.

However, the DSEIS fails to meaningfully assess and recognize the extent of the threat of such disconnection caused by river training structures, which are well recognized as causing cause lower water levels during low flow conditions. The DSEIS also fails to evaluate how trends in extreme flows (due to the construction of river training structures and climate change), may create additional side channel disconnections by transporting and depositing excessive sediment into the side channels. In the absence of this information, the DSEIS conclusion that the quantity of side channel habitat is stable or improving and that the Corps intends to avoid and minimize impacts to side channels is not supported by evidence. See DSEIS at 116.

The Conservation Organizations appreciate the effort that went into the side channel connectivity analysis in the DSEIS. See DSEIS at 53-58. However, this analysis focuses solely on hydrologic

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[107] Council on Environmental Quality, *Considering Cumulative Effects Under the National Environmental Policy Act* (January 1997) at 41 (emphasis added).

connectivity. The entire side channel analysis fails to address the biological value of side channel connectivity in the Middle Mississippi River and the impacts of the Project on those biological values. The DSEIS also does not provide information the side channel conditions that would maximize their value for fish and wildlife.

The DSEIS also fails to evaluate the impacts of climate change on the Middle Mississippi River side channels at both low and high flow conditions. Because the Middle Mississippi River is influenced by the Illinois, Upper Mississippi, Missouri, and Ohio Rivers, climate change is likely to have an extremely significant impact on the Middle Mississippi River and its vital side channels.

The DSEIS should provide a significantly more robust analysis of impacts to essential side channel habitat.

### 7. The DSEIS Fails to Evaluate Impacts to Braided Channel Habitat

An accurate assessment of fish and wildlife impacts requires a meaningful and accurate assessment of impacts to the full range of habitats that these species rely on. In addition to main channel border habitat and side channel habitat, important fish and wildlife habitat includes braided channels, crossover habitat, mid-channel bars, backwater habitat, riverine wetlands, and floodplain wetlands.

Impacts to braided channel habitat were highlighted in the Draft Environmental Assessment with Unsigned Finding of No Significant Impact, Regulating Work Projects Eliza Point/Greenfield Bend Phase 3; Public Notice P-2852 (2013-618). In that draft environmental assessment, the Corps wrote that the tentatively selected plan would result in 272.2 average annual habitat units for the shovelnose sturgeon," a species closely related to the river's endangered Pallid sturgeon. Environmental Assessment at 57. According to the Environmental Assessment, pallid sturgeon "are adapted to braided channels, irregular flow patterns, flooding of terrestrial habitat, extensive microhabitat diversity, and turbid waters (Mayden and Kahajda 1997)." *Id*. However, the 2003 Rodgers Study does not describe creation of this type of habitat, and the limitations in the table-top physical model prevent any assessment of whether such habitat will in fact be created.

Braided channel habitat will certainly be affected by the construction of new river training structures, and the DSEIS must analyze impacts to this and other diverse river habitats.

### 8. The DSEIS Fails to Evaluate Impacts to Wetlands

The DSEIS violates NEPA because it fails to evaluate impacts to vegetated and forested wetlands, including wetlands located in main channel border habitat and in the Mississippi River floodplain. Indeed, despite noting that Middle Mississippi River side channels can function as wetlands and that the Middle Mississippi River National Wildlife Refuge is managed to provide wetlands for migratory birds, the DSEIS provides **no analysis at all** of wetland impacts.

Assessing the impacts to wetlands requires a scientifically sound assessment of the impacts of the proposed Project on wetland hydrology and wetland plant species. This is critically important because "[h]ydrology is probably the single most important determinant of the establishment and maintenance of specific types of wetlands and wetland processes":

> "Hydrology affects the species composition and richness, primary productivity, organic accumulation, and nutrient cycling in wetlands. . . . Water depth flow patterns, and duration and frequency of flooding, which are the result of all the hydrologic inputs and outputs, influence the biochemistry of the soils and are major factors in the ultimate selection of the biota of wetlands. . . . Hydrologic conditions can directly modify or change chemical and physical properties such as nutrient availability, degree of substrate anoxia, soil salinity, sediment properties, and pH."[108]

Even "small changes in hydrology can result in significant biotic changes"[109] and produce ecosystem-wide changes:

> "**When hydrologic conditions in wetlands change even slightly, the biota may respond with massive changes in species composition and richness and in ecosystem productivity.**"[110]

As a result the impacts from even small changes in the duration and extent of inundation of wetlands in the Mississippi River system must be evaluated as such changes could create significant adverse impacts to the structure and function of those wetlands leading to adverse impacts to fisheries, wildlife habitat, plant communities, water quality, water quantity, soil moisture recharge, nutrient cycling, and flood pulse conditions.

As with all impacts analyses, the wetland assessment must look at the direct, indirect, and cumulative impacts to wetlands. The cumulative impacts assessment should look at the cumulative impacts to wetland resources and floodplain connectivity due to: river training structure construction and other channel modifications; dredging and dredged spoil disposal; the burying of at least 60 percent of the Middle Mississippi River banks under concrete and other types of revetment; construction of levees; and climate change.

### 9. The DSEIS Fails to Adequately Evaluate Impacts to Species Listed Under the Federal Endangered Species Act

The DSEIS violates NEPA because it fails to adequately evaluate the impacts to species listed under the Federal Endangered Species Act (ESA). As discussed in Section III of these comments, the Corps should also reinitiate Endangered Species Act consultation for the species evaluated in the 2000 Biological Opinion.

The only discussion of listed species in the DSEIS is a summary conclusion that there will be no impacts for species listed prior to 2000 other than those already contemplated in the 2000 Biological Opinion. A Biological Assessment for species listed after 2000 is provided at DSEIS Appendix B.

However, as a matter of law, past, present or future compliance with the ESA cannot satisfy the NEPA requirement to evaluate the impact of the proposed management alternatives on these species. This is because the Corps' legal obligations under the ESA and NEPA are entirely separate and apply fundamentally different standards. Compliance with the ESA Section 7 prohibition against jeopardizing the continued existence of a species does not satisfy NEPA's requirements to analyze significant impacts

[108] William J. Mitsch and James G. Gosselink, *Wetlands* (2nd ed.) (1993) at 67-68.
[109] *Id*. at 68.
[110] *Id*. at 68 (emphasis added).

that fall short of the threat of extinction.[111] "Clearly, there can be a significant impact on a species even if its existence is not jeopardized."[112]

As a fundamental matter, the analysis of impacts to listed species suffers from the many problems with the analyses of impacts and alternatives identified throughout these comments. The flaws in the Corps' analysis of main channel border habitat are particularly problematic because an important 2004 study shows that in the Middle Mississippi River, main channel border habitat is a preferred habitat for the federally endangered Pallid sturgeon.[113] A copy of this study is provided at Attachment E to these comments. The DSEIS does not include or discuss this study. As noted in these comments, the DSEIS provides no assessment of the Project's impacts on birds, including the federally endangered least tern, other than discussing the terms of the 2000 Biological Assessment and discussing the red knot in the 2016 Biological Assessment.

### 10. The DSEIS Fails to Meaningfully Evaluate Impacts to Fisheries

The DSEIS violates NEPA because it fails to meaningfully evaluate impacts to the full range of fish species found in the Project area. This failure presents a fundamentally flawed image of the impacts of the preferred alternative that renders the DSEIS inadequate.

Some 144 species of fish representing 22 families are likely found in the Project area.[114] However, the DSEIS does not provide information on the full suite of species utilizing the Middle Mississippi River, and does not provide any life cycle information for those species that it does identify. The DSEIS does not provide any information on the impacts of river training structures on critical aspects of those life cycles.

Notably, despite recognizing that the preferred alternative would result in a significant loss of main channel border habitat, the DSEIS does not evaluate the impacts to fisheries resources from these losses. For example, the DSEIS fails to discuss or reference an important 2004 study which shows that in

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[111] *See Greater Yellowstone Coalition v. Flowers*, 359 F.3d 1257, 1275-76 (10th Cir. 2004) (recognizing that FWS' conclusion that the action is not likely to cause jeopardy does not necessarily mean the impacts are insignificant); *Makua v. Rumsfeld*, 163 F. Supp.2d 1202, 1218 (D. Haw. 2001) ("A FONSI . . . must be based on a review of the potential for significant impact, including impact short of extinction. Clearly, there can be a significant impact on a species even if its existence is not jeopardized."); *National Wildlife Federation v. Babbitt*, 128 F. Supp.2d 1274, 1302 (E.D. Cal. 2000) (requiring EIS under NEPA even though mitigation plan satisfied ESA); *Portland Audubon Society v. Lujan*, 795 F. Supp. 1489, 1509 (D. Or. 1992) (rejecting agency's request for the court to "accept that its consultation with [FWS under the ESA] constitutes a substitute for compliance with NEPA.").

[112] *Makua v. Rumsfeld*, 163 F. Supp.2d 1202, 1218 (D. Haw. 2001) ("A FONSI . . . must be based on a review of the potential for significant impact, including impact short of extinction. Clearly, there can be a significant impact on a species even if its existence is not jeopardized.")

[113] Hurley, Keith L., Sheehan, Robert J., Heidinger, Roy C., Wills, Paul S. and Clevenstine, Bob. "Habitat Use by Middle Mississippi River Pallid Sturgeon." (Jul 2004), published in Transactions of the American Fisheries Society, Vol. 133, Issue 4 ( July 2004) at doi: 10.1577/T03-042.

[114] *See, e.g.*, November 18, 2013 Letter from the Office of Environmental Policy and Compliance, U.S. Department of the Interior to Col. Jeffery A. Anderson, Commander, Memphis District, U.S. Army Corps of Engineers (providing these numbers for the nearby project area of the Corps' St. Johns Bayou New Madrid Floodway Project).

the Middle Mississippi River, main channel border habitat is a preferred habitat for the federally endangered Pallid sturgeon.[115] A copy of this study is provided at Attachment E to these comments.

We note that the Corps would have obtained important information on the fisheries in the Project Area and the likely impacts to those fisheries from the Project if the Corps had obtained a Fish and Wildlife Coordination Act Report for the Project, as required by law. *See* Section IV of these comments.

### 11. The DSEIS Fails to Evaluate Impacts to Birds and Waterfowl

The DSEIS violates NEPA because it fails to evaluate impacts to birds and waterfowl found in the Project area. This failure presents a fundamentally flawed image of the impacts of the preferred alternative that renders the DSEIS inadequate.

The only mention of migratory birds in the DSEIS is a comment that the Middle Mississippi River National Wildlife Refuge is managed for migratory birds.[116] The word "waterfowl" does not appear anywhere in the DSEIS or its appendices. The DSEIS does include the terms of the 2000 Biological Opinion that relate to the federally endangered least tern, and the red knot is discussed in the Biological Assessment. However, as noted above, impacts to these species must also be evaluated in the DSEIS because "[c]learly, there can be a significant impact on a species even if its existence is not jeopardized."[117]

The Middle Mississippi River is a central component of the Mississippi River Flyway, which is used by vast numbers of migratory birds. Nearly half of all migratory birds, and 40 percent of all waterfowl migrate through the Mississippi River Flyway. One estimate suggests that 326 different species use the flyway.[118] The Department of the Interior has documented 193 species of migratory birds near the Project area, and tens of thousands of migrating shorebirds and waterfowl."[119]

A meaningful assessment of impacts to migratory birds must account for direct, indirect, and cumulative impacts, including the cumulative impacts of climate change, which can significantly exacerbate the impacts on the many migratory species that utilize the Middle Mississippi River.

As recognized by the United Nations Environment Program and the Convention on the Conservation of Migratory Species of Wild Animals, migratory wildlife is particularly vulnerable to the impacts of climate change:

> "As a group, migratory wildlife appears to be particularly vulnerable to the impacts of Climate Change because it uses multiple habitats and sites and use a wide range of

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115 Hurley, Keith L., Sheehan, Robert J., Heidinger, Roy C., Wills, Paul S. and Clevenstine, Bob. "Habitat Use by Middle Mississippi River Pallid Sturgeon." (Jul 2004), published in Transactions of the American Fisheries Society, Vol. 133, Issue 4 ( July 2004) at doi: 10.1577/T03-042.

116 DSEIS at 174.

117 *Makua v. Rumsfeld*, 163 F. Supp.2d 1202, 1218 (D. Haw. 2001) ("A FONSI . . . must be based on a review of the potential for significant impact, including impact short of extinction. Clearly, there can be a significant impact on a species even if its existence is not jeopardized.")

118 http://www.couleeaudubon.org/festival06_checklist.html (visited January 15, 2017).

119 November 18, 2013 Letter from the Office of Environmental Policy and Compliance, U.S. Department of the Interior to Col. Jeffery A. Anderson, Commander, Memphis District, U.S. Army Corps of Engineers (providing these numbers for the nearby project area of the Corps' St. Johns Bayou New Madrid Floodway Project).

resources at different points of their migratory cycle. They are also subject to a wide range of physical conditions and often rely on predictable weather patterns, such as winds and ocean currents, which might change under the influence of Climate Change. Finally, they face a wide range of biological influences, such as predators, competitors and diseases that could be affected by Climate Change. While some of this is also true for more sedentary species, migrants have the potential to be affected by Climate Change not only on their breeding and non-breeding grounds but also while on migration."

> "Apart from such direct impacts, factors that affect the migratory journey itself may affect other parts of a species' life cycle. Changes in the timing of migration may affect breeding or hibernation, for example if a species has to take longer than normal on migration, due to changes in conditions *en route*, then it may arrive late, obtain poorer quality breeding resources (such as territory) and be less productive as a result. If migration consumes more resources than normal, then individuals may have fewer resources to put into breeding . . . ."

* * *

> "Key factors that are likely to affect all species, regardless of migratory tendency, are changes in prey distributions and changes or loss of habitat. Changes in prey may occur in terms of their distributions or in timing. The latter may occur though differential changes in developmental rates and can lead to a mismatch in timing between predators and prey ("phenological disjunction"). Changes in habitat quality (leading ultimately to habitat loss) may be important for migratory species that need a coherent network of sites to facilitate their migratory journeys. Habitat quality is especially important on staging or stop-over sites, as individuals need to consume large amounts of resource rapidly to continue their onward journey. Such high quality sites may [be] crucial to allow migrants to cross large ecological barriers, such as oceans or deserts."[120]

Migratory birds are at particular risk from climate change. Migratory birds are affected by changes in water regime, mismatches with food supply, habitat shifts, changes in prey range, increased storm frequency, and sea level rise.[121]

We note that the Corps would have obtained important information on the birds and waterfowl that use the Project area, and the likely impacts to those species from the Project, if the Corps had obtained a Fish and Wildlife Coordination Act Report for the Project, as required by law. *See* Section IV of these comments.

### 12. The DSEIS Fails to Evaluate Impacts to Amphibians and Reptiles

The DSEIS violates NEPA because it fails to evaluate impacts to amphibians and reptiles. Indeed, the words "amphibian" and "reptile" are not found anywhere in the DSEIS or its appendices. This failure

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[120] UNEP/CMS Secretariat, Bonn, Germany, *Migratory Species and Climate Change: Impacts of a Changing Environment on Wild Animals* (2006) at 40-41 (available at http://www.cms.int/publications/pdf/CMS_CimateChange.pdf).
[121] *Id*. at 42-43.

presents a fundamentally flawed image of the impacts of the preferred alternative and renders the DSEIS inadequate.

Notably, despite recognizing that the preferred alternative would result in a significant loss of main channel border habitat, the DSEIS does not evaluate the impacts to amphibian and reptile species that utilize that habitat. For example, a 2016 study shows that "[s]hallow, low-velocity habitat seems most important to turtles" in the Middle Mississippi River and that "smooth softshell turtles used open side channels and unstructured main-channel borders most often."[122]

Evaluating the impacts of the Project on amphibians and reptiles is particularly important because these species are facing unprecedented risks of extinction. In the United States, the IUCN Red List of Threatened Species lists 56 amphibian species and 37 reptile species as known to be critically endangered, endangered, or vulnerable.[123] Worldwide, at least 1,950 species of amphibians are threatened with extinction of which 520 species are critically endangered, 783 are endangered, and 647 species are vulnerable. This represents 30 percent of all known amphibian species.[124] In 2004, scientists estimated that most of 1,300 other amphibian species are also threatened though sufficient data are currently lacking to be able to accurately assess the status of those species.[125] The IUCN Red List of Threatened Species also lists 879 species of reptiles as threatened with extinction worldwide, which represents 21 percent of all evaluated reptile species.[126]

A recent study demonstrates the increasingly dire conditions of amphibians worldwide:

> "Current extinction rates are most likely 136–2707 times greater than the background amphibian extinction rate. These are staggering rates of extinction that are difficult to explain via natural processes. No previous extinction event approaches the rate since 1980 (Benton and King, 1989).
>
> Despite the catastrophic rates at which amphibians are currently going extinct, these are dwarfed by expectations for the next 50 yr (Fig. 1). If the figure provided by Stuart et al. (2004) is true (but see Pimenta et al., 2005; Stuart et al., 2005), one-third of the extant amphibians are in danger of extinction. This portends an extinction rate of 25,000–45,000 times the expected background rate. Episodes of this stature are unprecedented. Four previous mass extinctions could be tied to catastrophic events such as super volcanoes and extraterrestrial impacts that

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[122] Braun, Andrew P., Phelps, Quinton E. "Habitat Use by Five Turtle Species in the Middle Mississippi River." Chelonian Conservation and Biology Jun 2016: Vol. 15, Issue 1, pg(s) 62-68 doi: 10.2744/CCB-1156.1 (available at http://www.bioone.org/doi/abs/10.2744/CCB-1156.1).

[123] IUCN Red List version 2013:2, Table 5: Threatened species in each country (totals by taxonomic group), available at http://cmsdocs.s3.amazonaws.com/summarystats/2013_2_RL_Stats_Table5.pdf (visited on November 24, 2013.)

[124] IUCN Red List version 2013:2, Table 3a: Status category summary by major taxonomic group (animals), available at http://cmsdocs.s3.amazonaws.com/summarystats/2013_2_RL_Stats_Table3a.pdf (visited on November 24, 2013).

[125] Science Daily, Amphibians In Dramatic Decline; Study Finds Nearly One-Third Of Species Threatened With Extinction (October 15, 2004), available at http://www.sciencedaily.com/releases/2004/10/041015103700.htm (visited on November 24, 2013).

[126] IUCN Red List version 2013:2, Table 3a: Status category summary by major taxonomic group (animals), available at http://cmsdocs.s3.amazonaws.com/summarystats/2013_2_RL_Stats_Table3a.pdf (visited on November 24, 2013).

> occur every 10 million to 100 million years (Wilson, 1992). The other mass extinction seems to be tied to continental drift of Pangea into polar regions leading to mass glaciation, reduced sea levels, and lower global temperatures (Wilson, 1992). The current event far exceeds these earlier extinction rates suggesting a global stressor(s), with possible human ties."[127]

Amphibians thrive in cool wetland environments, and are found in all types of wetlands except more saline coastal environments. Small, isolated wetlands play especially important roles in amphibian productivity.[128] Amphibian populations thrive when there are a variety of small ecosystems within a regional landscape in which a "dynamic equilibrium" of different populations becomes established.[129] However, if the environment becomes overly fragmented, the dynamic equilibrium is disturbed because patterns of emigration and immigration may be disrupted.

Amphibians spend part of their life cycles in an aquatic environment and part in a terrestrial environment (typically returning to water to breed). For example, some salamanders undergo larval development within an aquatic environment, and then live along wet streamsides following metamorphosis into adult stages. Those that do not breed in water still need moist environments to prevent extreme dehydration.[130] The tadpoles of most frog species develop in ponds, lakes, wet prairies, and other still bodies of water, while others are known to breed in a wide variety of wetland habitats. As adults, toads, frogs and some salamanders can travel relatively great distances from water sources, but they return to water to reproduce.

Recent studies also point to the role of global climate change in promoting potentially catastrophic impacts to amphibian populations. For example:

- Global climate change will result in changes to weather and rainfall patterns that can have significant adverse effects on amphibians. Drought can lead to localized extirpation. Cold can induce winterkill in torpid amphibians. It is possible that the additional stress of climate change, on top of the stresses already created by severe loss of habitat and habitat fragmentation may jeopardize many amphibian species.[131]

- Recent studies suggest that climate change may be causing global mass extinctions of amphibian populations. Particularly alarming is the fact that many of these disappearances are occurring in

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[127] McCallum, M. L. (2007). "Amphibian Decline or Extinction? Current Declines Dwarf Background Extinction Rate. *Journal of Herpetology* 41 (3): 483–491. doi:10.1670/0022-1511(2007)41[483:ADOECD]2.0.CO;2.

[128] Gibbons, J. Whitfield, Christopher Winne, et. al. 2006. Remarkable Amphibian Biomass and Abundance in an Isolated Wetland: Implications for Wetland Conservation. Conservation Biology Volume 20, No. 5, 1457–1465.

[129] Mann, W., P. Dorn, and R. Brandl. 1991. Local distribution of amphibians: The importance of habitat fragmentation. Global Ecology and Biogeography Letters 1:36-41.

[130] Semlitsch, R. D. 1987. Relationship of pond drying to the reproductive success of the salamander Ambystoma talpoideum. Copeia 1987:61-69; Pechmann, J. H. K., D. E. Scott, J. W. Gibbons, and R. D. Semlitsch. 1989. Influence of wetland hydroperiod on diversity and abundance of metamorphosing juvenile amphibians. Wetlands Ecology and Management 1:3-11.

[131] Sjogren, P. 1993a. Metapopulation dynamics and extinction in pristine habitats: A demographic explanation. Abstracts, Second World Congress of Herpetology, Adelaide, Australia, p. 244; Sjogren, P. 1993b. Applying metapopulation theory to amphibian conservation. Abstracts, Second World Congress of Herpetology, Adelaide, Australia, p. 244-245.

relatively pristine area such as wilderness areas and national parks.[132] One recent study suggests that climate change has allowed the spread of a disease known as chytridiomycosis which has led to extinctions and declines in amphibians. Climate change has allowed this disease to spread by tempering the climate extremes that previously kept the disease in check.[133] About two-thirds of the 110 known harlequin frog species are believed to have vanished during the 1980s and 1990s because of the chytrid fungus *Batrachochytrium dendrobatidis.* Other studies indicate that amphibians may be particularly sensitive to changes in temperature, humidity, and air and water quality because they have permeable skins, biphasic life cycles, and unshelled eggs.[134]

- Climate change may also affect amphibian breeding patterns.[135] Amphibians spend a significant part of the year protecting themselves from cold or shielding themselves from heat. They receive cues to emerge from their shelters and to migrate to ponds or streams to breed from subtle increases in temperature or moisture. As the earth warms, one potential effect on amphibians is a trend towards early breeding, which makes them more vulnerable to snowmelt-induced floods and freezes common in early springs. Some studies already indicate a trend towards earlier breeding in certain amphibian species.[136]

- Increases in UV-B radiation in the northern hemisphere due to ozone depletion is also having an adverse impact on amphibians.[137] One study suggests that ultraviolet-B (UV-B) radiation adversely affects the hatching success of amphibian larvae.[138] High levels of UV-B also induced higher rates of developmental abnormalities and increased mortality in certain species (*Rana clamitans* and *R. sylvatica*) than others that were shielded from UV-B.[139] UV-B also can have detrimental effects on embryo growth.

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[132] Pounds, J. A., and M. L. Crump. 1994. Amphibian declines and climate disturbance: The case of the golden toad and the harlequin frog. Conservation Biology 8:72-85; Lips, K. R. 1998. Decline of a Tropical Montane Amphibian Fauna. Conservation Biology 12:106-117; Lips, K., F.Brem, R. Brenes, J.D. Reeve, R.A. Alford, J. Voyles, C. Carey, L. Livo, A. P. Pessier, and J.P. Collins 2006. Emerging infectious disease and the loss of biodiversity. Proceedings of the National Academy of Sciences 103:3165-3170.
[133] Pounds, J.A., M.P.L. Fogden, J.H. Campbell. 2006. Biological response to climate change on a tropical mountain. Nature 398, 611-615.
[134] Carey, C., and M. A. Alexander. 2003. Climate change and amphibian declines: is there a link? Diversity and Distributions 9:111-121.
[135] Carey, C., and M. A. Alexander. 2003. Climate change and amphibian declines: is there a link? Diversity and Distributions 9:111-121.
[136] Beebee, T. J. C. 1995. Amphibian Breeding and Climate. Nature 374:219-220; Blaustein, A. R., L. K. Belden, D. H. Olson, D. M. Green, T. L. Root, and J. M. Kiesecker. 2001. Amphibian breeding and climate change. Conservation Biology 15:1804-1809; Gibbs, J. P., and A. R. Breisch. 2001. Climate warming and calling phenology of frogs near Ithaca, New York, 1900-1999. Conservation Biology 15:1175-1178.
[137] Blumthaler, M., and W. Ambach. 1990. Indication of increasing solar ultraviolet-B radiation flux in alpine regions. Science 248:206-208; Kerr, J. B., and C. T. McElroy. 1993. Evidence for large upward trends of ultraviolet-B radiation linked to ozone depletion. Science 262:1032-1034.
[138] Blaustein, A. R., P. D. Hoffman, D. G. Hokit, J. M. Kiesecker, S. C. Walls, and J. B. Hays. 1994a. UV repair and resistance to solar UV-B in amphibian eggs: A link to population declines? *Proceedings of the National Academy of Science* 91:1791-1795.
[139] Grant, K. P., and L. E. Licht. 1993. Effects of ultraviolet radiation on life history parameters of frogs from Ontario, Canada. Abstracts, Second World Congress of Herpetology, Adelaide, Australia, p. 101.

We note that the Corps would have obtained important information on the amphibians and reptiles that use the Project area, and the likely impacts to those species from the Project, if the Corps had obtained a Fish and Wildlife Coordination Act Report for the Project, as required by law. *See* Section IV of these comments.

### 13. The DSEIS Fails to Evaluate Impacts to Mammals

The DSEIS violates NEPA because it fails to evaluate impacts to mammals. Indeed, the word mammal is not included anywhere in the DSEIS. Bats are discussed only in the Biological Assessment, and impacts to bats in general are not discussed in the DSEIS.

Many mammal species are found in the Mississippi River Valley and many of those species utilize riparian areas. However, the DSEIS fails to provide any analysis whatsoever on the potential impacts to mammals from the Project, despite acknowledging a minimum loss of 1100 acres of channel border habitat. Because the Project will affect riparian and wetland areas, the DSEIS must evaluate impacts to the mammal species found in those areas.

We note that the Corps would have obtained important information on the mammals that use the Project area, and the likely impacts to those species from the Project, if the Corps had obtained a Fish and Wildlife Coordination Act Report for the Project, as required by law. *See* Section IV of these comments.

### 14. The DSEIS Fails to Evaluate Impacts to Plants

The DSEIS violates NEPA because it fails to evaluate impacts to plants, including wetland plant species. This failure presents a fundamentally flawed image of the impacts of the Project and renders the DSEIS inadequate. The impacts of the proposed alternatives on plant species, including wetland plant species in the main channel border habitat, must be analyzed.

### 15. The DSEIS Fails to Evaluate Key Information on Climate Change

The Conservation Organizations appreciate the work that the Corps put into the climate change analysis in the DSEIS. However, that analysis—and the related analysis of the cumulative impacts of climate change—fail to address key issues. See Section II.C.16 of these comments for a detailed discussion of problems with the DSEIS cumulative impacts analysis.

At the most fundamental level, the DSEIS fails to evaluate whether the impacts of climate change could exacerbate the adverse impacts of the preferred alternative or the No New Construction Alternative. The DSEIS also fails to assess whether the preferred alternative or the No New Construction Alternative would make the Middle Mississippi River and the species that rely on it less resilient to climate change. As discussed in Section II.C.16 of these comments, these issues must be examined.

Notably, because the DSEIS improperly rejects the comprehensive scientific evidence that demonstrates that river training structures increase flood heights, the DSEIS fails to address the additive effects of climate change on flood levels. As noted above, the Middle Mississippi is particularly susceptible to increased extreme weather from climate change because the river is influenced by multiple large river systems – the Illinois, Upper Mississippi, Missouri, and Ohio Rivers. The DSEIS climate change assessment should address the implications of this susceptibility.

### 16. The DSEIS Fails to Adequately Evaluate Cumulative Impacts

The DSEIS violates NEPA because it fails to meaningfully evaluate cumulative impacts. This failure renders the DSEIS grossly inadequate.

The cumulative impacts analysis is a critical component of NEPA review. It ensures that the reviewing agency will not "treat the identified environmental concern in a vacuum."[140] Cumulative impacts are defined as:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."[141]

A meaningful assessment of cumulative impacts must identify:

> "(1) the area in which effects of the proposed project will be felt; (2) the impacts that are expected in that area from the proposed project; (3) other actions – past, present, and proposed, and reasonably foreseeable – that have had or are expected to have impacts in the same area; (4) the impacts or expected impacts from these other actions; and (5) the overall impact that can be expected if the individual impacts are allowed to accumulate."[142]

In conducting the cumulative impacts assessment, it is not enough to simply catalog past actions. The DSEIS instead must determine the specific impacts of those actions on the system. The DSEIS must also assess whether the past degradation of the system combined with the proposed alternative will significantly affect the ecological health and functioning of the Middle Mississippi River and its floodplain. Indeed, this is the primary goal of the cumulative impacts analysis:

> "The analyst's primary goal is to determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative effects of other past, present, and future actions. Much of the environment has been greatly modified by human activities, and most resources, ecosystems, and human communities are in the process of change as a result of cumulative effects. **The analyst must determine the realistic potential for the resource to sustain itself in the future and whether the proposed action will affect this potential; therefore, the baseline condition of the resource of concern should include a description of how conditions have changed over time and how they are likely to change in the future without the proposed action.** The potential for a resource, ecosystem, and human community to sustain its structure and function depends on its resistance to stress and its ability to recover (i.e., its resilience). Determining whether the condition of the resource is within the range of natural variability or is vulnerable to rapid degradation is frequently problematic.

[140] *Grand Canyon Trust v. FAA*, 290 F.3d 339, 346 (D.C. Cir. 2002).

[141] 40 C.F.R. § 1508.7.

[142] *TOMAC, Taxpayers Of Michigan Against Casinos v. Norton*, 435 F.3d 852 (D.C. Cir. 2006) (quoting Grand Canyon Trust, 290 F.3d at 345); *Fritiofson v. Alexander*, 772 F.2d 1225, 1245 (5th Cir. 1985) (holding this level of detail necessary even at the less detailed review stage of an Environmental Assessment).

> Ideally, the analyst can identify a threshold beyond which change in the resource condition is detrimental. More often, the analyst must review the history of that resource and evaluate whether past degradation may place it near such a threshold. For example, the loss of 50% of historical wetlands within a watershed may indicate that further losses would significantly affect the capacity of the watershed to withstand floods. **It is often the case that when a large proportion of a resource is lost, the system nears collapse as the surviving portion is pressed into service to perform more functions.**"[143]

The DSEIS completely fails to satisfy this primary goal of a cumulative impacts analysis. While the cumulative impacts analysis incorporates a number of studies that discuss the significant decline in the ecological health of the Mississippi River due in large part to the construction and operation of the river's navigation system, the DSEIS cumulative impacts discussion blatantly ignores that information. For example, despite providing an extremely general discussion of the Status and Trends Reports, the DSEIS does not state that those reports documented a significant decline in the health of the river. *See* DSEIS 166-167.

The lack of consideration given to the significant ecological decline of the Middle Mississippi River can be seen very clearly in the DSEIS Cumulative Impacts Analysis Conclusion:

> "4.6.6 Cumulative Impacts Analysis Conclusion
> The Regulating Works Project, in combination with other actions throughout the watershed, has had past impacts, both positive and negative, on the resources, ecosystem and human environment of the MMR. However, this analysis is meant to characterize the incremental impacts of the current action in the broader context of other past, present, and future actions affecting the same resources. Although past actions associated with the Regulating Works Project likely adversely affected some segments of the MMR environment, the current practices employed in obtaining and maintaining a navigation channel integrate lessons learned from past experience and emphasize avoiding and minimizing environmental impacts to the greatest extent practicable. The District works closely with natural resource agency and navigation industry stakeholders throughout the project development process to ensure that all potential issues are addressed appropriately. This process, in conjunction with innovative river training structure designs and District restoration efforts, has contributed to a substantial reduction in adverse effects and equilibrium in many habitat conditions. Construction of river training structures is expected to continue to increase important low velocity habitat and increase bathymetric, flow, and substrate diversity. These improvements in Project implementation notwithstanding, the District has concluded that the adverse effects to shallow to medium-depth, moderate- to high velocity main channel border habitat, as discussed in Section 4.3.2 Impacts on Fishery Resources above, are potentially significant and warrant compensatory mitigation. No further incremental impacts associated with the Alternatives analyzed, in the context of other past, present, and reasonably foreseeable future actions, are anticipated to rise to a level of significance. See Table 4-10 below for a summary of cumulative impacts."

DSEIS at 190.

[143] Council on Environmental Quality, *Considering Cumulative Effects Under the National Environmental Policy Act* (January 1997) at 41 (emphasis added).

This conclusion completely ignores the significant and fundamental changes to the ecological health, form, and function of the Middle Mississippi River caused by past activities. This conclusion fails to account for the adverse impacts to the Middle Mississippi from reasonably foreseeable future activities. This conclusion completely ignores the extensive numbers of river training structures already in the Middle Mississippi—estimated at 1.5 miles of river training structure for each mile of the Middle Mississippi. This conclusion completely ignores the significant body of science that demonstrates that the construction of river training structures has significantly increased flood heights and has fundamentally altered the way the Middle Mississippi River responds to flood events. This conclusion ignores the fact that 34.85% of main channel border habitat in the Middle Mississippi River has already been lost, and fails to assess the ecological significance of losing an additional 8.53% of main channel border habitat on top of this already extremely significant loss. This conclusion fails even to recognize the significant past and present activities carried out under the Regulating Works Program and the Mississippi River and Tributaries Program, and the impacts of those activities.

The DSEIS cumulative impacts analysis also fails to address the additive effects of climate change on increasing flood levels in the Middle Mississippi River, and on decreasing the resiliency of the Middle Mississippi. The DSEIS fails to evaluate whether the impacts of climate change could exacerbate the adverse impacts of the preferred alternative or the No New Construction Alternative. The DSEIS also fails to assess whether the preferred alternative or the No New Construction Alternative would make the Middle Mississippi River and the species that rely on it less resilient to climate change.

Council on Environmental Quality guidance makes clear that analyzing the impacts of climate change is not restricted to evaluating whether a project could itself exacerbate climate change. The magnifying and additive effects that climate change would cause on the resources affected by the project must also be evaluated.

> "Climate change can affect the environment of a proposed action in a variety of ways. Climate change can increase the vulnerability of a resource, ecosystem, human community, or structure, which would then be more susceptible to climate change and other effects and result in a proposed action's effects being more environmentally damaging. For example, a proposed action may require water from a stream that has diminishing quantities of available water because of decreased snow pack in the mountains, or add heat to a water body that is exposed to increasing atmospheric temperatures. Such considerations are squarely within the realm of NEPA, informing decisions on whether to proceed with and how to design the proposed action so as to minimize impacts on the environment, as well as informing possible adaptation measures to address these impacts, ultimately enabling the selection of smarter, more resilient actions.
>
> * * *
>
> Therefore, climate change adaptation and resilience — defined as adjustments to natural or human systems in response to actual or expected climate changes — are important considerations for agencies contemplating and planning actions with effects that will occur both at the time of implementation and into the future."[144]

[144] Council on Environmental Quality, Revised Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions (December 2014) (internal citations omitted); *see Center for Biological Diversity v. Nat'l Hwy Traffic Safety Administration*, 538 F.3d 1172, 1217 (9th Cir. 2008) (holding that analyzing the

The Corps should fundamentally redo its cumulative impacts assessment to ensure that it provides a comprehensive, factually accurate, and realistic assessment of the magnitude and significance of the environmental consequences of the Project in the context of the cumulative effects of other past, present, and future actions. This assessment should determine how the preferred alternative will affect the ability of the Middle Mississippi River to sustain itself in the future.

### 17. The DSEIS Fails to Adequately Evaluate the Risk of Disproportionate Impacts to Low Income and Minority Communities

Executive Order 12898 requires that each Federal agency achieve environmental justice by identifying and addressing disproportionately high adverse human health or environmental effects of federal activities on minority and low-income populations. The DSEIS fails to comply with this Executive Order for at least three reasons.

*First*, the DSEIS fails to assess the potential for disproportionate effects on the health and safety of minority and low income populations from the significant risk of increased flooding created by construction of river training structures. See Section II.C.4 for a discussion of flood risks.

*Second*, the DSEIS environmental justice analysis looks only at county wide data to assess the potential for disproportionate impacts. DSEIS at 160. The DSEIS should also assess the potential for disproportionate impacts to individual communities (towns and cities) with large minority or low-income populations. This would provide a more accurate assessment of potential impacts.

*Third*, the DSEIS cannot conduct a meaningful environmental justice analysis without also assessing the reasonably foreseeable site-specific impacts, as required by law. See Section II.C.1 for a discussion of this requirement. The DSEIS conclusion that minority and low income communities will not be disproportionately impacted because "river training structure construction activities as well as dredging operations are anticipated to occur at locations along the entire length of the Project Area"[145] is not a meaningful assessment and is not supported by information in the DSEIS.

### 18. The DSEIS Fails to Evaluate Impacts to Ecosystem Services

The DSEIS fails to provide any assessment of the ecosystem services that will be lost as a result of the preferred alternative or of the No New Construction alternative. Ecosystem services valuations are well recognized as providing important information for decision makers. Understanding the impacts to these services is critical for assessing the full extent of Project impacts.

The importance of ecosystem services valuation is made clear in the 2013 *Principles and Requirements for Federal Investments in Water Resources* and *Interagency Guidelines* (collectively, the PR&G). The PR&G focus extensively on the importance of evaluating the value of ecosystem services lost and gained

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impacts of climate change is "precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct"); *Center for Biological Diversity v. Kempthorne*, 588 F.3d 701, 711 (9th Cir. 2009) (NEPA analysis properly included analysis of the effects of climate change on polar bears, including "increased use of coastal environments, increased bear/human encounters, changes in polar bear body condition, decline in cub survival, and increased potential for stress and mortality, and energetic needs in hunting for seals, as well as traveling and swimming to denning sites and feeding areas.").

[145] DSEIS at 160.

during project planning. While the Conservation Organizations recognize that the Corps is not yet utilizing the PR&G, the Corps should nevertheless evaluate the impacts on ecosystem services.

The Conservation Organizations urge the Corps to contract with an organization expert in conducting ecosystem services valuations to properly account for the ecosystem services that will be lost to the project.

### 19. The DSEIS Fails to Meaningfully Evaluate Mitigation and Fails to Comply With Federal Mitigation Requirements

The DSEIS violates NEPA because it fails to meaningfully evaluate mitigation. The DSEIS also fails to comply with federal mitigation requirements. Importantly, the DSEIS contention that mitigation for the Project is "discretionary"[146] is incorrect as a matter of law. Mitigation will be required as a matter of law for the entire Project upon completion of the DSEIS.[147] Mitigation is already required as a matter of law for any elements of the Project being carried out pursuant to an Environmental Assessment or "any report" where a project alternative was selected.[148]

NEPA requires that the DSEIS discuss mitigation measures with "sufficient detail to ensure that environmental consequences have been fairly evaluated."[149] A "perfunctory description" of the mitigating measures is not sufficient.[150]

The DSEIS also must discuss the effectiveness of the proposed mitigation:

> "An essential component of a reasonably complete mitigation discussion is an assessment of whether the proposed mitigation measures can be effective. The Supreme Court has required a mitigation discussion precisely for the purpose of evaluating whether anticipated environmental impacts can be avoided. A mitigation discussion without at least *some* evaluation of effectiveness is useless in making that determination."[151]

A bald assertion that mitigation will be successful is not sufficient. The effectiveness must instead be supported by "substantial evidence in the record."[152]

The Water Resources Development Acts require the Corps to mitigate the adverse impacts of the Project.[153] The Corps is required to mitigate all losses to fish and wildlife created by a project unless the

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[146] DSEIS, Appendix C at C-1.

[147] The Water Resources Development Act of 2007 requires the Corps to implement mitigation, and comply with mitigation planning requirements, for any project for which the Corps "select[s] a project alternative in any report." 33 U.S.C. § 2283(d). Thus, mitigation will be required for the Project as a matter of law upon issuance of the final SEIS, and mitigation is required as a matter of law for components of the Regulating Works Project that are proceeding under environmental assessments.

[148] *Id*.

[149] Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 352 (1989).

[150] Neighbors of Cuddy Mountain v. U.S. Forest Service, 137 F.3d 1372, 1380 (9th Cir.1998).

[151] *South Fork Band Council v. Dept. of Interior*, 588 F.3d 718, 727 (9th Cir. 2009) (internal citations omitted).

[152] Wyoming Outdoor Council v. U.S. Army Corps of Eng'rs, 351 F. Supp. 2d 1232, 1252 (D. Wyo. 2005).

[153] The Water Resources Development Act of 2007 requires the Corps to implement mitigation, and comply with mitigation planning requirements, for any project for which the Corps "select[s] a project alternative in any report." 33 U.S.C. § 2283(d). Thus, mitigation will be required for the Project as a matter of law upon issuance of

Secretary determines that the adverse impacts to fish and wildlife would be "negligible." 33 U.S.C. § 2283(d)(1). To ensure that this happens, the Corps is prohibited from selecting a "project alternative in any report" unless that report includes a "specific plan to mitigate fish and wildlife losses." *Id*. Accordingly, the DSEIS must include a specific mitigation plan.

Corps mitigation plans must ensure that "impacts to bottomland hardwood forests are mitigated in-kind and harm to other habitat types are mitigated to not less than in-kind conditions, to the extent possible." 33 U.S.C. § 2283(d)(1). Mitigation plans "shall include, at a minimum:"

1. The type, amount, and characteristics of the habitat being restored, a description of the physical actions to be taken to carry out the restoration, and the functions and values that will be achieved;
2. The ecological success criteria, based on replacement of lost functions and values, that will be evaluated and used to determine mitigation success;
3. A description of the lands and interest in lands to be acquired for mitigation, and the basis for determining that those lands will be available;
4. A mitigation monitoring plan that includes the cost and duration of monitoring, and identifies the entities responsible for monitoring if it is practicable to do so (if the responsible entity is not identified in the monitoring plan it must be identified in the project partnership agreement that is required for all Corps projects). Corps mitigation must be monitored until the monitoring demonstrates that the ecological success criteria established in the mitigation plan have been met; and
5. A contingency plan for taking corrective action in cases where monitoring shows that mitigation is not achieving ecological success as defined in the plan. 33 U.S.C. § 2283(d).

Corps mitigation plans must also comply with the "the mitigation standards and policies established pursuant to the regulatory programs" administered by the Corps. 33 U.S.C. § 2283(d).

Corps mitigation must be monitored until the monitoring demonstrates that the ecological success criteria established in the mitigation plan have been met. The Corps is also required to consult yearly on each project with the appropriate Federal agencies and the states on the status of the mitigation efforts. The consultation must address the status of ecological success on the date of the consultation, the likelihood that the ecological success criteria will be met, the projected timeline for achieving that success, and any recommendations for improving the likelihood of success. 33 U.S.C. § 2283(d).

In addition, mitigation lands for Corps civil works projects must be purchased before any construction begins. 33 U.S.C. § 2283(a). Any physical construction required for purposes of mitigation should also be undertaken prior to project construction but must, at the latest, be undertaken "concurrently with the physical construction of such project." *Id*.

The DSEIS fails to comply with these important mitigation requirements for at least the following reasons.

(1) The DSEIS does not discuss mitigation measures with "sufficient detail to ensure that environmental consequences have been fairly evaluated," and does not demonstrate that

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the final SEIS, and mitigation is required as a matter of law for components of the Regulating Works Project that are proceeding under environmental assessments.

the proposed mitigation will be ecologically successful.[154] To the contrary, the DSEIS acknowledges that "no appropriate habitat model(s) currently exists to capture the unique aspects of Middle Mississippi main channel border aquatic habitat" so the "Corps is attempting to develop a new main channel border habitat model." DSEIS, Appendix C at C-5.

(2) In direct violation of the longstanding NEPA requirements discussed above, the DSEIS fails to provide a meaningful discussion of mitigation actions and mitigation effectiveness and instead simply provides a list of possible activities and says that mitigation will occur "to the extent practicable":

> "Potential mitigation actions may include, but are not limited to, the following: wing dike notching, dike removal, wing dike creation using alternative designs (e.g., rootless dikes), use of rock piles, dredging or material placement of sand, and other possible activities. Mitigation will be tailored toward the specific habitat features that are significantly impacted. This habitat likely includes shallow to moderate depth, moderate to high velocity main channel border habitat. Such habitat may be challenging to design and effectively implement. The ability to design for such habitat, including the associated costs, may need to be carefully considered within the context of the impacts. Impacts will be mitigated to the extent practicable." DSEIS Appendix C at C-5.

(3) The DSEIS does not propose mitigation for all fish and wildlife impact that are more than negligible, as required by law. The DSEIS instead states that impacts must be "significant" before they require mitigation. DSEIS, Appendix C at C-5.

(4) The DSEIS does not propose any mitigation for the impacts caused by revetment, dredging, and dredged spoil disposal.

(5) The DSEIS cannot determine the actual amount of mitigation needed because it has not meaningfully assessed the full extent of the harm to fish and wildlife as a result of the direct, indirect, and cumulative impacts of the Project.

(6) The DSEIS does not provide a specific plan to mitigate the adverse impacts of the Project that satisfies the requirements discussed above, including the requirement to monitor mitigation efforts until it can be demonstrated that the mitigation has been ecologically successful.

The DSEIS also violates the Corps' civil works mitigation requirements by concluding that the Corps may not carry out required mitigation if funds are not available through the Regulating Works Project:

> "Funding mechanisms for implementing additional mitigation must then be identified. Depending on the amount of mitigation needed, funds may be available through the Regulating Works Project. This is especially the case for smaller activities. However, if large levels of funding are needed to address failed mitigation implemented in association with this SEIS, it may require additional action by Congress for either appropriation, or possibly even authorization. Thus,

[154] Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 352 (1989).

> funding would be provided for construction of planned mitigation projects, and post-project monitoring. It cannot be guaranteed that federal funds would be available, specific to this project, for contingency mitigation." DSEIS, Appendix C at C-8.

This demonstrates a lack of understanding of the Corps' mitigation requirements. As discussed above, mitigation will be required as a matter of law for the entire Project upon completion of the DSEIS, and mitigation is already required as a matter of law for any elements of the Project being carried out pursuant to an Environmental Assessment or "any report" where a project alternative was selected.[155] The Corps must mitigate the adverse impacts of the Project and the cost of carrying out that mitigation is a Project cost.

## III. The Corps Must Reinitiate Consultation on the 2000 Biological Opinion

The Corps is required to reinitiate consultation on the 2000 Biological Opinion because: (1) new information indicates that the Project may affect a listed species in a previously unforeseen way; and (2) the Project has been modified in a manner that causes an impact not considered in the 2000 Biological Opinion.[156]

Important information exists, including the information discussed throughout these comments, that demonstrate the ways in which the Project may affect a listed species in ways not foreseen in the 2000 Biological Opinion. For example:

(1) A 2004 study demonstrates that the precise type of habitat that would be significantly affected by the preferred alternative—main channel border habitat—is a preferred habitat type for federally endangered Pallid sturgeons in the Middle Mississippi River.[157] That study concludes:

> "Of the seven macrohabitats identified, pallid sturgeon were found most often in main-channel habitats (39% of all relocations) and main-channel border habitats (26%); the between-wing-dam habitats were used less often (14%)."
>
> "In the middle Mississippi River, pallid sturgeon were often found in the MCL and MCB habitats. The high use of these areas by pallid sturgeon makes any negative changes to these habitats potentially harmful to pallid sturgeon. Any changes in use of these habitats or alterations to them should be examined before future projects are undertaken. Conversely, the three of the four wingdam habitats represent the low-use habitats examined in this study. Any alterations or changes to these habitats would have a reduced chance of harming pallid sturgeon populations due to their infrequent use of these areas."
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> "Although the MCL is the area of highest use by middle Mississippi River pallid sturgeon, the habitat selectivity analysis presented here indicates that the ITD, MCB, and WDB

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[155] 33 U.S.C. § 2283(d).

[156] 50 C.F.R. 402.16.

[157] Hurley, Keith L., Sheehan, Robert J., Heidinger, Roy C., Wills, Paul S. and Clevenstine, Bob. "Habitat Use by Middle Mississippi River Pallid Sturgeon." (Jul 2004), published in Transactions of the American Fisheries Society, Vol. 133, Issue 4 ( July 2004) at doi: 10.1577/T03-042.

areas may actually represent preferred habitats. Much like results found in other studies (Bramblett and White 2001; Snook et al. 2002), habitats may be selected by pallid sturgeon to maximize forage opportunities. These habitats should be given consideration for any future projects aimed at creating pallid sturgeon habitat because they may be necessary for the recovery of this species. Enhancement and restoration of these habitats would represent an increase in habitat diversity, which could benefit many species in addition to the endangered pallid sturgeon."[158]

(2) The DSEIS discusses new science that shows that the modification of flow by river training structures may cause Pallid sturgeon to expend more energy during migration or when feeding. DSEIS at 140.

(3) The cumulative loss of main channel border habitat identified in the DSEIS, combined with other cumulative impacts including climate change, is also critical new information that indicates the Project may affect the listed species in previously unforeseen ways.

The Project has also been modified in a manner that causes an impact not considered in the 2000 Biological Opinion. For example, the Project is utilizing new forms of river training structures that cause different types of impacts to flow, and is constructing a significant number of new river training structures.

For at least these reasons, the Corps must reinitiate consultation on the 2000 Biological Opinion.

## IV. The Corps Must Comply with the Fish and Wildlife Coordination Act

The Corps is required to obtain a Fish and Wildlife Coordination Act Report for the DSEIS.

The DSEIS contends that the Regulating Works Project is exempt from the Fish and Wildlife Coordination Act because "60 percent or more of the estimated construction cost has been obligated for expenditure", presumably as of 2016. DSEIS at 197. However, the Fish and Wildlife Coordination Act cost exemption must be measured as of 1958, when the Fish and Wildlife Coordination Act was signed into law. The U.S. Fish and Wildlife Service's Fish and Wildlife Coordination Act Handbook states:

> "The only class of projects exempted from the provisions of Section 2 of the FWCA, then, are those on which project construction was 60 percent or more completed (based on obligation of estimated construction costs) on August 12, 1958. Projects that are later modified or supplemented thus fall under the provisions of Section 2 of the FWCA, even if the original project modified or supplemented was more than 60 percent constructed at the time of enactment of the FWCA." [159]

The DSEIS fails to provide any information or supporting evidence that this spending requirement was met in 1958. In fact, the DSEIS does not provide any information on either historic or anticipated spending for the Regulating Works Project, or on the original authorized total Project cost or the

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[158] *Id*.

[159] U.S. Fish and Wildlife Service, Water Resources Development Under the Fish and Wildlife Coordination Act (November 2004) at I-38 (https://www.fws.gov/ecological-services/es-library/pdfs/fwca.pdf, visited January 17, 2017.)

currently projected total Project cost. Moreover, since the Corps appears to interpret the Regulating Works Project as a perpetual authority, it would be impossible to determine a final spending amount and therefore impossible to determine when 60 percent of that amount has been spent.

Notably, the DSEIS contention that this cost exemption is to be determined as of 2016 is inconsistent with previous Corps decisions. In 1984, the Corps' Chief of Engineers stated in writing that for an ongoing project, the Fish and Wildlife Coordination Act cost exemption must be measured as of the date of enactment of the Fish and Wildlife Coordination Act (August 12, 1958):

> "The Fish and Wildlife Coordination Act (FWCA) of 1958 is applicable to any project where less than 60 percent of the estimated construction cost had been obligated as of 12 August 1958, the date of enactment."[160]

The same conclusion was reached in 1980:

> "The 1912 project, as amended, has been determined to have been less than 60 percent complete as of 12 August 1958 and is eligible under the Coordination Act. Water and land use changes which have occurred and continue to occur within the natural river area are directly attributable to the 1912 project, as amended. In addition, the prevention of erosion in the natural river meander belt is also a direct effect of the project and was not addressed in your draft report."[161]

In 2011, the Government Accountability Office concluded that the Fish and Wildlife Coordination Act applies to the Regulating Works Project:

> "The Corps' authority to use river training structures in the Mississippi River comes from several Rivers and Harbors Acts, which collectively require the Corps to maintain a 9-foot navigation channel in the river, and several Water Resources Development Acts, which also authorize projects in the Corps' civil works program. In using these structures, the Corps must comply with federal environmental laws such as the National Environmental Policy Act (NEPA), the Clean Water Act (CWA), and the Fish and Wildlife Coordination Act, as well as applicable state requirements. The Corps also has its own guidance that district offices are to use when planning, designing, and building river training structures."[162]

The Corps did not object to, or otherwise disagree with, this finding.

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[160] April 24, 1984 Letter from the USACE Chief of Engineers to the Secretary of the Army at page 4, including with the Missouri River Bank Stabilization and Navigation Project Final Feasibility Report and Final EIS for the May 1981 Fish and Wildlife Mitigation Plan (file:///C:/Users/sametm/Downloads/MO%20River%20BSNP%20Feas%20%20Mit%201981.pdf, visited January 17, 2017).
[161] February 19, 1980 letter from Col. Walker C. Bell, USACE District Engineer, Kansas City District to Tom Saunders, Area Manager, U.S. Fish and Wildlife Service.
[162] Government Accountability Office, Mississippi River: Actions Are Needed to Help Resolve Environmental and Flooding Concerns about the Use of River Training Structures, GAO-12-41 (December 2011), at Summary Page, 16, 20.

The Conservation Organizations also note that the scope of the Project, the significance of the adverse impacts, and the importance of the Mississippi River to fish and wildlife conservation, clearly warrant preparation and full consideration of a Fish and Wildlife Coordination Act Report.

## Conclusion

The Conservation Organizations strongly oppose the preferred alternative in the DSEIS and urge the Corps of Engineers to develop and select an alternative that will protect communities and the ecological health of the Middle Mississippi River. The Conservation Organizations urge the Corps to initiate a National Academy of Sciences study on the effect of river training structures on flood heights to inform development of this alternative, and urge the Corps to fully address the many legal, scientific, and factual deficiencies discussed throughout these comments

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Attachments

# Attachment A

Conservation Organization Comments
On The
Regulating Works Project
Draft Supplemental Environmental Impact Statement (November 2016)

doi:10.2489/jswc.71.6.140A

FEATURE

# Mississippi River threatens to make Dogtooth Bend peninsula in Illinois an island

Kenneth R. Olson and Lois Wright Morton

The receding floodwaters of the Mississippi River in January of 2016 left behind barren sand dunes on southern Illinois farmland reminiscent of the windswept dunes of the movie *Lawrence of Arabia* (figure 1). Large sand deposits up to 1.3 m (4 ft) deep covered nearly 800 ha (2,000 ac) of farmland south of Miller City, Illinois, in the Dogtooth Bend peninsula. Rainfall almost three times above average in November and December of 2015 over Missouri set in motion record flooding with the Cape Girardeau river gage breaking the 1993 record at 14.89 m (48.86 ft) and led to the breaching of Len Small levee on January 2, 2016. Floodwaters cut deep craters and scoured the landscape as they poured through the breach at mile marker 34 and then followed an old meander channel across the narrow neck of Dogtooth Bend peninsula to reconnect with the Mississippi River at mile marker 15 (figure 2). Levee breaches and land scouring are not new events for this region, occurring in 1993, 2011, and 2016; and there is high likelihood these farmlands will experience similar events in the future. Each event deepens the meander channel when the floodwaters take a 4.6 km (3.5 mi) shortcut and threaten to permanently reroute the Mississippi River leaving Dogtooth Bend peninsula an island. This would result in landowners and farmers of 6,000 ha (15,000 ac) in the Dogtooth Bend area no longer having road access to their land if the Mississippi River realigns naturally. In some cases the land use would likely shift from agriculture to other uses.

**Figure 1**

**Mississippi River floodwaters deposited many tons of sand on farmland and roads in Dogtooth Bend peninsula when the Len Small levee breached in January of 2016. The sand dunes left behind required graders and snow plows to open the road for local traffic.**

## HISTORY OF FLOODING OF THE DOGTOOTH BEND PENINSULA IN SOUTHWEST ILLINOIS

The Mississippi River has a long history of continually changing course. After the last glacier advance at the end of the Great Ice Age, the melting ice waters flooded and altered the flow of many channels and streams including the ancient Mississippi and ancient Ohio rivers. The middle Mississippi Indians in the fourteenth and fifteenth centuries built two ceremonial mounds and a village near Milligan Lake (Maruszak 1977) at an elevation of 100 m (328 ft) in the area of Dogtooth Bend peninsula (figure 2) along a waterway or meander channel of the Mississippi River (elevation approximately 90 m [295 ft]). This suggests that humans lived here for more than 700 years and the area was seldom flooded.

However, the farmers and homeowners who settled in early 1800s on the bottomlands of southwest Alexander County, locally known as Dogtooth Bend peninsula, have battled flooding from the Mississippi River for the last 200 years. Illinois became a state in 1818, and Alexander County was established on March 4, 1819. Farming of the Mississippi and Ohio bottomlands started in the 1840s and depending on location continues to present day. Flooding in those early years was less of a problem since only corn (*Zea mays* L.), oats (*Avena sativa* L.), and soybean (*Glycine max* [L.] Merr.; after 1930s) were grown during the summer growing season. There was very little winter wheat (*Triticum aestivum* L.) as it would be vulnerable to early spring or late fall flooding.

In the 1880s the Missouri farmers on the west side the Mississippi River south of Commerce, Missouri (figure 3), began constructing levees to protect their bottomlands. This redirected Mississippi River floodwaters toward southwest Alexander County, Illinois, where lands were not leveed. During this same period, Missouri farmers also built levees south of Cape Girardeau, Missouri, to block the Mississippi River during flood events from entering its ancient valley and flood-

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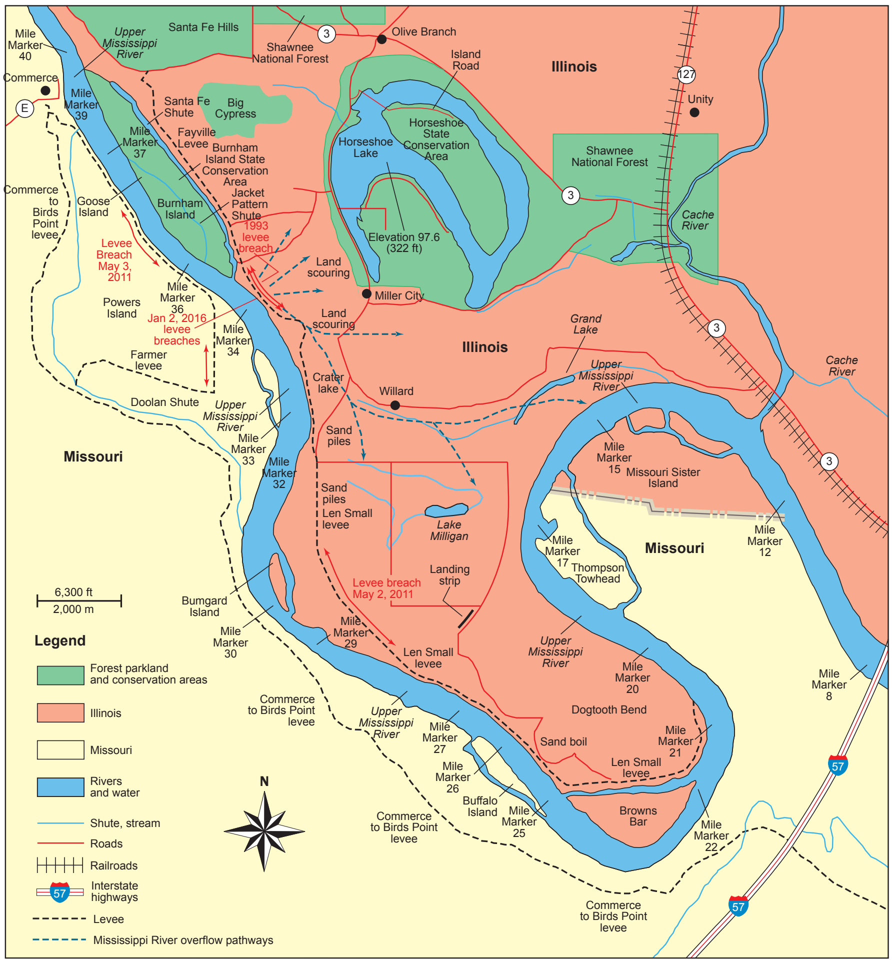
**Figure 2**

**This map of the Dogtooth Bend area in southwest Illinois shows the 1993, 2011, and 2016 breach locations and the 2016 Mississippi River floodwater overland flow patterns. The blue dotted line represents a new channel cutting through southeast Alexander County and floodwaters flowing north of Lake Milligan and then exiting into the Mississippi River at mile marker 15.**




ing lands around the Big Swamp. The Alexander County, Illinois, bottomland farmers were likely not aware of how the Missouri farmer levees built between 1880 and 1915 (shown in figure 3 by thick black lines on the west side of the river—one south of Cape Girardeau and the other south of Commerce) might affect the Illinois lands on the east side of the Mississippi River.

After the 74 km (46 mi) Little River Drainage District Headwaters project diversion levee and channel was constructed in 1916, the runoff from the 288,000 ha (720,000 ac) Ozark Plateau via the Castor and Whitewater rivers and Crooked Creek was diverted into the Mississippi River north of the Thebes Gap and south of Cape Girardeau (figure 3) (Olson and Morton 2016a). Prior to the creation of the diversion channel, the Ozark Plateau waters entered the Mississippi River north of Helena, Arkansas, more than 365 river miles to the south (Olson and Morton 2016b). The Little River Headwaters Diversion levee and channel effectively raised the floodwater peaks recorded on the river gages at Cape Girardeau, Missouri; Thebes in Alexander County, Illinois; Cairo, Illinois; and Hickman, Kentucky. New floodwalls and levee systems were built to address threats of urban flooding—Cairo, Illinois, in 1928; the New Madrid Floodway, Missouri, from 1928 to 1932; and Cape Girardeau, Missouri, between 1956 and 1964 (Olson and Morton 2016c). To reduce agricultural land flooding, the Hickman levee (Kentucky) was strengthened, the Missouri levees south of Commerce were aggressively maintained, and a new federal levee was created from Commerce to Birds Point, Missouri, which connected to the New Madrid Floodway setback levee (Olson and Morton 2012; Olson and Morton 2016b).

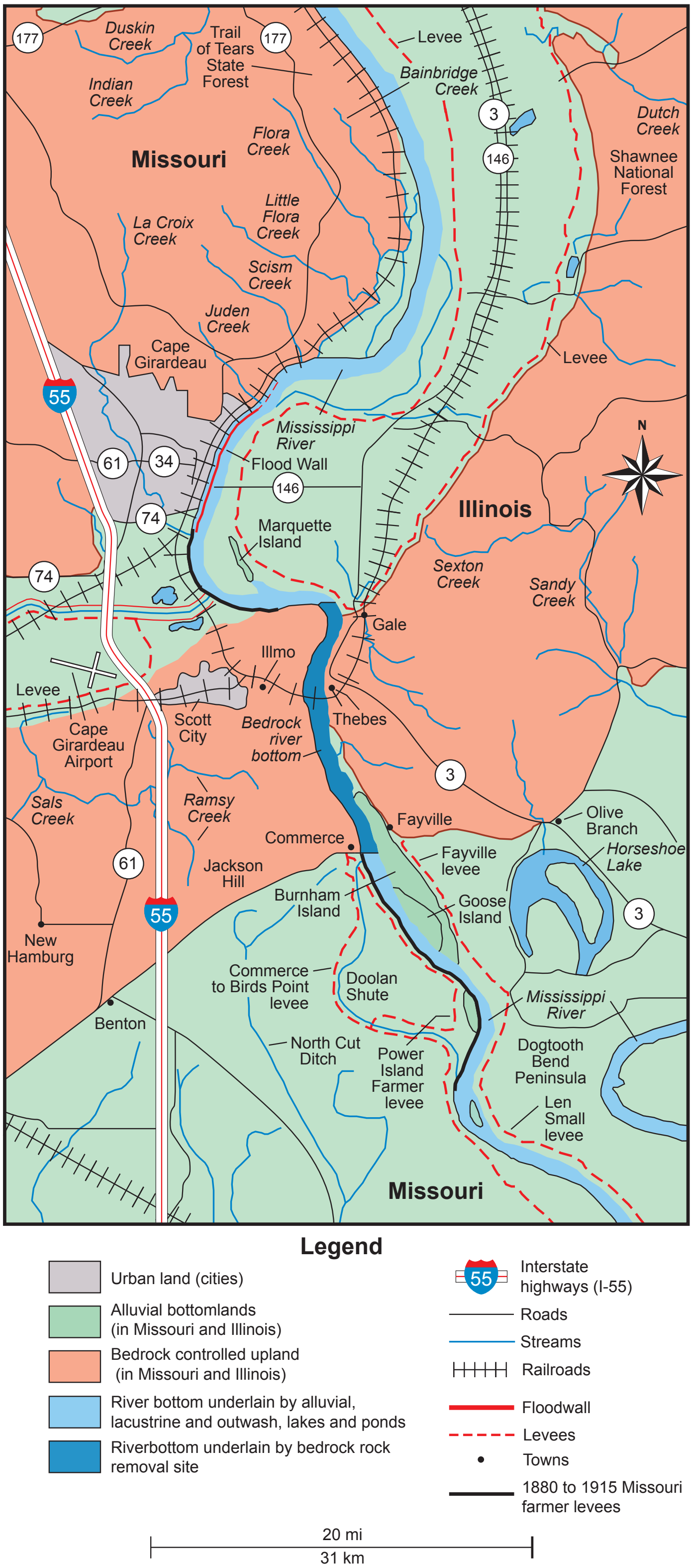
Between the 1840s and 1943 the Alexander County bottomland farmers were not protected from Mississippi River floodwaters. There is little historical evidence that the Illinois farmers and landowners were aware of the impact on river height from creating the 72 km (45 mi) Little River Drainage District Headwaters Diversion (in the year 1916) (Olson and Morton 2016a, 2016b, 2016c) or the construction of additional levees on the west side of the river. However, the Dogtooth Bend area at 10 m (33 ft) above the Mississippi River began to experience more frequent flooding and water flowing into old meander channels as the river reached greater peak heights during flood events.

## LEN SMALL LEVEE AND DRAINAGE DISTRICT

By 1940, it was apparent to Illinois landowners that they needed to protect their farms and homes from river flooding, and they created the Len Small Levee and Drainage District (LSLDD) in the Dogtooth Bend area (1943) and later the Fayville levee extension in 1969 (figure 2). The new farmer drainage district built a sand core levee, which was lower and weaker than Missouri and Kentucky farmer and mainline federal levees near the confluence of the Mississippi and Ohio rivers. With the construction of LSLDD levees, the Mississippi River was now confined by levees on both sides to a less than 2.5 km (1.5 mi) wide corridor from Commerce, Missouri, at mile marker 39 to mile marker 15. This reduction in the original Mississippi River floodplain which was six times wider than the new corridor, meant the loss of considerable space for storing flood waters and resulted in increased peak heights during major flooding events (figure 2). However, during the first 50 years,

**Figure 3**

**This map shows the location of the Missouri Little River Drainage District diversion channel outlet below Cape Girardeau and the Missouri and Illinois farmer levees south of the Thebes Gap and Commerce, Missouri, which narrowed the original 16 km wide Mississippi River floodplain to less than 2 km.**




from 1943 to 1993, no documented Len Small breach occurred.

Then, in 1993, the Len Small–Fayville levee failed when the Mississippi River reached record heights and was repaired. It failed again in 2011, with breaches and craters in five places. The largest 2011 breach was repaired when LSLDD pushed sand into the levee hole, making a sand core barrier between the river and farmland, which the US Army Corps of Engineers (USACE) in 2012 covered with a clay cap at a cost of US$5 million. This was the second known federal involvement in building or repairing the Len Small farmer levee. The 1993 and 2011 levee breaches resulted in the flooding of 6,800 to 14,000 ha (17,000 to 35,000 ac) with an unknown number of buildings damaged and removed after the 1993 flood and 169 structures damaged during the 2011 flood. The Federal Emergency Management Agency awarded the State of Illinois an US$8.7 million grant that required a state match to purchase these structures beginning in April of 2015, but only a few homes were purchased before July 1, 2015. After the Illinois legislature failed to pass a state budget in July of 2015, the state matching funds were not available and the program could not be fully implement before the 2016 flood.

## FLOOD OF 2016

The 2016 Len Small levee breach was much more severe than 2011 because of its location (figure 2). The fast moving river cut a 1.6 km (1 mi) long breach during late December of 2015 through early January of 2016 (figure 4) and scoured out a crater lake and deep gullies into adjacent agricultural lands. The southeast flow of the Mississippi River floodwaters through the breach created a new channel (figure 5) from river mile marker 34 through Alexander County, connected to an old meander channel, and then exited back into the main stem river at mile marker 15, a distance of 4.6 km (3.5 mi). This shortcut across Dogtooth Bend peninsula by-passed about 15 river miles (24 km) of the current Mississippi River path (figure 2). Approximately seven river lane-line buoys, hundreds of trees (figure 6), irrigation pivots, and other debris were carried onto the Dogtooth Bend bottomlands along with millions of tons of sand deposited on more than 600 ha (1,500 ac) of farmland. Another 800 ha (2,000 ac) were subjected to land scouring by the Mississippi floodwaters. The county lost 11 to 13 km (7 to 8 mi) of roads with others buried by sand (figure 1). After ditches and culverts filled with sand, drainage was nearly impossible.

The LSLDD staff members (Jim Taflinger, personal communication, April 15, 2016) were pessimistic that the district had sufficient resources to repair the levee, fill the crater lake extending 1 km (0.6 mi) through the levee, and fill and regrade the 2 km (1.3 mi) channel created by the 1993 levee breach and the 2011 deepening of the old meander channel north of Lake Milligan to mile marker 15. It is currently not clear what actions the USACE will take and what resources they have to support the LSLDD repair of the Len Small–Fayville levee. A damage assessment including both a land scouring and sand depositional survey and an updated soil survey (conducted by the USDA Natural Resource Conservation Service [NRCS]) of the 6,800 ha (17,000 ac) of LSLDD land and perhaps a total of 14,000 ha (35,000 ac) of southwest Alexander County covered by floodwaters is needed. This information is necessary to guide current repair decisions and evaluate alternative investments and activities in preparation for future flooding. Until repairs to the levee breach are made, the Alexander County bottomlands are totally exposed to the next Mississippi River flooding event.

Following the January of 2016 winter flood, the USACE moved a large amount of rock in front of the 1,200 m (4,000 ft) breach (figure 4) in anticipation of spring floods to keep the Mississippi River from extending the 4.6 km (3.5 mi) channel to the next downstream bend in the Mississippi River. If the channel were to permanently cross Dogtooth Bend peninsula, it would become an island cutting off more than 6,000 ha (15,000 ac), at least one hunting structure, and one home from the Illinois mainland. The USACE conducted a sonar survey of the 2016 Len Small levee breach to identify craters, holes, scouring and the extent of damage. The flooding took out tree lines and wiped out large chunks of the levee with sonar revealing scouring of soil and underlying parent material as deep as 9 m (30 ft) according to Alexander County engineer Jeff Denny (personal communication, April 20, 2016). However, the sonar survey showed the damage could have been much worse, finding the damaged area was not as large as in 1993.

**Figure 4**

**The 2016 Len Small levee breach was 1.6 km long. US Army Corps of Engineer crews, working from barges in the Mississippi River channel, dropped rocks in front of and against levee banks in an attempt to stabilize them. This rock barrier covering a portion of the south end of the levee breach is shown in the right side of picture.**

## REPAIR AND RESTORATION EFFORTS POST-2016 LEN SMALL LEVEE BREACH

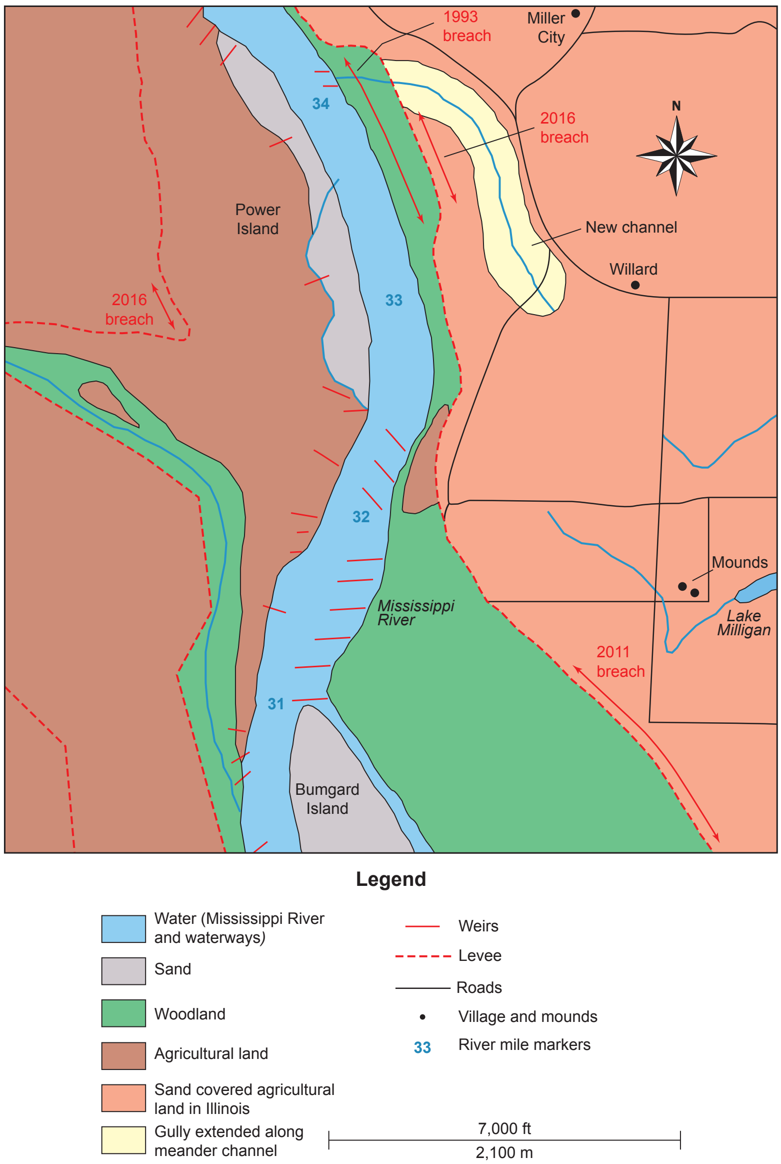
The USACE sonar survey helped the LSLDD to prioritize repairs and target restoration efforts. However local, state, and federal financial resources were limited, and many important repairs were put on hold until resources were available. After farmers, homeowners, and county crews worked to make sure their homes were safe, farmers turned to the spring work of preparing fields for planting. By April some landowners had begun removing the sand from their fields or incorporating it into the topsoil with a combination chisel plow and disk (figure 7). Some soybeans were planted by late April in fields with thin sediment deposits.

However, by August of 2016, nearly eight months after the breach, the levee still had a gaping hole, and many repairs had not yet occurred. Without repairs to the levee breach, there was little value in fixing the roads, in cleaning out the ditches, or moving the sand off fields; and planting crops was risky. Spring or summer floodwaters could again pour through the hole, drowning crops and covering roads, ditches, and fields with new sand and debris. Delayed planting reduced crop yield potential, and much of the 2016 harvest was at risk. This was not a new experience for farmers in the Mississippi and Ohio river confluence area. Back in 2011, New Madrid Floodway farmers (Missouri) planted 24,000 ha (90,000 ac) of soybeans from June 15 to July 7 and experienced modest yield reductions (Olson and Morton 2012, 2013). However, 12,000 ha (30,000 ac) were not planted that year (2011) in the New Madrid Floodway. The same year, 140 New Madrid Floodway farmers sued the USACE when major flooding damaged (land scouring, crater lake, gully fields, and sand deposition) their land. Alexander County farmers are part of this familiar debate about farmland in the floodplain and who is responsible for its protection.

## POST-2016 AND FUTURE ALTERNATIVES

Dogtooth Bend farmers and landowners, members and staff of the LSLDD, community and state-level leaders, and the USACE have some difficult decisions ahead in repairing the current landscape and in preparing for future flood events that predispose the Mississippi River to

**Figure 5**




**A close-up map of the 2016 Len Small levee breach on the Mississippi River from mile marker 34 to 30. Floodwaters poured through the breach depositing sand over a large part of the area and created the new channel shown on the map (yellow area).**

realign and create a new flow path across Dogtooth Bend peninsula. These decisions affect future land uses, resource allocations, and the livelihoods of the people of southern Illinois.

Agriculture is currently the primary land use in this area. There is a need for an updated county soil survey by USDA NRCS that assesses gully formation locations, soil erosion, sediment deposition damages, and land uses. The most recent soil survey of Alexander County (Williams et al. 2007) is almost 10 years old, with two major levee breaches occurring since the last survey. Extensive land scouring and sand deposition can adversely impact soil productivity and crop yield. Many landowners removed sand from their fields after levee breaches in 2011 and 2016; others simply piled the sand up, taking land out of agricultural production. An unknown number of gullies have not been filled or regraded and are farmed around when tilling and planting occur, leaving the gullies to revert to wetland vegetation. Thus, long-term soil productivity has decreased (Olson and Morton 2015), and these changes in land use affect land values. Without an updated soil survey of the Dogtooth Bend area, the land continues to be taxed as if no land scouring or sand deposition had occurred because land productivity indices are not adjusted to reflect the soil degradation, land scouring, or sand deposition. Further, longer term planning for existing and new land uses is hindered without sufficient information to evaluate investments in reclamation of farmland or nonfarm uses.

The Mississippi River Commission (MRC)/USACE and the LSLDD are partners in managing the river landscape and need to develop and evaluate alternative strategies for addressing the river-land relationships in the Dogtooth Bend area. Several alternative courses of action are presented in this paper. While many of the details of each alternative would need to be evaluated and negotiated, they offer a start in visioning different scenarios to guide preparation for the future.

The first alternative is to continue, as in the past, to repair the Len Small levee. This could impede and delay the eventual and natural tendency of the Mississippi to take a shortcut and realign its downstream course. This alternative is a near-term fix. There is a high likelihood at some future date that another flood event will occur, and the Len Small levee will breach again, creating new craters and gullies and flooding farmland. Since 1993, major weirs and bank stabilizing efforts along the Mississippi River banks in this area have been put in place three times. Although these structures have slowed the water and bank erosion, they have not prevented the breaches of 2011 and 2016 and are likely inadequate to deter levee damage during future high water events.

A second alternative is to proactively construct a diversion channel, with embankments on both sides, where the old meander channel is currently located. During high water periods, the channel would temporarily redirect excess Mississippi River floodwaters across the neck of Dogtooth Bend peninsula and allow the water to exit back into the river at mile marker 15. The existing Mississippi River 3 m (9 ft) channel between mile

**Figure 6**

**Hundreds of trees were transported by floodwaters and dropped on agricultural lands along with sand and lane line buoys like the red one shown here.**

**Figure 7**

**A combination chisel plow and disk is being used to incorporate the sand into the topsoil. The tillage equipment driver attempted to avoid the crater lake, gullies, and land scoured area.**

markers 34 and 15 would be maintained for navigation. One or more bridges would need to be built over the diversion channel to allow access to farmland, agricultural structures, and homes; and to recreational hunting, fishing, birdwatching uses. Hydrologic studies and environmental, economic, and social acceptability analyses would be necessary to fully evaluate the investments needed and impacts on the region.

A third alternative is to assist the Mississippi River realignment tendency and construct a 1 km (0.6 mi) wide new Mississippi River channel through the 4.6 km (3.5 mi) shortcut between mile marker 34 and 15 where the Mississippi River is already cutting with each major flooding event. The USACE could accelerate this process even more by making this channel between mile markers 34 and 15 the main stem river navigation channel. This would also require thorough hydrologic, environmental, social, and economic assessments.

An elaboration of the third alternative is to create a new Mississippi River channel with low rise levees on each side of the navigation channel and set back about 1.1 km (0.7 mi). This would make Dogtooth Bend an island in Illinois and turn the current Mississippi River channel between mile markers 34 and 15 into an oxbow lake. Dogtooth Bend Island could be used for floodwater storage during major flooding events since it is 4,800 ha (12,000 ac) in size, which along with thousands more acres in the oxbow lake and other nearby islands and adjacent land not levee-protected within the current main-line federal and farmer levees, would enlarge flood storage capacity in the area. If the new Mississippi River channel is used for navigation, the current Mississippi River shipping channel length would be reduced by 24 km (15 mi). Landowners would need to be compensated if the Dogtooth Bend area is used for a new Mississippi River channel or for temporary flood storage during the non-growing season.

Historically, the Mississippi River bottomlands have experienced hundreds of Mississippi River realignment events and course changes in the river. The large number of oxbow remnants and interior old meanders (e.g., nearby Horseshoe Lake area) are evidence of the past and harbingers of the future. Federal, state, and local managers of the Mississippi and Ohio river landscapes can impede or delay the Mississippi River realignment by attempts to maintain the status quo, but realignment will eventually happen. Over time, the mighty Mississippi River will eventually win, as it always has in the past.

## CONCLUSIONS

Prior to the construction of the farmer (Len Small–Fayville) levee in Illinois and the farmer (Commerce to Birds Point) levee in Missouri, the Mississippi River was 16 km (10 mi) wide between mile markers 39 to 15 (figure 3). The creation of these two levees restricted the Mississippi River floodplain to less than 2 km (1.5 mi) and increased the peak height of the river during flooding events that occurred after 1943. The resulting increased river velocity and height place both levees, as well as downstream levees, at risk of failure.

The USACE/MRC mission includes the maintenance of the mainline levees that protect Cairo, Illinois, and the Illinois, Missouri, Kentucky, and Arkansas bottomlands and the maintenance of navigation on the Mississippi River. The USACE cannot strengthen the existing Len Small-Fayville levee without increasing the risk of losing their own mainline levees (Cairo levee and floodwall, the Commerce to Birds Point levee and the New Madrid Floodway setback levee). If the Cairo floodwall and levee were to fail, it would put nearly 3,000 residents and 400 structures at risk. If the Commerce to Birds Point levee or the New Madrid Floodway setback levee were to fail, 800,000 ha (2,000,000 ac) in Missouri, Kentucky, and Arkansas bottomlands could be flooded with both crops and soils damaged. The opening of the New Madrid Floodway can be used to reduce the pressure and peak height by as much as 1.2 m (4 ft) on confluence area levees (Olson and Morton 2012). The floodway was used in 1937 and 2011. There is a need for additional floodwater storage in the confluence area of the greater Ohio and Mississippi rivers (Olson and Morton 2016a, 2016b, 2016c). A regional effort on both sides of the Ohio and Mississippi rivers is needed to strategically identify floodplain areas that could provide temporary water storage and policy incentives for landowners of low-lying lands to profitably invest in crops and income alternatives.

Climate scientists predict a continued pattern of extreme rainfall events in the upper Mississippi River region (Olson and Morton 2016c). This suggests that unexpected above-average rainfall events in the Ohio and Mississippi river basins will continue to increase the frequency of extreme flooding events on these great rivers. As the frequency of intense precipitation events increase, the current Illinois and Missouri farmer levee systems are likely to repeatedly fail if repaired to existing height and strength. The current solution to prevent flooding in the Dogtooth Bend area is not working. Combinations of land use changes and new structures are needed to address the problem. Whatever solutions are chosen, there will need to be a significant investment of human and financial resources to prepare for the future.

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# Attachment B

Conservation Organization Comments
On The
Regulating Works Project
Draft Supplemental Environmental Impact Statement (November 2016)

*Journal of Earth Science, Vol. 27, No. 1, p. 117–122, February 2016* *ISSN 1674-487X*
*Printed in China*
DOI: 10.1007/s12583-016-0639-y

# River Management and Flooding: The Lesson of December 2015–January 2016, Central USA

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**ABSTRACT: The huge winter storm of December 23–29, 2015 delivered heavy rainfall in a broad swath across the USA, deluging East-Central Missouri. Record high river levels were set at many sites, but damages were most pronounced in developed floodplain areas, particularly where high levees were built or river channels greatly narrowed. An average of 20 cm of rain that mostly fell in three days impacted the entire 10 300 km$^2$ Meramec Basin. Compared to the prior record flood of 1982, the highest relative stage (+1.3 m) on Meramec River occurred at Valley Park proximal to (1) a new levee, (2) a landfill in the floodway, (3) large floodplain construction fills, and (4) tributary creek basins impacted by suburban sprawl. Even though only a small fraction of the 1.8 million km$^2$ Mississippi River watershed above St. Louis received extraordinary rainfall during this event, the huge channelized river near and below St. Louis rapidly rose to set the 3rd-highest to the highest stages ever, exhibiting the flashy response typical of a much smaller river.**
**KEY WORDS: floods, Mississippi River, levees, floodplain development.**

## 0 INTRODUCTION

Human modification of landscapes and climate are profoundly impacting rivers and streams. Urbanization with its attendant impervious surfaces and storm drains is known to accelerate the delivery of water to small streams, causing flash flooding, channel incision and widening, and loss of perennial flow. The landscapes of large river basins in the central USA have been profoundly modified by agricultural activities and development. Meanwhile, large river channels have been isolated from their floodplains by progressively higher levees, and dramatically narrowed by wing dikes and other navigational structures (e.g., Pinter et al., 2008; Funk and Robinson, 1974). Direct consequences are higher, more frequent floods and underestimated flood risk (Criss, 2016; Belt, 1975). In many areas rainfall is becoming heavier, exacerbating flood risk (e.g., Pan et al., 2016), while new floodplain developments greatly magnify flood damages (Pinter, 2005).

The extraordinary winter storm of December 23–29, 2015 provides additional evidence for progressive climate change, while delivering more tragic examples of record flood levels and underestimated flood risk. What is perhaps most remarkable is that the flood on the middle Mississippi River had a much shorter duration than its prior major floods, and closely resembled the flashy response of a small river. This paper discusses how the Meramec River and the middle Mississippi River responded to this massive storm, and examines how their recent response differed from prior events.

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Manuscript received January 8, 2016.
Manuscript accepted January 14, 2016.

## 1 STORM SYNOPSIS

Very strong El Nino conditions developed during fall 2015, bringing some welcome relief to the California drought as well as anomalously warm temperatures to much of the USA. An extraordinary winter storm, appropriately named "Goliath", delivered heavy rainfall in a broad belt across the central USA, as a long cold front developed parallel to, and south of, a southwest to northeast-trending part of the jet stream. Rain delivery was greatest in the central USA, particularly southwest of St. Louis, Missouri (Fig. 1). The three-day rainfall delivered by Goliath is considered to be a "25-year" to "100-year" event at most meteorological stations in this region (NOAA, 2013). With this huge addition of late December precipitation, the record-high annual rainfall total (155.5 cm) was recorded at St. Louis in its official record initiated in 1871 (NWS, 2016a), although less reliable records suggest that annual rainfall was greater in 1848, 1858 and 1859. Flooding associated with Goliath resulted in great property damage and caused at least 12 fatalities in Missouri, 7 in Illinois, 2 in Oklahoma and 1 in Arkansas.

The extraordinary rainfall that fell at St. Louis on Dec. 26–28 closely followed significant rainfall on Dec. 21–23. The earlier storm saturated the ground, so runoff from the second pulse was greatly amplified.

## 2 MERAMEC RIVER FLOOD

Meramec River drains a 10 300 km$^2$ watershed in East-Central Missouri, and enters the Mississippi River 30 km south of St. Louis (Fig. 2). This river has very high wildlife diversity and is one of the very few un-impounded rivers in the USA (Criss and Wilson, 2003; Frederickson and Criss, 1999; Jackson, 1984). Population density is low, except for the lower basin near St. Louis. Intense rainfall events cause flash flooding of the basin, as recorded by numerous long-term gauging stations (Fig. 2). Winston and Criss (2002) described one such flash flood, and the references cited in the aforementioned publications provided abundant information on the basin.

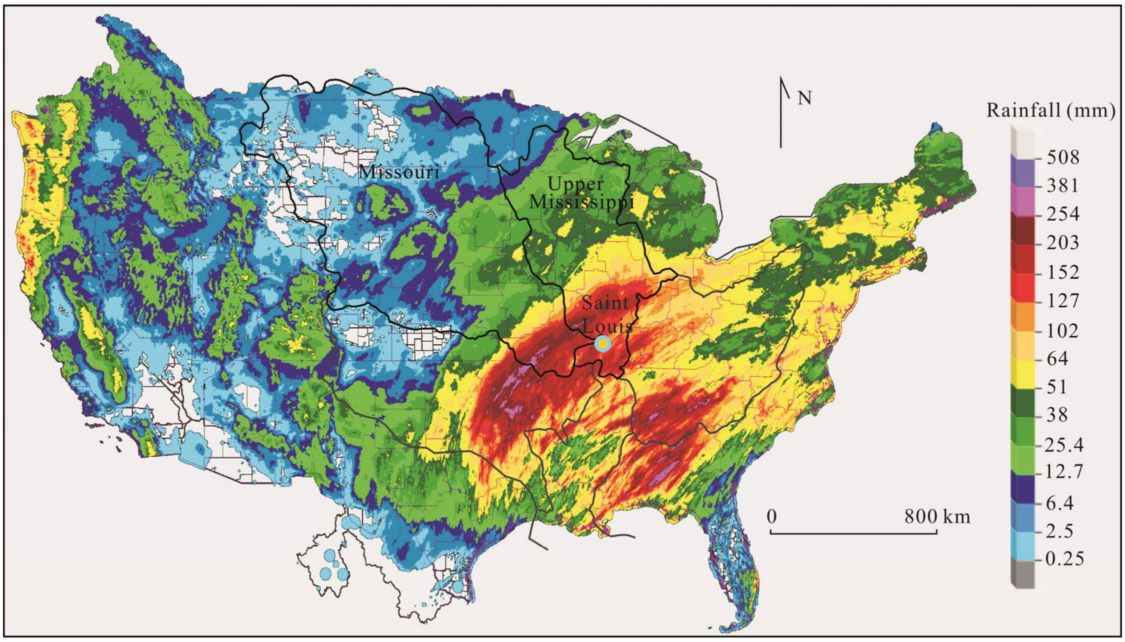


**Figure 1.** Map showing the observed, 7-day precipitation for December 22–29, 2015, according to NWS (2016a). Superimposed on this map are the boundaries of the upper Mississippi and Missouri watersheds (labeled) and other major river basins. Goliath delivered an average of 20 cm of rain to the entire Meramec River Basin (Fig. 2), but extraordinary rainfall exceeding 10 cm (orange, red and purple shading) impacted only a small fraction of the huge Mississippi-Missouri watershed upstream of St. Louis (blue dot near center).

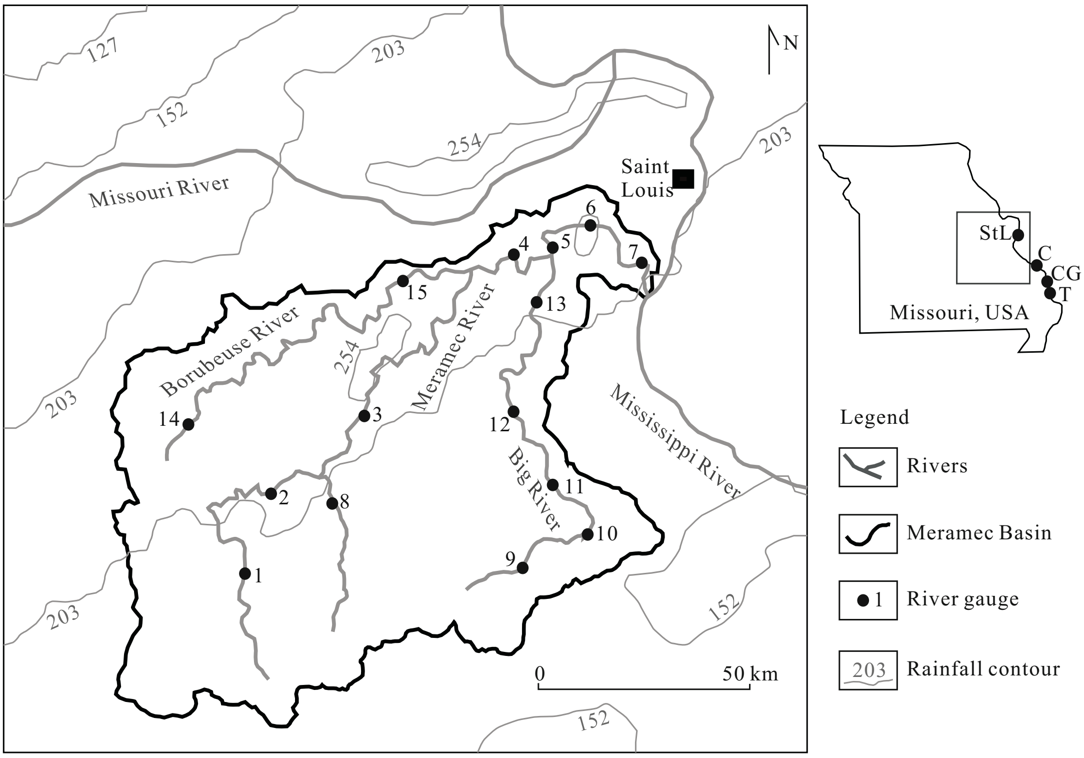


**Figure 2.** Map of East-Central Missouri showing the 10 300 km$^2$ Meramec River Basin (dark outline) and contours for precipitation delivered from December 22–29, 2015 according to NWS (2016a). Labeled dots are river gauging stations; stage hydrographs for the stations along the main stem of Meramec River (#1 to #7) are shown in Fig. 3. Water levels at Union (#15), Eureka (#5), Valley Park (#6) and Arnold (#7) set new records, while that at Pacific (#4) came close. The index map of Missouri shows the area of detail, and the location of river gauges at St. Louis (StL), Chester (C), Cape Girardeau (CG) and Thebes (T) along the middle Mississippi River (cf. Fig. 6).

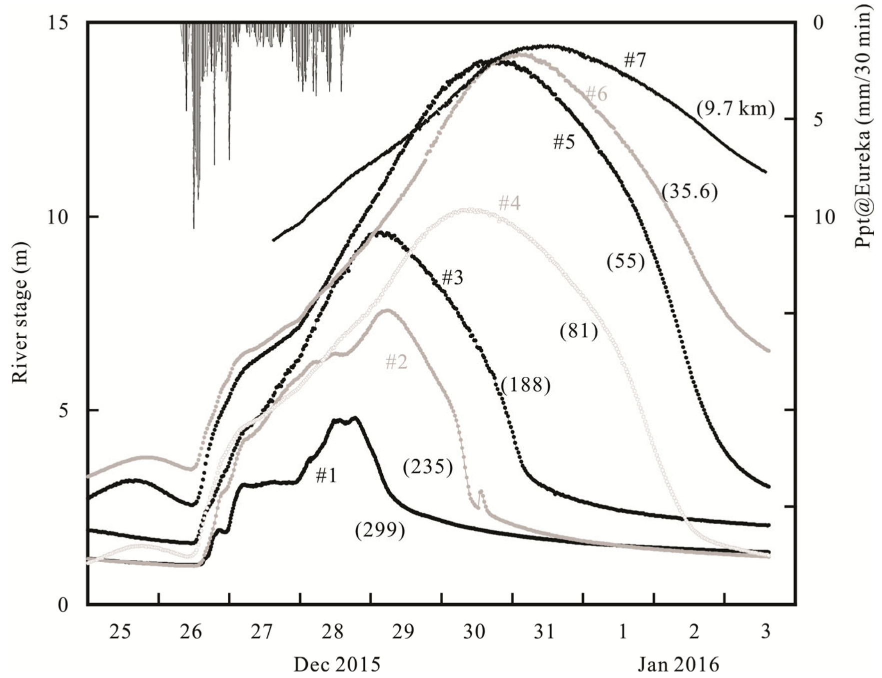


**Figure 3.** Stage hydrographs showing the propagation of the 2015 flood wave down the main stem of Meramec River, for sites #1 to #7 on Fig. 2. Numbers in parenthesis are the distance in km above the confluence with the Mississippi River to the south of St. Louis. Hydrographs for each site are plotted relative to its local datum, except that 0.75 m was added to the Valley Park hydrograph (#6) for clarity. Thin bars at upper left represent 30 minute precipitation (right scale). Data from USGS (2016) and NWS (2016b).

Goliath delivered an average of 20 cm of rain, mostly in 3 days, to the Meramec River Basin (Fig. 2). The resultant flood wave rapidly grew as it propagated downstream (cf. Yang et al., 2016), moving at a rate of about 3 km/h in the lower basin, where it set all-time record high stages (Fig. 3).

Runoff after storm Goliath was extraordinary, with flows attaining a value approaching 4 500 $m^3/s$, as documented by direct field measurements at the Eureka gauging station on December 30 (USGS, 2016). Of the precipitation delivered above Eureka by Goliath, 85% returned as runoff at Eureka in only 14.3 days. For comparison, the average, long-term annual flow at Eureka is only 92 $m^3/s$ for a basin that receives an average of about 109 cm of precipitation per year, indicating an average runoff fraction of only 27% that is similar to the ~30% average for the USA.

## 3 COMPARISON TO 1982

The prior flood of record in most of the lower Meramec Basin occurred on December 6, 1982, during another very strong El Nino condition, although at some basin sites the flood of August 1915 was more extreme. Given the strong similarities in time-of-year, ENSO condition and basin response, it is very useful to compare the peak water levels of 1982 to those of 2015 (Fig. 4). The river stage at Pacific was slightly lower in 2015 than in 1982; this site is not rated for discharge, but the observed stage is consistent with the recent combined peak flows upstream at Sullivan and Union also being slightly lower in 2015. Big River enters the main stem of Meramec River about 4.8 km above the Eureka gauging station, and the peak flow at the lowermost station along it (#13 on Fig. 2) was about 150 $m^3/s$ greater in 2015 than in 1982. Given these small differences, one might expect that the 2015 peak flow at Eureka would closely match that of 1982, but direct field measurements at Eureka on Dec. 30, 2015 suggest that the peak flow was 4 500 $m^3/s$ (USGS, 2016), when it was only 4 100 $m^3/s$ in 1982 (USGS, 1983). Taking this 400 $m^3/s$ difference at face value, and using the rating curves (USGS, 2016, 1983), the associated river stage at Eureka should have been only about 0.5 to 0.6 m higher at Eureka in 2015 than in 1982, when the observed difference was 0.97 m.

Alternatively, the estimated difference between the 2015 and 1982 stages at Eureka would be only about 0.25 m if it is assumed that the flow at Pacific was identical in the two years, and the ~150 $m^3/s$ difference for the flows on the lower Big River is accounted for. That the observed 2015 stage at Eureka was much higher than suggested by these two estimates (crosses, Fig. 4) demands explanation.

An even greater difference between the 2015 and 1982 river levels occurred at Valley Park (Fig. 4). This area has changed in the following way between these floods: (1) the size and height of a landfill at Peerless Park (cover photo) was greatly increased, significantly restricting the effective width of the Meramec River floodway mapped by FEMA (1995); (2) the 5.1 km-long Valley Park levee (Fig. 5) was constructed in 2005, restricting the width of the inundation area of the regulatory "100-year flood" (see FEMA, 1995) by as much as 70%, while reducing floodwater storage capacity; (3) the adjacent basins of three small tributaries, Williams, Fishpot and Grand Glaize Creeks, experienced rapid suburban development, destroying the riparian border, increasing the impervious surface, and making flash floods frequent (Hasenmueller and Criss, 2013); and (4) the floodplain area experienced continued commercial development on construction fill, impeding overbank flow while amplifying flood damages. It would appear that these changes added at least 1.0 m to the 2015 water levels at Valley Park, and at least 0.4 m upstream at Eureka, compared to what levels would have been in the 1982 landscape condition. Water levels may also have increased at Arnold due to such changes, but this is not clear, because the Mississippi River level was nearly 2 m higher in 2015 than in 1982 at the mouth of Meramec River during its flooding. This higher level at the confluence would impede the flow of the lowermost Meramec River, and flatten and elevate its water surface.

One final difference is that water temperatures measured by USGS (2016) were higher in 1982 (~13 °C) than in 2015 (~6 °C) near the times of peak flooding, so both the density and viscosity of water were higher in 2015. The associated effects on river levels are complex and not easy to determine. Nevertheless, if the 2015 peak stage and flow at Pacific were both similar to

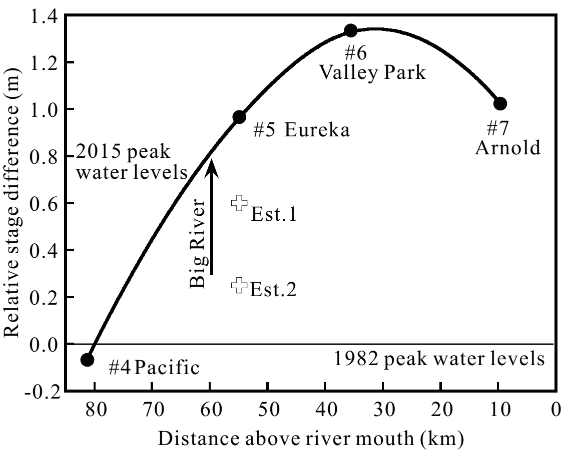


**Figure 4.** Relative difference between the peak water levels of December 30–31, 2015 and those of December 6, 1982 at different sites in the lower Meramec Basin (cf. Fig. 2). This difference was greatest close to Valley Park, where a large levee was built in 2005; this and other changes appear to have increased stages at Valley Park as well as upstream and downstream. Two estimates (crosses) suggest what the stage difference between these floods should have been at Eureka, had the 2015 flood occurred under the 1982 landscape condition (see text). Big River (arrow) enters the Meramec River from the south, 4.8 km upstream of Eureka.


**Figure 5.** The Valley Park levee looking south, only 1 hour after the flood gates were reopened on January 2, 2016. The floodwater level (dark) almost breached the levee and exceeded the estimated level for a "100-year flood" (FEMA, 1995) by nearly 2 m, forcing evacuation of the protected area to the left. Bicyclist (circled) on levee top shows scale. Photo by Robert E. Criss.

those in 1982, as is seemingly demanded by available data, temperature effects at Eureka are probably small.

Eight great floods (site stage >11 m) occurred at Eureka since 1915. For the six that occurred prior to 1995, the local stage at Valley Park was 0.96 to 1.40 m lower (avg. 1.20 m) than the local stage at Eureka. Only two >11 m floods occurred at Eureka since, in 2008 and 2015, and for those the local stage at Valley Park was only 0.68 and 0.59 m lower than that at Eureka. These relative differences clearly indicate that the stages of large floods at Valley Park have recently increased, relative to stages at Eureka, by about 0.8±0.5 m. New developments such as the 2005 Valley Park levee are the probable cause for this large difference.

## 4 THE JANUARY 2016 FLOOD ON THE MIDDLE MISSISSIPPI RIVER

Only a day after the peak flooding on the lower Meramec River, water levels on the Mississippi River at St. Louis were the 3rd highest ever recorded, and only a few days later, record stages were set downstream at Cape Girardeau and Thebes (Fig. 6). This flood is truly remarkable in several respects.

First, the Mississippi River at St. Louis was above flood stage for only 11 days during this recent flood, compared to 104 successive days in 1993 and 77 days in 1973, the only years with higher floods at St. Louis. We have found a good trend between peak stage and flood duration, with the greatest anomaly being this recent flood, and the next greatest being the brief 2013 flood which ranks 7th. Clearly, during January 2016 the middle Mississippi River experienced what might be considered a flash flood, as it exhibited a response similar to rivers whose basins are a hundred times smaller.

Second, the January 2016 flood occurred at the wrong time of year. Great floods on large midwestern rivers have historically occurred during spring, when heavy precipitation is

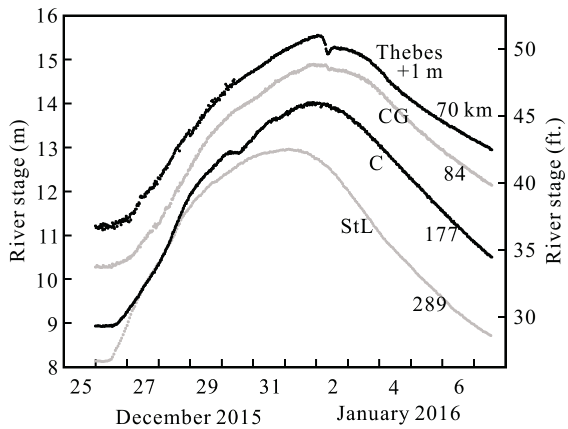


**Figure 6.** Stage hydrographs at St. Louis (StL), Chester (C), Cape Girardeau (CG) and Thebes, showing propagation of the 2015–2016 flood wave down the middle Mississippi River (cf. Fig. 2). The official stages depicted for each station are relative to its local datum, except that 1 m was added to the data at Thebes (top curve) for clarity. Numbers on curves are distance in kilometers above the Ohio River. The effect of a downstream levee being overtopped is evident near the flood crest at Thebes. This flood is remarkable for its short duration, time of year, and for the new record levels set at Cape Girardeau and Thebes. Data from USGS (2016).

added to rivers swollen with snowmelt. A partial exception was the August 1 peak of the great 1993 flood, but the protracted period of flooding was initiated during late spring. The other significant exception was the 10th highest flood at St. Louis, which occurred on December 7, 1982. Just like the current event, the 1982 flood peak on the Mississippi at St. Louis occurred only one day after the lower Meramec flood peak of December 6, 1982, discussed above. Ehlmann and Criss (2006) proved that the lower Missouri and middle Mississippi Rivers are becoming more chaotic and unpredictable in their time of flooding, height of flooding, and magnitude of their daily changes in stage. This chaotic behavior is primarily the result of extreme channelization of the river, and its isolation from its floodplain by levees (e.g., Criss and Shock, 2001; GAO, 1995; Belt, 1975). The channels of the lower Missouri and middle Mississippi Rivers are only half as wide as they were historically, along a combined reach exceeding 1 500 km, as clearly shown by comparison of modern and historical maps (e.g., Funk and Robinson, 1974).

Third, while the area of extreme precipitation during December 26–28, 2015 spanned the entire Meramec Basin, only 5% of the gigantic watershed of the Mississippi River above St. Louis experienced 7-day rainfall greater than 10 cm (Fig. 1). Nevertheless, because the Mississippi and Missouri rivers are so channelized and leveed proximal to St. Louis, the rainfall that was rapidly delivered to the nearby part of the watershed had nowhere to go, so river levels surged. Downstream, river stages were even higher because of the addition of floodwaters from Meramec River, affecting Chester, and then from the addition of Kaskaskia River, affecting the narrow Mississippi at Cape Girardeau and Thebes. For these sites, the fraction of their upstream watersheds affected by great December precipitation was only slightly larger than for St. Louis.

Finally, the record high water levels just set at Cape Girardeau and Thebes would have been even higher, but for the damaging surge of overbank floodwater that followed the overtopping of the Len Small Levee north of Cairo. The stage hydrograph for Thebes clearly shows that a sharp, 0.5 m reduction occurred when the water was still rising (Fig. 6), so the stage recorded just prior to that drop underestimates what the peak level would have been. A smaller but similar effect occurred slightly later at Cape Girardeau.

## 5 DISCUSSION

The aftermath of storm Goliath provides another example in an accelerating succession of record floods, whose tragic effects have been greatly magnified by man. The heavy rainfall was probably related to El Nino, and possibly intensified by global warming. Heavy rainfall impacted the entire Meramec basin, which accordingly flooded. But new record stages were set only in areas that have undergone intense development, which is known to magnify floods and shorten their timescales.

The Mississippi River flood at St. Louis was the third highest ever, yet it occurred at the wrong time of year, and its brief, 11-day duration was truly anomalous. Basically, this great but highly channelized and leveed river exhibited the flashy response of a small river, and indeed resembled the response of Meramec River, whose watershed is smaller by 160×. Yet, only a few percent of the watershed above St. Louis received truly heavy rainfall during this event; the river rose sharply because the water simply had nowhere else to go.

Further downstream, new record stages on the middle Mississippi River were set. Those record stages would have been even higher, probably by as much as 0.25 m, had levees not failed and been overtopped. The sudden drop of the water level near the flood crest at Thebes clearly demonstrates how levees magnify floodwater levels. In this vein, it is very significant that the water levels on the lower Meramec River were highest, relative to prior floods, proximal to a new levee and other recent developments. Forthcoming calls for more river management, including higher levees and other structures, must be rejected. Additional “remediations” to this overbuilt system will only aggravate flooding in the middle Mississippi Valley (see Walker, 2016).

Finally, this event provides abundant new examples of greatly underestimated flood risk. During this event, water levels on the lower Meramec River were 1 to 2 m above the official “100-year” flood levels (e.g., FEMA, 1995), while those that at Cape Girardeau and Thebes were 0.5 and 0.7 m higher, respectively. New commercial and residential developments in floodplains are foolhardy.

## 6 CONCLUSIONS

The huge winter storm of Dec. 23–29, 2015 delivered heavy rainfall in a broad swath across the USA, with as much as 25 cm of rain falling on East-Central Missouri in three days. The entire 10 300 $km^2$ Meramec Basin received an average of ~20 cm of rain during this event, and the river responded with a dramatic pulse that grew as it propagated downstream at ~3 km/h. Record high water levels were set at several sites, all in areas where the floodplain was developed, runoff was accelerated, high levees were built, or the floodway was restricted. In particular, compared to the prior record flood of 1982 on the Meramec River, the highest relative stage (+1.3 m) was seen proximal to a landfill in the floodway and to a new levee and that restricted the effective width of the “100-year” water surface by as much as 65%.

In contrast, Goliath’s extraordinary rainfall impacted only a tiny fraction of the huge, 1.8 million $km^2$ Mississippi River Basin above St. Louis, yet flooding occurred which was truly remarkable for the high water level, time of year, and brief duration. This continental-scale river exhibited the flashy response typical of a much smaller river such as the Meramec. This unnatural response is clearly consistent with the dramatic channelization of the middle Mississippi River and its isolation from its floodplain by levees, as clearly pointed out by Charles Belt more than 40 years ago. It is time for this effect to be accepted and for flood risk and river management to be reassessed.

## ACKNOWLEDGMENTS

Comments of an anonymous reviewer are appreciated. We thank Associate Editor Yanru Song for dedicated efforts during the final preparation of the flood volume, and AE Shuhua Wang and Yao Ge for advice, much correspondence and careful attention to manuscript processing earlier on. The final publication is available at Springer via http://dx.doi.org/10.1007/s12583-016-0639-y.

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# Attachment C

Conservation Organization Comments
On The
Regulating Works Project
Draft Supplemental Environmental Impact Statement (November 2016)

# Discussion of "Analysis of the Impacts of Dikes on Flood Stages in the Middle Mississippi River" by Chester C. Watson, David S. Biedenharn, and Colin R. Thorne

**DOI:** 10.1061/(ASCE)HY.1943-7900.0000786

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Thanks to Watson and colleagues (original paper) for bringing further attention to the issue of flood magnification on portions of the Mississippi and other navigable rivers. Unfortunately their article does more to cloud this issue than clarify it. The original paper claims to present an "objective review" (p. 1072, 1077) of the specific gauge technique and the hydraulic impacts of navigational dikes. It should be understood that this article is functionally identical to Watson and Biedenharn (2009), a consulting report commissioned by the St. Louis District of the U.S. Army Corps of Engineers for the purpose of refuting previous studies showing rising flood levels linked to ongoing dike construction on the Middle Mississippi River (MMR).

Watson et al.'s review of the broader issues here—empirical increases in flood levels and frequencies on the Mississippi River system, and the causal mechanisms thereof—is a highly incomplete analysis. It ignores the large breadth of methodologies, study rivers, locations, and years of record in previous studies. Instead, Watson et al. limit their analyses to a single station (St. Louis, MO) on a single river, using a truncated data record (Pinter 2010, 2015), and their criticisms target a single methodology (specific gauge analysis) largely in a single 12-year-old paper (Pinter et al. 2001). In actuality, numerous scientific studies and Corps of Engineers reports, dating back to the 19th century, have noted large increases in flood levels in association with wing-dike construction. For example, Hathaway (unpublished data, 1933) concluded "[i]t would appear that the bankful [sic] carrying capacity of the Missouri River would be permanently reduced by existing works, such as dikes and revetments used in shaping and controlling the stream for modern barge transportation." Recent studies have utilized hydrologic analyses; rigorous statistics; geospatial analyses; and one-dimensional, two-dimensional, and three-dimensional (1D, 2D, and 3D) hydraulic modeling to confirm, both empirically and theoretically, the potential for significant increases in flood levels in response to the dense emplacement of wing-dike structures, such as employed on the MMR. For example, Pinter et al. (2008, 2010) reported results from a 4-year NSF-funded initiative to assemble more than 8 million hydrologic data for the Mississippi-Missouri system, using Corps structure-history databases, and digitizing and rectifying river maps and surveys dating back to the mid-1800s. A large multivariate statistical model showed that many river engineering toolkits showed no association with increased flooding (e.g., much of the Lower Mississippi), but large empirical increases occurred when and where many wing-dikes were built in proximity to long-term measurement stations.

In place of reviewing this broad body of research, Watson et al. instead simply make a dogmatic assertion that "dikes are designed to have strong impacts at low flows that diminish as discharge increases and disappear at flows above bankfull," paraphrasing statements from St. Louis District staff that submerged wing dikes become "invisible to the river's flow." A recent U.S. Government Accountability Office (GAO) study noted the discrepancy between assertions of "hydraulic invisibility" and empirical evidence to the contrary, concluding that "despite the Corps' efforts, professional disagreement remains over the cumulative impact of river training structures during periods of high flow," disagreement that should be resolved through additional "physical and numerical modeling" (GAO 2011). In fact, recent modeling studies demonstrate the significant effects of flow turbulence and large-scale vertical and horizontal eddy circulation (Huthoff et al. 2013a, b), flow dynamics that are undeniably clear by observation of these structures during flood events. The Dutch government just completed a €45 million program to lower 450 wing dikes (groynes) on the Rhine system as part of its "Room for the River" strategy to reduce flood levels.

The Watson et al. manuscript attempts to refute the suggestion that wing dikes may increase flood levels, but the actual work here is limited to specific gauge analysis. The paper presents itself as the final word on the specific gauge technique, but Watson et al. make broad and surprising statistical errors. To begin with, they calculate p values to test null hypotheses of no trend over time in specific stages (stages for fixed discharge values), asserting, "For $p$-values greater than 0.1, the null hypothesis is accepted." In fact, failure to meet such a confidence threshold (typically 95% or 99%) means that the null hypothesis cannot be rejected with that level of confidence. Freshman textbooks teach students to avoid this error: "Null hypotheses are never accepted. We either reject them or fail to reject them . . . failing to reject $H_0$ does not mean that we have shown that there is no difference" (Dallal 2001). Nonetheless, Watson et al. repeatedly assert that their statistics prove that MMR specific stages are invariant over time. Furthermore, between rejecting $H_0$ for $p$ values <0.01 and (erroneously) accepting $H_0$ for $p > 0.1$, the authors create a new statistical outcome of "inconclusive." Where Watson et al.'s own analyses show significant increases in flood stages (above the 99% confidence level), the authors use "visual inspection of the data" to infer secondary mechanisms and use *post facto* subdivisions of their time series in order to mask the statistical trend. In fact, our research group long ago reviewed such secondary factors, including the effects of sediment concentrations and water temperature on stages, and quantified these effects on MMR stages (e.g., Pinter et al. 2000; Remo and Pinter 2007). Statistical trends, when significant, represent long-term driving forces, such as wing-dike impacts, rising up from the many known sources of short-term variability.

It is hard to deny that some process is driving flood levels higher on rivers such as the MMR and Lower Missouri River. Historical time series of stage data, which are unequivocally homogenous over time (e.g., Criss and Winston 2008), show strong and statistically significant increases, and these increases exceed by ~10× the maximum credible increases in climate-driven and land-cover-driven flows (e.g., Pinter et al. 2008). Watson et al. obliquely acknowledge the upward trend in flood magnitudes and frequencies, but conjecture that levee construction is the cause. In reaching this conclusion, Watson et al. present no evidence, but instead speculate about enhanced momentum losses due to channel-overbank flow shear and about voluminous "sediment accumulation . . . between the channel and the levee"; speculative processes that are contradicted by real-world measurements (e.g., Bhowmik and Demissie 1982; Heine and Pinter 2012). In fact, the large multivariate study by Pinter et al. (2010) identified the age, location, and extent of every large levee system added to the Mississippi–Lower Missouri system during the past 100+ years, documenting that levees do contribute some but not all of the observed flood-level increases on the MMR and elsewhere (confirming modeling by Remo et al. 2009). These issues are too important to be addressed by unsupported speculation, especially when voluminous data exist to rigorously test these hypotheses.

Despite protestations to the contrary, the Watson et al. paper reveals broad areas of agreement with earlier studies on wing-dike impacts. They acknowledge that the "USACE has constructed numerous river engineering structures in and along the MMR." In fact, Watson et al. significantly underestimate the number of such structures by starting their count around 1930. Most dike construction on the Mississippi River near St. Louis was early, with 26,500 linear meters of dikes built prior to 1930 in the 10 river miles (16.5 km) centered on St. Louis. Wing dikes and similar training structures have been, and continue to be, the dominant tool for navigation engineering on the MMR, with a total of 1,200 linear meters of dikes per 1.0 km of channel. Watson et al. state that stages for the lowest, in-channel flows trend downward over time after wing-dike construction, which has been noted at St. Louis and other gauging stations by all previous studies. Dike-induced flow acceleration in the navigation channel stimulates bed scour, which lowers the water-surface elevation for low flows. Watson et al. also note that stage trends for larger in-channel flows go flat (become statistically "inconclusive"), as flow retardation by dikes balances the increased depths. And for flood flows, they acknowledge a statistically significant upward trend overall. In fact, measured flood stages at St. Louis in 1993 were ~1.2 m higher than for equal flows in the 1940s, even though most dike construction was earlier. Where we differ is that Watson et al. ignore the very large range of other research quantitatively showing how much of this increase, and similar and larger increases at numerous other stations, is linked to levee construction and how much is attributable to wing-dike construction.

There are legitimate discussions that researchers could have, for example the advantages of different approaches to specific gauge analysis (e.g., Watson's "rating curve" and "direct step" approaches), but instead Watson et al. limit themselves to reviewing a single technique on a single river at a single station using a truncated period of record (Pinter 2010, 2015). There is clear empirical evidence of statistically significant increases in flood magnitudes and frequencies on the Mississippi and other rivers, and extensive research and broad-based evidence that river-training structures have contributed to these increases. Current dike construction projects on the Mississippi River rely on the Watson et al. paper and the corresponding consulting report (Watson and Beidenharn 2009) as the central demonstration that large-scale new dike fields will not impact flood levels. Sound engineering design, environmental assessment, and flood-risk management should be based on vigorous science rather than advocacy and misdirection.

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# Discussion of "Mississippi River Streamflow Measurement Techniques at St. Louis, Missouri" by Chester C. Watson, Robert R. Holmes Jr., and David S. Biedenharn

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Thanks to the authors of the original paper for another manuscript addressing pressing issues of hydrology and flooding on the Middle Mississippi River (MMR). Like another paper (Watson et al. 2013) and discussion (Pinter 2014), the authors of the original paper present findings from studies funded by the St. Louis District of the U.S. Army Corps of Engineers (USACE), in this case presenting elements of the Watson and Biedenharn (2009) and Huizinga (2009) reports. The original paper reviews historical discharge measurements and measurement techniques on the MMR, and in particular, discharges measured by the USACE prior to circa 1940. Unfortunately, the authors of the original paper present this review without necessary background and literature review, for example with no mention of Pinter (2010), a statistical study that tested the same issues. Outside readers will not understand the context or the purpose of the Watson et al. (2013) paper without additional background.

The seemingly arcane question of historical discharge measurements has been the focus of extensive discussion on the MMR. These discussions began with studies identifying rising trends in flood magnitudes and frequencies on the MMR and selected other river reaches. The long-term hydrologic effects of climate change, land use, and upstream dam storage on MMR flooding have also been documented and quantified (e.g., Pinter et al. 2002, 2008, 2010), but multiple studies have identified in-channel navigational construction (a variety of dikes and dike-like structures; see review in Pinter et al. 2010; Pinter 2014) as the largest influence on MMR flood trends over time. Put simply, this is the source of contention driving USACE investment in this issue and driving ongoing work on both sides.

After record flooding in 1973, Belt (1975) and Stevens et al. (1975) published studies linking flood-level increases over time with ongoing construction of navigational channel works. The MMR appears to be the most densely diked river reach in the United States, and perhaps of any river worldwide, with an average of about 1,370 m (linear) of dikes and weirs constructed per kilometer of MMR channel. The Belt (1975) and Stevens et al. (1975) papers stimulated vigorous discussion, in particular four letters responding to te Stevens et al. (1975), as follows: (1) Dyhouse (1976), (2) Stevens (1976), (3) Strauser and Long (1976), and (4) Westphal and Munger (1976), and various opinion articles disseminated by the St. Louis District of the USACE (e.g., P. R. Munger, et al., Contract DACW-43=75-C-0105, presented at U.S. Army Corps of Engineers, St. Louis, Missouri, 1976; Dyhouse 1985, 1995). Critiques included the argument that early discharge data on the Mississippi River cannot be compared with recent data because early discharge measurements (<1933 at St. Louis) used floats to measure flow velocity rather than Price current meters. In order to test this assertion, "[t]he Corps commissioned the University of Missouri Rolla to evaluate historical methods of discharge measurement, investigating the accuracy of the techniques and the need for any adjustments to historical discharge data" (Dyhouse 1985). Stevens (1979) completed same-day measurements of velocity and discharge near Chester, Illinois, using Price current meters and several varieties of floats.

Watson et al. repeat a now familiar assertion that Stevens (1979) identified systematic and significant differences between float-based and meter-based measurements. That is not the case. Stevens (1979) concluded that "an experienced person, using accepted techniques, can obtain excellent discharge determinations using any of the velocity measuring vehicles." Watson et al. points to differences between float-based and meter-based measurements, but the only broad differences in the Stevens (1979) results involved surface floats (as opposed to other varieties of floats), a technique used for only 10 of the thousands of early MMR discharge measurements. All 10 surface-float measurements were made in 1881 during very low flows at St. Louis (no surface-float measurements at the other gaging stations; i.e., Chester or Thebes). Furthermore, Stevens (1979) explicitly conclude that their results "do not substantiate correction of all recorded past discharges that have been determined using floats." And yet exactly such data modifications have been made, justified by citing Stevens (1979).

The Upper Mississippi River System Flow Frequency Study (UMRSFFS) was initiated in 1997 to update flow frequencies previously quantified in 1975 along the Upper Mississippi, Missouri, and Illinois River systems. When the UMRSFFS was released in 2004, areas of increased flood frequencies were identified in other USACE districts, but the new flood profiles were broadly lower through the St. Louis District, including drops of up to 52 cm (1.7 ft) for the 100-year flood. These decreases were puzzling given the empirical hydrologic trends, and remained enigmatic despite detailed review of the UMRSFFS methodology and results. A Freedom of Information Act request for additional UMRSFFS documentation (Missouri Coalition for the Environment v. U.S. Army Corps of Engineers, 07–2218) was refused by the USACE on the basis of "deliberative process privilege," a ruling subsequently upheld by a U.S. District Court. The St. Louis District results became clear only with the discovery of Dieckmann and Dyhouse (1998), a presentation made at a United States interagency meeting. Dieckmann and Dyhouse (1998) reported that "flood peak discharges at St. Louis prior to 1931 [and at the Chester and Thebes gages prior to c. 1940] were adjusted downward to reflect over-estimates made throughout the period when floats were primarily used for velocity measurements," citing Stevens (1979). These post facto data changes are nowhere presented in the public UMRSFFS methodology. More recent hydrologic measurements also were altered (Pinter 2010). Together these modified input data were used to calculate UMRSFFS flow frequencies and are now the basis for flood profiles and new flood-hazard maps throughout the St. Louis District. Similarly, the USGS Missouri Water Science Center has now altered its flood peak dataset, reducing the 1844 flood flow at St. Louis from 38,200 to 28,300 $m^3/s$ (1.35 million to 1 million $ft^3/s$), based on Dyhouse (1995) and Dieckmann and Dyhouse (1998), and despite detailed analysis of 1844 measurements by Stevens (1979) suggesting a flow of 38,500 $m^3/s$ (1.36 million $ft^3/s$) at St. Louis. Most scientists would argue for much greater caution before altering original data.

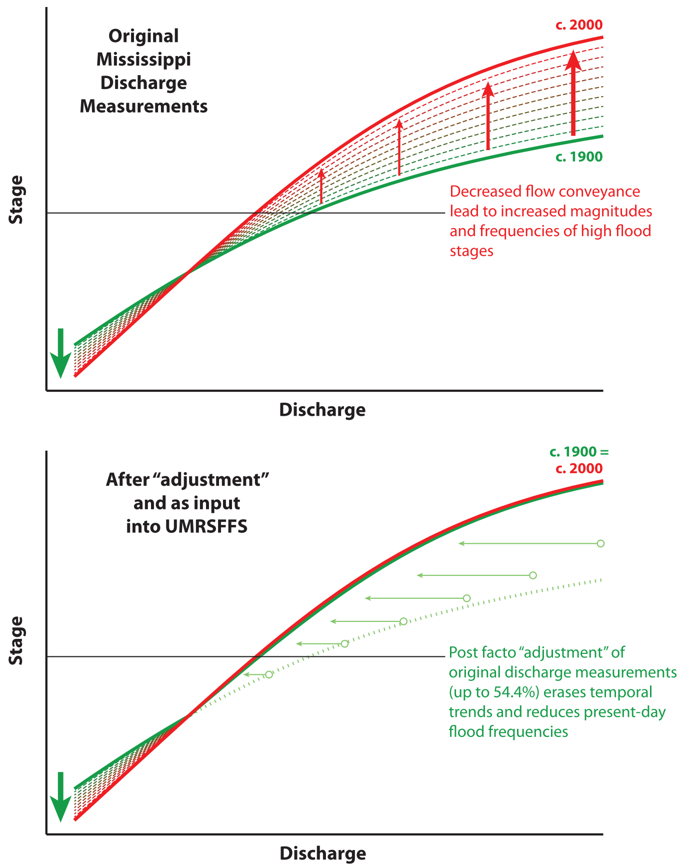


**Fig. 1.** (Color) Conceptual illustration showing how modification of historical discharge measurements (Dieckmann and Dyhouse 1998) erases temporal trends in MMR rating curves documented by previous researchers, including increases in flood stages for fixed discharges (red arrows); these modifications also reduce calculated flood frequencies

The effect of modifying early discharge measurements, as suggested by Dieckmann and Dyhouse (1998) and Watson et al., is to erase temporal trends in MMR rating curves (including rising flood stages) that previous researchers had ascribed primarily to construction of navigational structures in and along the MMR channel (Fig. 1). In the process, flood frequencies and magnitudes calculated using these input discharges are significantly reduced. The Dieckmann and Dyhouse (1998) data modifications reduced the UMRSFFS output flood magnitudes by up to 10% and more, for example a reduction of $> 3{,}100\ m^3/s$ ($> 110{,}000\ ft^3/s$) for the 100-year flood at St. Louis (Pinter 2010). Pinter et al. (2012) completed flood-loss modeling on the MMR, quantifying losses with and without the data adjustment mentioned previously; flood damages modeled based on the adjusted input discharges were up to 79% less than calculated using the original and unaltered annual flow maxima.

Pinter (2010) presented the issue of data adjustment in the UMRSFFS and set out to test the hypothesis that older discharge measurements were systematically overestimated relative to later USGS measurements. The study tested this hypothesis using 2,150 historical discharge measurements digitized from the three principal stations [(1) St. Louis, (2) Chester, and (3) Thebes] on the Middle Mississippi River, including 626 float-based discharges and 1,516 meter-based discharges, and including 122 paired measurements (pairs of meter-based and float-based measurements taken at the same locations on the same days). In all statistical tests, the hypothesis that early discharges were overestimated was rejected; on the contrary, in the cases where differences between early and later discharges were significant, the pre-USGS discharge measurements averaged slightly less (not more) than the later measurements. These statistical tests included separate analyses of the paired values and of all floats versus all meters, and separate tests at all three gaging stations.

The authors of the original paper provide no new data, and their one new analysis is a statistical comparison in one paragraph spanning pp. 1067–1068. The rest of their review discusses sources of variability in streamflows (e.g., temperature-based and bed-related hysteresis), largely duplicating Watson et al. (2013); see reply in Pinter (2014). That statistical comparison evaluates discharge values from Stevens (1979) and Ressegieu (Memo to division engineer, presented at Upper Mississippi Valley Division, U.S. Army Corps of Engineers, St. Louis, Missouri, 1952). Assessment of this comparison is impossible, because the authors of the original paper provide neither these data nor any indication of which data they looked at. One concern is that the authors of the original paper utilize the very small number of measurements in Stevens (1979) and Ressegieu (Memo to division engineer, presented at Upper Mississippi Valley Division, U.S. Army Corps of Engineers, St. Louis, Missouri, 1952), eschewing the several thousand meter-based and float-based discharges, including numerous paired measurements, assembled in Corps (1935). A copy of Ressegieu (Memo to division engineer, presented at Upper Mississippi Valley Division, U.S. Army Corps of Engineers, St. Louis, Missouri, 1952), which is a memo and internal assessment by the St. Louis District dated May 27, 1952, was recently obtained from the St. Louis District. Ressegieu (Memo to division engineer, presented at Upper Mississippi Valley Division, U.S. Army Corps of Engineers, St. Louis, Missouri, 1952) followed Congressional hearings in which "A House committee Thursday blasted the army engineers for their navigation work on the lower Missouri River, asserting that a 250-million dollar program appears actually to have increased flooding" (Sioux City Journal 1952), just as Stevens (1979) was initiated by the St. Louis District just after publication of Belt (1975). Ressegieu (Memo to division engineer, presented at Upper Mississippi Valley Division, U.S. Army Corps of Engineers, St. Louis, Missouri, 1952) looked at Mississippi discharge measurements and reached the same conclusion as Stevens (1979), that USACE "'rod float' measurements … for all practicable purposes may be considered equal" to USGS metered discharges," exactly contrary to the Dieckmann and Dyhouse (1998) rationale for altering pre-USGS discharge measurements.

Until now, most USACE workers and consultants have ascribed the source of purported heterogeneity in historic discharge data to the use of floats for velocity measurements (Dyhouse 1976, 1985, 1995; Stevens 1976; Strauser and Long 1976; Westphal and Munger 1976; Dieckmann and Dyhouse 1998; P. R. Munger, et al., Contract DACW-43=75-C-0105, presented at U.S. Army Corps of Engineers, St. Louis, Missouri, 1976). Pinter (2010) showed that the large majority of early discharges were based on Price current meters, and that float-based charges are not systematically higher (if anything lower) than meter-based measurements. Watson et al. now shift stance and assert that historical discharge bias results from changes in Price current meter design and measurements made from boats versus bridges. The finding of the authors of the original paper, that "pre-1930s discrete streamflow measurement data are not of sufficient accuracy to be compared with modern streamflow values" seems to be a conclusion in search of supporting evidence. Even Ressegieu (Memo to division engineer, presented at Upper Mississippi Valley Division,

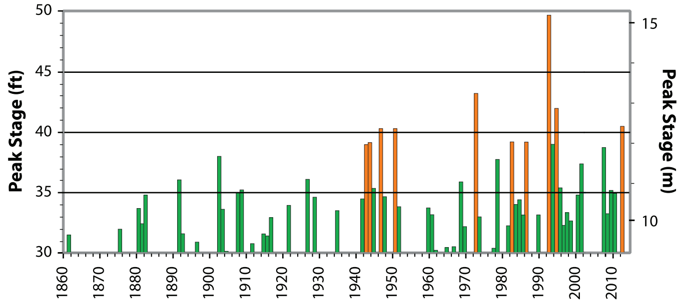


**Fig. 2.** (Color) Peak stages above flood level (30 ft above datum) for the Mississippi River at St. Louis; homogenous daily stages date back to 1861, and the 10 highest flood peaks (in orange) all occur in the latter half of the record; probability that this represents the random distribution of a stationary time-series is on the order of 0.00098

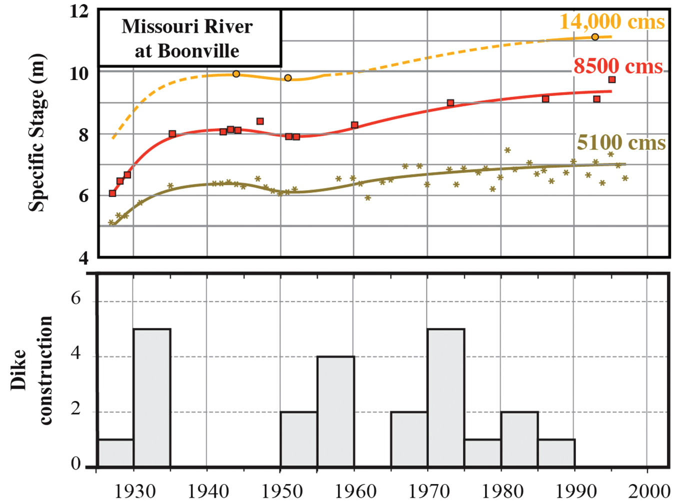


**Fig. 3.** (Color) Like most stations analyzed by Pinter et al. (2008, 2010), and others, discharges on the Missouri River at Boonville were developed exclusively by the USGS; flood stages increased when and where new navigational dikes were constructed (number of dike segments built within the 3.2 km of channel centered on the gage; data from Pinter and Heine 2005)

U.S. Army Corps of Engineers, St. Louis, Missouri, 1952) concluded that "it is not recommended that the C. of E. measured discharges be revised." At a minimum, the narrow analysis in the original paper does not justify redacting or altering thousands of discharge measurements, which represent key evidence of the hydrologic, hydraulic, and geomorphic response of the Mississippi River to its early engineering history.

Watson et al. concludes that "previous attempts ... to assign a positive trend in stage ... for a particular streamflow across the 1933 date boundary are incomplete without accounting for the pre-1933 measurement bias." Again, this is a familiar assertion, and several previous publications (Criss and Winston 2008; Criss 2009; Pinter et al. 2001, 2002, 2008) have shown that stage data alone provide a useful so-called empirical reality check that is independent of any question of discharge data homogeneity (Fig. 2). Stage data are dense, precise, and unequivocally homogenous (once any datum shifts have been noted). Criss and Winston (2008) examined the long and homogenous stage record for the Mississippi River at Hannibal, Missouri, with the period 1973–2013 experiencing 14 floods at or above the predicted 10-year level in the past 40 years, seven above the 25-year level, four at the ≥50-year level, and two at the ≥200-year level [Criss and Winston (2008), data updated through 2013]. Criss (2009) tested records of peak stages at stations on the Mississippi, Missouri, and other rivers, and found that observed flood stages pervasively exceeded UMRSFFS predictions, with significance levels ranging from 90–99.9%. Stage time series are sufficiently long, dense, and precise that rising trends clearly exceed the quantified effects of climate change and levee construction alone. Watson et al. focuses solely on pre-USGS versus post-USGS discharges (pre-1933 and post-1933 at St. Louis, 1942 at Chester, and 1941 at Thebes), but the large majority of the 67 stations analyzed in Pinter et al. (2008, 2010) utilized only USGS discharge values. All of those results showed rising stage trends in heavily diked river reaches (e.g., Fig. 3). Watson et al. carefully limit their discussion to the St. Louis location alone, when their conclusion that rising stage trends are "simply the result of mixing two discrete observation data sets" is negated, by definition, at locations where all discharges are from the USGS; in fact, the majority of all sites studied.

Pinter (2010) was a technical analysis, but the paper and subsequent discussions (e.g., Wald 2010) raised troubling questions. The UMRSFFS report and its appendices exceed several thousand pages but included no explanation of the large-scale adjustment of input data in the St. Louis District's portion of the study. These adjustments remained unknown until the discovery of the Dieckmann and Dyhouse (1998) report, although the data modifications affected resulting flood frequencies more than any other study assumption (e.g., choice of statistical distribution, or skew values), which are outlined in the UMRSFFS in great detail. No quantitative analysis was done to justify this data manipulation, which instead apparently was based on Stevens (1979) and on flume experiments; "adjustments in the data made by the corps were correct [because f]low tests using scale models determined that actual water flows in floods occurring in 1844 and 1903 could not possibly have been as high as were estimated using instruments of the time" [G. Dyhouse, quoted in Wald (2010)]. The Watson et al. paper serves to provide post facto justification for altering historical input data in the UMRSFFS and other applications. Even putting aside the specific technical question of historical data homogeneity, scientists and engineers should agree that the highest possible thresholds for (1) rigorous analysis, (2) transparency, and (3) burden of proof should apply before original measurement data are manually altered. Those thresholds should be highest of all for hydrologic data and flood-frequency analyses, which directly impact floodplain and river management projects, policies, and public safety.

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# Closure to "Analysis of the Impacts of Dikes on Flood Stages in the Middle Mississippi River" by Chester C. Watson, David S. Biedenharn, and Colin R. Thorne

**DOI:** 10.1061/(ASCE)HY.1943-7900.0000786

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We welcome discussion of our paper and appreciate Dr. Pinter's interest in it. In this closure, we seek to reduce the "cloudiness" that reading our paper has apparently introduced to the discusser's understanding of the impact of dikes on flood stages by reiterating the paper's purpose and findings and by clarifying the procedural steps within it. However, before doing so, we must correct the discusser's understanding that the published paper is "*functionally identical*" to Watson and Biedenharn (2009). This is false. It is true that similarities exist between these documents in that both apply specific gauge techniques, but the same can be said of multiple publications by the authors, none of which are "*functionally identical*." The unique feature of the published paper is that it sets out, clearly and for the first time, a general methodology for specific gauge analysis, with the intent of reducing confusion concerning how this technique should be performed and what can and cannot be concluded from its outcomes.

The discusser criticizes our use of data from a single hydrometric station (St. Louis) and we agree that it would have been preferable to illustrate weaknesses of the rating curve method and advantages of the direct step method using multiple stations. Indeed, the original manuscript included further examples, for the gauges at Chester and Thebes; however, the published paper was condensed according to the *Journal of Hydraulic Engineering* guidelines. Notwithstanding this, and although data for Chester and Thebes would have reinforced the points made in our paper, we believe that, even using a single example, the published paper provides reliable guidance for standardizing specific gauge analyses to improve their objectivity and reliability. This is significant because it pertains to the misinterpretation that underlies much of the discusser's critique. Dr. Pinter suggests that, "The Watson et al. manuscript attempts to refute the suggestion that wing dikes may increase flood levels, but the actual work here is limited to specific gauge analysis." In responding, it may be helpful to reiterate the aim of the published paper, as stated in the Abstract, which is to provide

"an objective review of the specific gauge analysis technique that explains how the method should be performed and the results interpreted; identifies strengths and limitations; examines the uncertainties associated with application to the Middle Mississippi River given the available data; and reassesses the conclusions that can and cannot reasonably be drawn regarding the impacts of dikes and levees on flood stages, based on specific gauge analysis of the Middle Mississippi River."

It follows that in limiting our discourse to consideration of evidence acquired using specific gauge analysis, we were not choosing to "ignore the very large range of other research" but focusing on material relevant to achieving the aim of our paper, the purpose of which is restated above. In fact, we agree wholeheartedly with Dr. Pinter that multiple sources of evidence can and should be accessed when investigating the hydrologic, hydraulic, and morphological impacts of engineered structures (including wing dikes) on fluvial systems, but doing so was beyond the scope of our paper.

Building on his misconception that the purpose of our paper was to "refute the suggestion that wing dikes may increase flood levels," Dr. Pinter describes our statement that, "dikes are designed to have strong impacts at low flows that diminish as discharge increases and disappear at flows above bankfull," as a "dogmatic assertion." This is wrong; it is actually a statement of fact. Dikes are designed to have diminishing effect with increasing stage and to have no effect at bankfull flow. Whether particular dike fields perform in accordance with that design intention is a different matter and one for which conflicting evidence exists. In this context, we strongly agree with Dr. Pinter that the performance of dikes in low flow merits and requires further investigation, and recommend that this is given high priority.

The discusser writes that our purpose in visually inspecting and subdividing the time series of stages recorded at St. Louis was to "*mask the statistical trend*." It was not. Inspection of the data should be the first step in any statistical treatment and our purpose was to identify any breaks in the trends and subdivide the time series accordingly, in order to recognize and account for the effects of extreme floods that are known to cause abrupt changes to channel morphology and conveyance capacity in large alluvial rivers for a variety of reasons.

Our use of statistics is also criticized, and this deserves a considered response. In setting the level of significance for a statistical test, the key is to guard against making either a type I or type II error. A type I error is made through incorrect rejection of a true null hypothesis. That is, a type I error would be made if we were to incorrectly reject the null hypothesis and conclude that there likely is a trend in the stages for a given discharge, when actually there is not. A type II error is failure to reject a false null hypothesis. That is, we don't reject the null hypothesis and conclude that there likely is no trend in water stages when actually there is a trend. The probability ($p$-value) should be selected to make it difficult to make whichever type of error is the least preferable. Using a very low $p$-value guards against a type I error. Using a high $p$-value guards against making a type II error. But in our study, neither type of error is better or worse than the other. Hence, we sought to guard against *both* type I and type II errors, while also recognizing the high level of uncertainty in the data. Our way of achieving this was to use not one, but two $p$-values, creating a statistical outcome of "inconclusive" for probabilities falling between them. This reflects the fact that for the purposes of the analysis performed to detect trends in stages for specific discharges, there is no safe side onto which to put the risk of making either a type I or type II error. The result is that, in deciding whether or not to reject the null or alternative hypotheses, we sought a clear indication from the statistics; and where we didn't find a clear indication, we logically deemed the test to have been *inconclusive*. That seemed, and still seems, sensible to us.

The authors note that, notwithstanding his criticisms of our paper, Dr. Pinter (Pinter et al. 2010) agrees that levee construction *has* raised flood elevations in the Middle Mississippi River, and we recommend that interested readers access the large and rich body of literature debating the extent to which engineering interventions (including levees) are responsible for some, though not all, of the observed flood-level increases in the Middle Mississippi River and elsewhere.

We are encouraged by the fact that Dr. Pinter chooses to close his discussion by recognizing the legitimacy of our discussion of different approaches to specific gauge analysis (i.e., the rating curve and direct step approaches). We are flattered that he believes current dike construction projects on the Mississippi River rely on the published paper and Watson and Biedenharn (2009) as the "*central demonstration that large-scale new dike fields will not impact flood levels*," though we must point out that this is not actually true. Professional Engineers with the U.S. Army Corps of Engineers and related federal (and state) agencies charged with design and construction of river-training works conduct thorough analyses for all federally-funded projects, and it is inconceivable that they would rely on the results of one academic paper and a single research report.

That said, the authors cannot but agree with Dr. Pinter that: "Sound engineering design, environmental assessment, and flood-risk management should be based on vigorous science rather than advocacy and misdirection." Further, we are confident that readers of the *Journal of Hydraulic Engineering* are sufficiently astute to differentiate between vigorous science and advocacy and misdirection in the papers, discussions, and closures selected for publication in this and other learned journals.

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# Closure to "Mississippi River Streamflow Measurement Techniques at St. Louis, Missouri" by Chester C. Watson, Robert R. Holmes Jr., and David S. Biedenharn

**DOI:** 10.1061/(ASCE)HY.1943-7900.0000752

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The writers welcome the discussion of the original paper. The discusser voices concern that the original paper did not include a literature review adequate to provide so-called outside readers with the proper context for the research reported in the original paper. The original paper covers all the data available to the writers and reviews of the methods and techniques of discharge measurement of which the writers are aware. The original paper did not include extended bibliographies and long tabulations of data that are available from referenced sources. All sources of data were clearly referenced in the original paper and the writers remain confident that it will satisfy the needs of the great majority of readers of the *Journal*.

The discusser states that the original paper asserts that Stevens (1979) identified systematic and significant differences between the performance of the AA, 61 cm (24 in.), and 91 cm (36-in.) Price meters. This is incorrect. At no point in the original paper is it asserted that Stevens (1979) indicated this point. What is stated in the original paper, and restated in this closure, is that the authors of the original paper found the Stevens (1979) data to generally indicate a discharge overestimation bias in pre-1933 discharge measurement methods that were employed prior to implementation of USGS standard methods.

The Stevens (1979) conclusion that, "an experienced person, using accepted techniques, can obtain excellent discharge determination using any of the velocity measuring vehicles" needs to be put in context and, in the writers' opinion, corrected. Stevens (1979) made some fundamental errors (in the writers' opinion) in the definition of what constitutes a so-called excellent discharge measurement. Stevens (1979, p. 38) considered all measurements within $\pm 10\%$ of the reference measurement to be excellent, basing this rationale (incorrectly, in the writers' opinion) on the statement that, "an excellent discharge measurement, according to WRD criteria, is within $\pm 5$ percent of the actual flow" [WRD is the Stevens (1979) reference to the USGS]. The USGS considers an excellent measurement to be within $\pm 2\%$ of the true discharge and, furthermore, considers measurements that differ from the true discharge by more than $\pm 8\%$ to be poor (Turnipseed and Sauer 2010). To illustrate this, consider that according to the Year 2014 St. Louis rating curve, a stage of 9.4 m (30 ft) corresponds to a discharge of 14,980 $m^3/s$ (529,000 $ft^3/s$). Varying that discharge by $\pm 10\%$ would result in a difference of no less than 1.46 m (4.8 ft) in the stage. This suggests that the Stevens (1979) conclusion concerning what constitutes an excellent discharge measurement is invalid; many of the gagings that Stevens (1979) considers excellent would more correctly be considered poor by current USGS standards.

The discusser states that large differences were found only in the discharge measurements based on surface floats. Whereas Stevens (1979) notes that 57% of the rod floats had differences greater than $\pm 10\%$ of the true discharge Stevens (1979) also found serious errors in boat meter measurements, stating that 34% of the boat meter measurements (made using pre-1933 methods and equipment) were in error by more than $\pm 5\%$ but less than $\pm 10\%$, while 7% were in error by more than $\pm 10\%$. More importantly, the analysis in the original paper indicates that all pre-USGS standardization methods have a significant overestimation bias when compared to the post-1933 discharge gaging methods.

The original paper provides accounts of these early methods of discharge measurement; surface floats, ice cake, rod floats, and meters. In the discussion, it is stated that a large majority of early discharges were based on Price meters. This is incorrect, at least for measured discharges relevant to debate concerning the existence of historical trends in flood magnitudes and stages. Table 1 in the original paper shows that, for discharges greater than 11,330 $m^3/s$, meters were not used in the majority of the measurements until the last 5 years of the pre-1933 era, and that between 1866 and 1927 the majority of the measurements in this range were made using equipment other than meters.

The discusser suggests that the original paper was "... eschewing the several thousand meter-based and float-based discharges, including numerous paired measurements ..." The data used in the original paper were those having concurrent measurements of discharge with multiple techniques and in comparison with a Price AA meter using techniques developed by the USGS. Stevens (1979) and Ressegieu (1952) provided a total of hundreds of measurements. The writers are not aware of thousands of measurements meeting these criteria.

In closing, the discusser is thanked for interest in the paper while noting, but not responding to the wider discourse on possible trends in flood stages and the validity (or otherwise) of attempting to correct historical discharges measured using pre-USGS standard methods and equipment to account of bias. Discussion of the points raised in the discussion should (and no doubt will) continue, and the discusser's comments require no specific responses on the writers' part as they have no relevance to the original paper and because the writers believe that readers of the *Journal* can judge the merit of the discusser's arguments based on the substantive literature on this subject and their own cognizance of the issues raised in the discussion.

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# Attachment D

Conservation Organization Comments
On The
Regulating Works Project
Draft Supplemental Environmental Impact Statement (November 2016)

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IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF ILLINOIS

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| NATIONAL WILDLIFE FEDERATION, PRAIRIE RIVERS NETWORK, MISSOURI COALITION FOR THE ENVIRONMENT, RIVER ALLIANCE OF WISCONSIN, GREAT RIVERS HABITAT ALLIANCE, and MINNESOTA CONSERVATION FEDERATION,<br><br>Plaintiffs,<br><br>vs.<br><br>UNITED STATES ARMY CORPS OF ENGINEERS; LT. GENERAL THOMAS P. BOSTICK, Commanding General and Chief of Engineers, LT. GENERAL DUKE DELUCA, Commander of the Mississippi Valley Division of the Army Corps of Engineers,<br><br>Defendants. | CASE NO. 14-00590-DRH-DGW<br><br>**DECLARATION OF NICHOLAS PINTER, Ph.D. IN SUPPORT OF PLAINTIFFS' MOTION FOR PRELIMINARY INJUNCTION; EXHIBITS 1-3**<br><br>HEARING: TBD<br>TIME: TBD |

I, Nicholas Pinter, declare as follows:

**Professional Experience and Background**

1. I am a Professor in the Geology Department and Environmental Resources and Policy Program at the Southern Illinois University, and Director of the SIU's Integrative Graduate Education, Research and Training (IGERT) program in "Watershed Science and Policy." I have a Ph.D. (1992) from the University of California, Santa Barbara and an M.S. (1988) from Penn State University. I have authored, edited, or contributed to at least five books and authored over 39 peer-reviewed, published scholarly articles in rivers, flood hazard, and related fields.

2. My primary field of expertise is in earth-surface processes (geomorphology) applied to a broad range of theoretical questions and practical applications. Much of my recent work focuses on rivers, fluvial geomorphology, flood hydrology, and floodplains. This research includes field-based work, modeling, and significant public-policy involvement.

3. My lab uses hydrologic and statistical tools, 1D and 2D hydraulic modeling, and loss-estimation modeling to quantify the impacts of river and floodplain engineering, and to assess regional floodplain management strategies and mitigation solutions. My research group has also compiled a large NSF-funded GIS database of over 100 years of channel hydrography, floodplain topography, and engineering construction and infrastructure on over 2500 miles of the Mississippi and Missouri Rivers in order to empirically test the causal connections between channel and floodplain modifications and flood response. Another recent NSF-funded project assessed the impacts of progressive levee growth along the Mississippi River through hydraulic modeling of multiple calibrated time steps and multiple change conditions.

4. My research group also runs a series of FEMA-funded grants doing hazard modeling and mitigation planning across the central United States. To date, the group has completed more than 40 FEMA disaster mitigation studies, and we have a number of new plans and plan updates on-going. One principal modeling tool is the Hazus-MH package that, along with various GIS-based and modeling tools, allows estimation of disaster damages and effects for a range of hazards and disaster scenarios. This modeling capability nicely bridges the gap between pure hydrologic and hydraulic analyses (as well as site-specific earthquake studies) and broad societal impacts.

5. My Curriculum Vitae is attached hereto as Exhibit 1.

**Documents Reviewed for this Declaration**

6. I am familiar with the literature regarding the morphology and dynamics of the Mississippi and other rivers and the interaction between river engineering structures and floods, including the studies cited in Appendix A, Summary of Research on the Effects of River Training Structures on Flood Levels, to the Final Environmental Assessments with Finding of No Significant Impact prepared by the U.S. Army Corps of Engineers ("Corps") for the Dogtooth Bend, Monsenthein/Ivory Landing, and Eliza Point/Greenfield Bend projects, and the Draft Environmental Assessment and Unsigned Finding of No Significant Impact for the Grand Tower project.

7. I have reviewed the Environmental Assessments with Finding of No Significant Impact for the Dogtooth Bend, Monsenthein/Ivory Landing, and Eliza Point/Greenfield Bend projects, and the Draft Environmental Assessment and Unsigned Finding of No Significant Impact for the Grand Tower project.

**Analysis**

8. I have been asked to form an independent professional opinion as to whether building new river training structures, including those planned by the Corps in the Dogtooth Bend, Monsenthein/Ivory Landing, Eliza Point/Greenfield Bend, and Grand Tower projects, may pose a significant risk of irreparable harm to the natural environment and to people and the property of people who live, work, attend school, or recreate in the floodplains, including by raising flood stage heights on the Mississippi River. As discussed in the following analysis, I conclude that the Corps' proposed projects, and river training structures generally, do pose such a risk.

9. Damages from floods worldwide have risen dramatically over the past 100 years (Munich Re Group, 2007). While much of this increase is due to economic development in floodplains (Pinter, 2005; Pielke, 1999), it is also clear that flooding itself has physically increased in magnitude and frequency on many rivers, including the Mississippi River. (Pinter et al., 2006a; Pinter et al., 2006b; Helms et al., 2002). Historical time series of stage data, which are

unequivocally homogenous over time (Criss and Winston, 2008), show strong and statistically significant increases of flood heights on the Mississippi River over time.

10. A number of processes can lead to flood magnification or otherwise alter flood response in a river basin. These include climate change, agricultural practices, forestry practices, urbanization, road construction, construction of other impervious surfaces, loss of wetlands, decreases in floodplain storage areas, construction and operation of dams, and modifications and engineering of river channels. The range of these changes can alter the volume and timing of runoff (discharge or flow of water) entering and moving through river systems. In addition, other natural or human-induced changes to river channels and their floodplains can alter the conveyance of flow with the river channels, resulting in increases or decreases in water levels (including flood stages) for the same discharge.

11. The Mississippi River has been intensively engineered by the Corps over the past 50 to 150-plus years (depending on the reach), and some of these modifications are associated with large decreases in the river's capacity to convey flood flows. Numerous scientific investigations including Corps reports, some dating back to the 1950s, have noted large increases in flood levels in association with wing-dike construction. For example, investigators recognized as early as 1952 that "the carrying capacity of the river has been decreased so materially by the [river training] work that floods have occurred at such points as Waverly, Boonville and Hermann, Mo., at lower gauge readings with smaller volumes of water than the 1929 flood stage." (Schneiders, 1996 at 346). These investigations have prompted some agencies to rethink their river management strategies. In the Netherlands, for example, the government has begun modifying river training structures on the Rhine River to reduce this recognized risk. General Accounting Office, "Mississippi River: Actions Are Needed to Help Resolve Environmental and Flooding Concerns about the Use of River Training Structures (December 2011) ("GAO Report") at 41. To date, however, the Corps has never addressed in an EIS the vast body of peer-reviewed, independent research showing that river-training structures increase flood heights. *Id.*

12. My research has looked extensively at the extent and causes of flood magnification, particularly on the Mississippi River. This research documents that climate, land-use changes, and

river engineering have contributed to statistically significant increases in flooding along portions of the Mississippi River system. However, the most significant cause of flood height increases on the Middle Mississippi River and Lower Missouri River can be traced to the construction of wing dikes and other river training structures. Indeed, flood height increases on those river segments exceed by a factor of ten the maximum credible increases that could be expected from climate-driven and land-cover-driven flow increases (e.g., Pinter et al., 2008). The large multivariate study by Pinter et al. (2010) identified the age, location, and extent of every large levee system added to the Mississippi-Lower Missouri system during the past century, documenting that levees do contribute some but not all of the observed flood-level increases on the Middle Mississippi and elsewhere (confirming modeling by Remo et al., 2009; see Exhibit 2 to this declaration).

13. Recent theoretical analysis has shown that increased flood levels caused by wing-dike construction are "consistent with basic principles of river hydro- and morphodynamics" (Huthoff et al., 2013). This study concluded that even with extremely conservative parameters used in modeling, "the net effect of wing dikes will be higher flood levels." *Id.*

14. This theoretical analysis is supported by empirical studies that have utilized hydrologic analyses; rigorous statistics; geospatial analyses; and 1D, 2D, and 3D hydraulic modeling to confirm, empirically as well as theoretically, the potential for significant increases in flood levels in response to the dense emplacement of wing-dike structures, such as employed on the Middle Mississippi River. Among this body of research, my research group was funded by the National Science Foundation to construct two large river-related databases to rigorously test for trends in flood magnitudes over time on over 4000 kilometers (over 2400 miles) of the Mississippi and Missouri Rivers, and to quantify the impacts on flood levels from each unit of channel and floodplain infrastructure construction or other change.

15. Our hydrologic database consists of more than 8 million discharge and river stage values, including new synthetic discharges generated for 41 stage-only stations. This hydrologic database was used to test for significant trends in discharges, stages, and ''specific stages.'' We also conducted an extensive review of the validity of using discharge data taken from different types of measurement devices (float meters vs. other types of meters). Pinter (2010) tested whether

it was appropriate to utilize older discharge measurements by examining 2150 historical discharge measurements digitized from the three principal stations on the Middle Mississippi River (MMR), including 626 float-based discharges and 1516 meter-based discharges, and including 122 paired measurements. All statistical tests we performed demonstrated that it was appropriate to utilize both older historical discharge data and newer discharge data as those different types of measurement tools produced accurate discharge measurements.

16. Our geospatial database consists of the locations, emplacement dates, and physical characteristics of over 15,000 structural features constructed along the study rivers over the past 100 to 150 years. In developing this database we utilized: more than 4000 individual map and survey sheets; structure-history databases from six Corps Districts; databases from other agencies including the Coast Guard; and archival maps and surveys digitized and calibrated into a modern coordinate system and frame of reference. Within this database we parameterized 130 bridges, 54 dam structures, 25 artificial meander cut-offs, 1093 levees, and 13,231 wing-dam segments, among many other structures.

17. Together these two databases were used to generate reach-scale statistical models of hydrologic response. These models quantify changes in flood levels at each station in response to construction of wing dikes, bendway weirs, meander cutoffs, navigational dams, bridges, and other river modifications.

18. Our analyses show that while climate and other land-use changes did lead to increased flows, *the largest and most pervasive contributors to increased flooding on the Mississippi River system were wing dikes and related navigational structures*. In contrast, large reaches of the Mississippi and Missouri Rivers with little or no dike construction showed *no* significant increases in flood levels. System-wide, the hydrologic pattern was that large-scale increases in flood levels occurred when and where large numbers of dikes and dike-like structures have been built. Progressive levee construction was the second largest contributor.

19. Our analyses demonstrate that wing dikes constructed downstream of a location were associated with increases in flood height ("stage"), consistent with backwater effects upstream of these structures. Backwater effects are the rise in surface elevation of flowing water upstream

from, and as a result of, an obstruction to water flow. These backwater effects were clearly distinguishable from the effects of upstream dikes, which triggered simultaneous incision and conveyance loss at sites downstream. On the Upper Mississippi River, for example, stages increased more than four inches for each 3,281 feet of wing dike built within 20 RM (river miles) downstream. These values represent parameter estimates and associated uncertainties for relationships significant at the 95 percent confidence level in each reach-scale model. The 95-percent level indicates at least a 95% level of certainty in correlation or other statistical benchmark presented, and is considered by scientists to represent a statistically verified standard. Our study demonstrated that the presence of river training structures can cause large increases in flood stage. For example, at Dubuque, Iowa, roughly 8.7 linear miles of downstream wing dikes were constructed between 1892 and 1928, and were associated with a nearly five-foot increase in stage. In the area affected by the 2008 Upper Mississippi flood, more than six feet of the flood crest is linked to navigational and flood-control engineering.

20. More than 143 linear miles of wing dikes have been constructed on the Middle Mississippi River over the past 100 years (Remo and Pinter 2007; Remo et al. 2008). This represents about 3,960 feet of wing dikes per mile (or about 2,460 feet per kilometer) of channel. Wing dikes have also been heavily utilized on the Lower Missouri River, with over 383 linear miles constructed since 1890. This represents nearly 3,700 feet of wing dike per mile (or about 2,300 feet per kilometer) of channel in the Lower Mississippi River. These and similar river training structures are utilized to assist in river bank protection and stimulate channel scour which can reduce the amount of dredging required to maintain adequate navigation depths (e.g. COPRI 2012).

21. The effects of wing dikes and other structures during flooding should not be confused with effects during periods of low flow. There is general agreement that during low in-channel flows, wing dikes lead to lowered water levels. This happens because the dikes cause channel incision, which is a process of channel adjustment by which channel flow removes sediment from the stream bed and ultimately establishes a lower bed elevation. Channel incision is a process that has been well documented after dike construction in many (but not all) areas of the alluvial Mississippi and Missouri Rivers (e.g., Pinter and Heine 2005; Maher 1964).

22. For example, water levels at St. Louis measured during periods of low to average flows have decreased over a period of about 60 years. This decrease reflects the well documented effects of dike construction (also dredging) that has constricted the channel, eroded the channel bed, and thus lowered such non-flood water levels. Downstream at the Chester and Thebes measurement stations, water levels have also decreased during low flows, but they have risen for all conditions from average flows up to large floods. At Grand Tower, Illinois, water levels for just average flows have increased by almost three feet due to dike and weir construction. Near Grand Tower, bedrock underlies parts of the Middle Mississippi channel and limits incision (Jemberie et al. 2008). At all of these locations, *at flood flows* (flows equal to four or more times the average annual discharge level), *water levels have increased by three to ten feet or more.*

23. Many other studies confirm and corroborate these findings. Particularly after the record-breaking floods on the Middle Mississippi, researchers sought to answer why such large increases in flood levels had occurred for the same discharges (volumes of flow) that had been observed in the past. (e.g., Belt 1975; Stevens et al. 1975). Since then, multiple studies involving hydrologic time-series analyses, statistical analyses, geospatial analyses, and hydraulic modeling have correlated the timing and spatial distribution of dike construction with increases in flood stages (e.g., Criss and Shock 2001; Wasklewicz et al. 2004; Jemberie et al. 2008; Pinter et al. 2008; Remo et al. 2009; Pinter et al. 2010, and others).

24. Wing dikes and other river training structures increase flood heights during high water because of the way they interact with river flow and the way they change the shape and form of the river channel. Since the beginning of historical “training” (engineering of the river to facilitate navigation) of the Mississippi and Missouri rivers, construction of dikes has narrowed large portions of these river channels to one-half or less of their original width. In addition, construction of dikes, bendway weirs, and other in-channel navigational structures has increased the "roughness" of the channel, leading to decreased flow velocities during floods.

25. Channel roughness is a measure of objects and processes that cumulatively resist the flow of water through a given reach of a river, including drag effects of sedimentary grains, bedforms (e.g., ripples and dunes on the bed), vegetation, turbulence, eddy circulation, and many

others. A rough river bed exerts more resistance than a smooth river bed, resulting in slower flow of water. All other factors being equal, a flood that passes through a river reach with half the average flow velocity will result in average water depths that are double what they would otherwise be.

26. Recent modeling studies demonstrate the significant effects of flow turbulence and large-scale vertical and horizontal eddy circulation (Huthoff et al., 2013) of river training structures during flood events. Other recent studies have focused on flow dynamics around submerged wing dikes and their impact on channel flow resistance (e.g., Yossef 2005; Yossef and de Vriend 2011; Azinfar and Kells 2011). These studies show that submerged wing dikes create flow mixing in their wake zones (e.g., Yossef 2005; Yeo and Kang 2008; Jamieson et al. 2011). These recirculating flows consume energy from the bulk flow field, causing increases in effective resistance near wing dikes and through wing-dike fields. The impact of wing dikes on flow resistance was quantified by Yossef (2004, 2005), whose proposed relationship allows for an initial assessment of wing-dike impact on water levels (e.g., Azinfar 2010). According to Yossef's laboratory experiments, the effective cumulative hydraulic roughness of the bank zone relates to the size and longitudinal distance between the wing dikes.

27. The role of river training structures in increasing flood heights is well recognized. For example, in the Netherlands, the impacts of wing dikes (navigational "groynes") on flood levels have both been recognized and taken into account in flood protection strategies. The government of the Netherlands recently completed a €45 million program to lower 450 wing dikes (groynes) on the Rhine system as part of its strategy to reduce flood levels.

28. Changes in channel geometry and roughness related to river engineering tools employed for improved navigation and flood control are the principal drivers behind changes in flood stage on the Mississippi River. The increases in flood stage are caused by both the direct effects of wing dikes, meaning interaction with flow, and the indirect effects of wing dikes, meaning the effects of the wing dike in changing the shape or form of the river bed. Hydrodynamic simulations of indirect and direct effects of wing dikes show decreases in velocity, increases in roughness, and corresponding increases in flood stage.

29. River training structures constructed by the Corps to help maintain the nine-foot navigation channel have caused large-scale increases in flood levels, up to 15 feet in some locations and by some measures, and six to ten feet over broad stretches of the river where these structures are prevalent. Such large increases in flood heights in these rivers have occurred when and where – and only when and where – wing dikes, bendway weirs, and other river training structures have been built. These structures have led to significant increases in the frequency and magnitude of large floods.

30. The projects now proposed on the Middle Mississippi River are particularly problematic for several reasons. First, as mentioned above, bedrock underlies parts of the Middle Mississippi channel near the Grand Tower project, which limits incision (Jemberie et al. 2008). In such locations, the ameliorating effect of new wing dikes in causing bed incision is reduced or eliminated, leading in the past to the largest observed increases in flood levels.

31. The new dike construction projects now proposed on the Middle Mississippi are also problematic because they threaten nearby levees that already have identified deficiencies. The Dogtooth Bend Project is immediately downstream of one of the sites where the Len Small levee failed during floods in 2011 (Dogtooth Bend EA at E2). This 5,000-foot breach yielded to fast-moving water that "scored farmland, deposited sediment, and created gullies and a crater lake" (K.R. Olson and L.W. Morton, "Impacts of 2011 Len Small levee breach on private and public Illinois lands," *Journal of Soil and Water Conservation*, Vol. 68:4, attached as Exhibit 3).

32. The proposed Grand Tower project spans approximately seven River Miles along the Big Five Levee Drainage and Levee Districts, including the Preston, Clear Creek, East Cape, and Miller Pond levees, together protecting over 49,000 acres of Illinois floodplain. The proposed Grand Tower wing dike project also lies just downstream of the Degognia/Fountain Bluff and Grand Tower Drainage and Levee Districts, protecting a further 56,000 acres. Currently, every segment of these levee systems have "Unacceptable" ratings following Corps inspections and assessment. The Dogtooth Bend Project likewise poses an unusually high potential for flood damage. The Cairo levee system ("Mississippi and Ohio Rivers Levee System at Cairo & Vicinity") is located a few miles downstream of the Dogtooth Bend Project. Although the greatest

effects of wing dikes occur upstream, statistically significant increases in flood levels have also been identified downstream. Corps inspections have identified major deficiencies in the Cairo levee system, leading to its current "Unacceptable" rating in the National Levee Database.

33. My work with local levee commissioners and other informed officials has revealed deep concern and widespread discussion about levee safety and performance during future floods, even without additional stresses. For at least the past decade, local stakeholders have repeatedly called for the St. Louis District of the Corps of Engineers to rigorously and independently assess the cumulative impacts of wing-dike construction in the Middle Mississippi River. Instead, a new wave of dike construction has been undertaken, with each new project evaluated – perfunctorily – on an individual basis and without regard to cumulative effects.

34. The new dike construction projects here – at Dogtooth Bend, Monsenthein/Ivory Landing, Eliza Point/Greenfield Bend, and Grand Tower – pose significant threats of increased flooding and flood risk. They are the latest manifestations of a flawed process that has allowed construction of hundreds of new dikes and dike-like structures that are causing elevated flood stages throughout the Middle Mississippi River. Unless these new dike construction projects are halted to allow their reconsideration based on a comprehensive Supplemental Environmental Impact Statement that takes the foregoing studies and analyses into consideration, needless and potentially severe flooding will likely occur.

35. I declare under penalty of perjury that the foregoing facts are true of my personal knowledge, that the foregoing expressions of professional judgment are honestly held in good faith, that I am competent to and if called would so testify, and that I executed this declaration on June 24, 2014 in Chicago, Illinois.

Nicholas Pinter

Nicholas Pinter, Ph.D

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Yeo, H.K., and J.G. Kang, 2009. Flow analysis around a submerged groyne. Advances in water resources and hydraulic engineering, Vol. 5, Springer, Berlin, 1762–1766.

Yossef, M.F.M., 2004. The effect of submergence level on the resistance of groynes—An experimental investigation. Advances in hydroscience and engineering (CD-ROM), National Center for Computational Hydroscience and Engineering, University, MS.

Yossef, M.F.M., 2005. Morphodynamics of rivers with groynes, Delft University Press, Delft, The Netherlands.

Yossef, M.F.M., and H.J. De Vriend, 201. Flow details near river groynes: Experimental investigation. Journal of Hydraulic Engineering 137: 504–516.

EXHIBIT
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## EDUCATION

1988 - 1993 PhD., Geology, University of California, Santa Barbara
1986 - 1988 M.S., Geology, Penn State University, Univ. Park, PA
1982 - 1986 B.A., Geology and Archaeology, Cornell University, Ithaca, NY

## RESEARCH AREAS

- Geomorphology: the geology of the earth-surface
- Human influences on landscapes and geomorphic processes
- Rivers, flooding, and floodplain management

## PROFESSIONAL POSITIONS

1996 - Full Professor (since 7/05), Southern Illinois University
Author: Prentice Hall and John Wiley & Sons
1995 -1996 Postdoctoral Researcher, Yale University

## RECENT HONORS/AWARDS

- 2013-2018: Fulbright Specialist, U.S. State Dept., Bureau of Educational and Cultural Affairs (roster)
- 2013: Nominee: W.K. Kellogg Foundation & APLU Engagement Award (to SIU Olive Branch team)
- 2012: Illinois Mitigation Award: Illinois Association of Floodplain and Stormwater Managers
- 2010: Marie Curie Fellowship (IIF), European Commission
- 2010: Fulbright Fellowship (declined; see above)
- 2009: Leo Kaplan Research Award, Sigma Xi, SIU Chapter
- 2008: SIU College of Science, Outstanding Researcher award
- 2007: Alexander von Humboldt Foundation, Germany Research Renewal Fellowship
- 2005, 2006: SIU nominee, Jefferson Fellows Program; National Academy of Sciences
- 2003 Friedrich Wilhelm Bessel Prize; Alexander von Humboldt Foundation
- 2002 John D. and Catherine T. MacArthur Foundation, Research and Writing Award
- 2000 Fulbright Foundation Fellowship
- 1999 Charles A. Lindbergh Foundation Prize

## BOOKS, WORKSHOPS, EDITED VOLUMES, and OTHER PROF. ACTIVITIES

**Invited Written Testimony:** Statement submitted for hearings entitled "A Review of the 2011 Floods and the Condition of the Nation's Flood Control Systems," before the Senate Environment and Public Works Committee, United States Senate, Washington DC, October 18, 2011.

**Panelist, U.S. National Academy of Science:** Committee on Missouri River Recovery and Associated Sediment Management Issues, 2008-2010.

**Associate Editor**: Environmental & Engineering Geoscience, Association of Environmental & Engineering Geologists, Denver, CO.

**Convener, American Association for the Advancement of Science Workshop:** Managing rivers and floodplains for the new millennium. AAAS national meeting, 2006.

**External Reviewer, National Research Council, The National Academies:** Review of the U.S. Army Corps of Engineers Restructured Upper Mississippi River-Illinois Waterway Navigation Study.

**Member, Advisory Board**: The Nature Conservancy Great Rivers Center (Upper Mississippi, Parana-Paraguay, and Upper Yangtze River systems).

**Lead Editor**: Pinter, N., G. Grenerczy, J. Weber, S. Stein, and D. Medak, 2006. The Adria Microplate: GPS Geodesy, Tectonics, and Hazards. Spring Verlag.

**Expert Witness**: e.g., B&H Towing, Inc., Case No. 06-05-0233 (U.S. District Court, Southern District of W. Virginia); Great Rivers Habitat Alliance v. U.S. Army Corps of Engineers, No. 4:05-CV-01567-ERW (U.S. District Court, Eastern District of Missouri); Great Rivers Habitat Alliance v. City of St. Peters, No. 04-CV-326900 (Circuit Court of Cole County, Missouri); Henderson County Drainage District No. 3 et al. v. United States, No. 03-WL-179780 (Ct. Fed. Cls, Kansas City), etc.

**Associate Editor**: Geomorphology, Elsevier Science, 2004-2008

**Instructor, European Union Advanced School on Tectonics**: 3D Monitoring of Active Tectonic Structures, International Centre for Theoretical Physics, Trieste, April 18-22, 2005.

**Convener, NATO Advanced Research Workshop**: The Adria microplate: GPS geodesy, tectonics, and hazards. Veszprém, Hungary; April, 2004.

**Convener, Pardee Keynote Symposium**: Pinter, N., and J.F. Mount, 2002, Flood hazard on dynamic rivers: Human modification, climate change, and the challenge of non-stationary hydrology. Geological Society of America national meeting, 2002.

**Author**: Keller, E.A. and N. Pinter, 2002. Active Tectonics: Earthquakes and Landscape. Prentice-Hall.

**Co-Editor**: Burbank, D.W., and N. Pinter, 1999. Landscape evolution: The interactions of tectonics and surface processes. Basin Research, vol. 11, num. 1.

**Author**: Pinter, N, 1996. Exercises in Active Tectonics. Prentice Hall.

**Convener and Instructor**: Pazzaglia, F.J., and N. Pinter, 1996. Geomorphic expression of active tectonics. Short course at the 1996 Geological Society of America meeting, Denver.

**Convener, Theme Session**: N. Pinter, and D.W. Burbank, 1996. Feedbacks between tectonics and surface processes in orogenesis. Geological Society of America meeting, Denver.

**Author**: Pinter, N., and S. Pinter, 1995. Study Guide for Environmental Science. J. Wiley & Sons.

## REFERENCES

| | | | |
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| Thomas Gardner | Trinity University, San Antonio, TX 78212 | tgardner@trinity.edu | 210-736-7655 |
| Edward Keller | Univ. of California, Santa Barbara, CA 93106 | keller@geol.ucsb.edu | 805-893-4207 |
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## FUNDED PROJECTS

**Active**: NSF Infrastructure Management for Extreme Events: Community resilience through pro-active mitigation in the rural Midwest.

**Active**: NSF IGERT: Multidisciplinary, team-based training watershed science and policy. (Lead PI: Pinter; $3.2 million) **+ International Supplement**

**Active**: FEMA: Illinois multi-hazard mitigation initiative (Lead PI: Pinter; with Indiana University-Purdue University at Indianapolis). ~40 awarded + ~12 pending.

NSF RAPID: A massive floodplain reconnects: physical and biotic responses of the Birds Point levee breach in the Mississippi River (J. Garvey, lead PI).

IEMA: Illinois statewide flood-hazard assessment (J. Remo, lead PI).

Walton Family Foundation: Olive Branch, IL Relocation Initiative: Community Disaster-Recovery Networking

NSF Sedimentology and Paleobiology program: Testing hypotheses of latest Pleistocene paleo-environmental collapse, Northern Channel Islands, California (Lead PI: Pinter; collaborative project with Northern Arizona University; Univ. of Oregon)

Emergency Management Institute curricula: HAZUS-MH for earthquakes.

U.S. Steel: Levee-breach modeling, Metro East Drainage and Levee District area.

European Commission, Marie Curie IIF Program: Early anthropogenic signatures on landscapes: geomorphic, paleobotanical, and other paleo-environmental fingerprints.

NSF, Geography and Regional Science: A multivariate geospatial model of levee impacts on flood heights, Lower Mississippi River + **International Supplement** awarded

National Geographic Society: Testing a hypothesis of latest Pleistocene paleo-environmental collapse, Northern Channel Islands, California.

USGS Upper Midwest Environmental Sciences Center: Development of a virtual hydrologic and geospatial data repository for the Mississippi River System

NSF, Office of International Science and Engineering: U.S.-Chile: Morphotectonic evolution of the U.S.-Chile: Mejillones Peninsula, northern Chile using precise GPS measurement of uplifted coastal terraces

NSF Hydrologic Sciences Program: Multivariate geospatial analysis of engineering and flood response, Mississippi River System, USA.

NSF, International Science and Engineering: US-Chile cooperative research on the Cenozoic paleoceanographic and paleoclimatic evolution of northern and central Chile. (Ishman and Pinter)

NATO Science Program: The Adria microplate: GPS geodesy, tectonics, and hazards.

John D. and Catherine T. MacArthur Foundation: Exporting Natural Disasters: Flooding and Flood Control on Transboundary Rivers

NATO: The Adria Microplate: Postdoctoral Fellowship for Dr. G. Grenerczy.

USGS National Cooperative Geologic Mapping Program (6/03-5/04). Plio-Pleistocene Deposits of the White/Inyo Mountains Range Front, Inyo and Mono Counties, CA

Alexander von Humboldt Foundation: Human forcing of hydrologic change and magnification of flood hazard on German Rivers

NASA (9/01-8/02)). Assessing mass wasting and landslide susceptibility using GIS and remotely sensed imagery, Santa Cruz Island, California. (ESS Fellowship for E. Molander)

Association of State Floodplain Managers (9/01-8/02). Rapid revision of flood-hazard mapping. (Fellowship for R. Heine)

Missouri Coalition for the Environment (7/01-5/02). Hydrologic history of the Lower Missouri River.

NOAA Channel Islands National Marine Sanctuary (12/99-6/02). Orthorectification of 1997, pre-El Niño air-photo set from the California Channel Islands.

Petroleum Research Fund (7/99-10/01). Timing and rates of basin inversion from tectonic geomorph-ology, Pannonian Basin, Hungary. (**Supplement** [5/00-4/01] for an ACS-PRF Summer Fellow)

USGS National Cooperative Geologic Mapping Program (5/00-4/01). Mapping landslide susceptibility, Santa Cruz Island, California: A field- and GIS-based analysis.

National Park Service, Channel Islands National Park (4/00-9/00). Orthorectification of 1998, post-El Niño air-photo set from the California Channel Islands.

USGS National Cooperative Geologic Mapping Program (6/99-5/00). Mapping coastal terraces and Quaternary cover on Santa Rosa and San Miguel Islands, California, using dual-frequency kinematic GPS positioning.

NSF Active Tectonics Program (3/97-2/00), (**Supplement** granted). Testing models of fault-related folding, Northern Channel Islands, California.

NASA (9/00-8/01)). Assessing mass wasting and landslide susceptibility using GIS and remotely sensed imagery, Santa Cruz Islands, California. (ESS Fellowship for W.D. Vestal)

National Earthquake Hazards Reduction Program (7/97-12/99): Slip on the Channel Islands/Santa Monica Mountains Thrust. (**Supplement** granted)

NSF, Instrumentation and Facilities Program (8/97-7/99): Acquisition of a GIS-dedicated UNIX workstation laboratory.

SIU Office of Research Development (8/97-5/99). Effects of levee construction and channelization on stage-discharge flood response of the Upper Mississippi River.

National Research Council (1997). Active tectonics of the Pannonian Basin, Hungary.

National Earthquake Hazards Reduction Program (2/92-7/93). Latest Pleistocene to Holocene rupture history of the Santa Cruz Island fault. (with Ed Keller)

## PUBLICATIONS

**Books:** National Research Council, 2010. Missouri River Planning: Recognizing and Incorporating Sediment Management. National Academy Press: Washington, DC.

Pinter, N., G. Grenerczy, J. Weber, S. Stein, and D. Medak (eds.), 2006. The Adria Microplate: GPS Geodesy, Tectonics, and Hazards. Springer Verlag.

Keller, E.A. and N. Pinter, 2002. Active Tectonics: Earthquakes and Landscape, 2nd Edition. Prentice-Hall: Upper Saddle River, NJ.

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Pinter, N., and S. Pinter, 1995. Study Guide for Environmental Science. John Wiley & Sons: New York.

**Papers:** Huthoff, F., N. Pinter, and J.W.F. Remo, 2014. Reply to discussion of "Theoretical analysis of stage magnification caused by wing dikes, Middle Mississippi River, USA". Journal of Hydraulic Engineering, in press.

Huthoff, F., J.W.F. Remo, and N. Pinter, in press. Improving flood preparedness using hydrodynamic levee-breach and inundation modeling: Middle Mississippi River, USA. Journal of Flood Risk Management.

Pinter, N., S. Baer, L. Chevalier, R. Kowalchuk, C. Lant, and M. Whiles, 2013. An "IGERT" model for interdisciplinary doctoral education in water-related science and policy. Journal of Contemporary Water Research and Education, 150: 53-62.

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Remo, J.W.F., A. Khanal, and N. Pinter, 2013. Assessment of chevron dikes for the enhancement of physical-aquatic habitat within the Middle Mississippi River, USA. Journal of Hydrology, 501: 146-162.

Huthoff, F., H. Barneveld, N. Pinter, J. Remo, H. Eerden, 2013. Optimizing design of river training works using 3-dimensional flow simulations. In Smart Rivers 2013 (Conference Proceedings), Liege, Belgium and Maastricht , Netherlands, 23-27 September, 2013.

Remo, J.W.F., and N. Pinter, 2012. Hazus-MH earthquake modeling in the central USA. Natural Hazards, 63:1055–1081.

Dierauer, J., N. Pinter, J.W.F. Remo, 2012. Evaluation of Levee Setbacks for Flood-Loss Reduction, Middle Mississippi River, USA. Journal of Hydrology, 450: 1-8.

Pinter, N., J. Dierauer, J.W.F. Remo, 2012. Flood-damage modeling for assessing impacts of flood frequency adjustment, Middle Mississippi River, USA. Hydrologic Processes, 26: 2997–3002.

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Pinter, N., 2012. Early history of the Upper Mississippi River In Brad Walker (Ed.), Our Future? A Vision for a Land, Water and Economic Ethic in the Upper Mississippi River Basin, pp. 10-12. St. Louis: Missouri Coalition for the Environment.

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Heine, R.A., and N. Pinter, 2012. Levee effects upon flood levels: An empirical assessment. Hydrological Processes, 26: 3225–3240.

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Bormann, H., N. Pinter, and S. Elfert, 2011. Hydrological signatures of flood trends on German rivers: flood frequencies, flood heights and specific stages. Journal of Hydrology, 404: 50-66.

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Flor, A.D., N. Pinter, and J.W.F. Remo, 2010. Evaluating levee failure susceptibility on the Mississippi River using logistic regression analysis. Engineering Geology, 116: 139-148.

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Scott, A.C., N. Pinter, M.E. Collinson, M. Hardiman, R.S. Anderson, A.P.R. Brain, S.Y. Smith, F. Marone, and M. Stampanoni, 2010. Fungus, not comet or catastrophe, accounts for carbonaceous spherules in the Younger Dryas 'impact layer'. Geophysical Research Letters, 37: doi:10.1029/2010GL043345.

Pinter, N., A.A. Jemberie, J.W.F. Remo, R.A. Heine, and B.A. Ickes, 2010. Empirical modeling of hydrologic response to river engineering, Mississippi and Lower Missouri Rivers. River Research and Applications, 26: 546-571.

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Anderson, R.S., S. Starratt, R.B. Jass, and N. Pinter, 2009. Fire and vegetation history on Santa Rosa Island, Channel Islands: Long-term environmental change in southern California. Journal of Quaternary Science, DOI: 10.1002/jqs.

Pinter, N., 2009. Non-stationary flood occurrence on the Upper Mississippi-Lower Missouri River system: Review and current status. In R. E. Criss and Timothy M. Kusky (Eds.), Finding the Balance between Floods, Flood Protection, and River Navigation, pp. 34-40. Saint Louis University, Center for Environmental Sciences. Available online, URL: http://www.ces.slu.edu/.

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Jemberie, A.A., N. Pinter, and J.W.F. Remo, 2008. Hydrologic history of the Mississippi and Lower Missouri Rivers based upon a refined specific-gage approach. Hydrologic Processes, 22: 7736-4447, doi:10.1002/hyp.7046.

Pinter, N., and S.E. Ishman, 2008. Reply to comments on "Impacts, mega-tsunami, and other extraordinary claims." GSA Today, vol. 18(6): e14.

Szilagyi, J., N. Pinter, and R. Venczel, 2008. Application of a routing model for detecting channel flow changes with minimal data. Journal of Hydrologic Engineering, 13: 521-526.

Remo, J.W.F., N. Pinter, B. Ickes, and R. Heine, 2008. New databases reveal 200 years of change on the Mississippi River System. Eos, 89(14): 134-135.

Pinter, N., and S.E. Ishman, 2008. Impacts, mega-tsunami, and other extraordinary claims. GSA Today, 18(1): 37-38.

Remo, J.W.F, and Pinter, N., 2007. The use of spatial systems, historic remote sensing and retro-modeling to assess man-made changes to the Mississippi River System. In: Zaho, P. et al. (eds.), Proceedings of International Association of Mathematical Geology 2007: Geomathematics and GIS Analysis of Resources, Environment and Hazards. State Key Laboratory of Geological Processes and Mineral Resources, Beijing, China, pp. 286-288.

Bada, G., Grenerczy, G., Tóth, L., Horváth, F., Stein, S., Cloetingh, S., Windhoffer, G., Fodor, L., Pinter, N., Fejes, I., 2007. Motion of Adria and ongoing inversion of the Pannonian basin: Seismicity, GPS velocities and stress transfer. In: Stein, S., Mazzotti, S., (Eds.), Continental Intraplate Earthquakes: Science, Hazard, and Policy Issues. Geological Society of America Special Paper 425, p. 243–262, doi: 10.1130/2007.2425(16).

Remo, J.W.F., and N. Pinter, 2007. Retro-modeling of the Middle Mississippi River. Journal of Hydrology 337: 421-435.

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Pinter, N., 2006. New Orleans revival recipes. Issues in Science and Technology, 22(3): 5-6.

Pinter, N., and G. Grenerczy, 2006. Recent advances in peri-Adriatic geodynamics and future research directions. In N. Pinter, G. Grenerczy, J. Weber, S. Stein, and D. Medak (eds.), The Adria Microplate: GPS Geodesy, Tectonics, and Hazards, pp. 1-20. Springer Verlag.

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Pinter, N., 2005. Policy Forum: One step forward, two steps back on U.S. floodplains. Science, 308: 207-208.

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Pinter, N., and W.D. Vestal, 2005. El Niño-driven landsliding and postgrazing recovery, Santa Cruz Islands, California. Journal of Geophysical Research, 110, F2, doi. 10.1029/2004JF000203.

Pinter, N., and R.A. Heine, 2005. Hydrodynamic and morphodynamic response to river engineering documented by fixed-discharge analysis, Lower Missouri River, USA. Journal of Hydrology, 302: 70-91.

Schweigert, P., N. Pinter, and R.R. van der Ploeg, 2004. Regression analysis of weather effects on the annual concentrations of nitrate in soil and groundwater. Journal of Plant Nutrition and Soil Science, 167: 309-318.

Pinter, N., K. Miller, J.H. Wlosinski, and R.R. van der Ploeg, 2004. Recurrent shoaling and dredging on the Middle and Upper Mississippi River, USA. Journal of Hydrology, 290: 275-296.

Scott, A.T., and N. Pinter, 2003. Extraction of coastal terraces and shoreline-angle elevations from digital terrain models, Santa Cruz and Anacapa Islands, California. Physical Geography, 24: 271-294.

Gieska, M., R.R. van der Ploeg, P. Schweigert, and N. Pinter, 2003. Physikalische Bodendegradierung in der Hildesheimer Börde und das Bundes-Bodenschutzgesetz. Berichte über Landwirtschaft 81(4): 485-511.

Pinter, N., C.C. Sorlien, and A.T. Scott, 2003. Isostatic subsidence in response to thrust faulting and fold growth. American Journal of Science, 303: 300-318.

Pinter, N., and R. Thomas, 2003. Engineering modifications and changes in flood behavior of the Middle Mississippi River. In R. Criss and D. Wilson, (eds.), At The Confluence: Rivers, Floods, and Water Quality in the St. Louis Region, pp. 96-114.

Pinter, N., R. Thomas, and J.H. Wlosinski, 2002. *Reply* to U.S. Army Corps of Engineers *Comment* on "Assessing flood hazard on dynamic rivers." Eos: Transactions of the American Geophysical Union, 83(36): 397-398.

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Pinter, N., B. Johns, B. Little, and W.D. Vestal, 2001. Fault-related folding in California's Northern Channel Islands documented by rapid-static GPS positioning. GSA Today, 11(5): 4-9.

Pinter, N., R. Thomas, and N.S. Philippi, 2001. Side-stepping environmental conflicts: The role of natural-hazards assessment, planning, and mitigation. E. Petzold-Bradley, A. Carius, and A. Vincze (eds.), Responding to Environmental Conflicts: Implications for Theory and Practice, p. 113-132. Dordrecht: Kluwer Academic Publishers.

Lueddecke, S.B., N. Pinter, and S. McManus, 2001. Greenhouse effect in the classroom: A project- and laboratory-based curriculum. Journal of Geological Education, 49: 274-279.

Pinter, N., R. Thomas, and J.H. Wlosinski, 2000. Regional impacts of levee construction and channelization, Middle Mississippi River, USA. In J. Marsalek, W.E. Watt, E. Zeman, and F. Sieker (eds.), Flood Issues in Contemporary Water Management, p. 351-361. Dordrecht: Kluwer Academic Publishers.

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Pinter, N., C.C. Sorlien, and A.T. Scott, 1998. Late Quaternary folding and faulting of the Santa Cruz Island, California. In P.W. Weigand (ed.), Contributions to the Geology of the Northern Channel Islands, Southern California. Pacific Section, American Association of Petroleum Geologists: Bakersfield, CA, MP-45: 111-122.

Pinter, N., S.B. Lueddecke, E.A. Keller, and K. Simmons, 1998. Late Quaternary slip on the Santa Cruz Island fault, California. Geological Society of America Bulletin, 110: 711-722.

Lueddecke, S.B., N. Pinter, and P. Gans, 1998. Plio-Pleistocene ash falls, sedimentation, and range-front faulting along the White-Inyo Mountains front, California. Journal of Geology, 106: 511-522.

Pinter, N., and M.T. Brandon, 1997. How erosion builds mountains. Scientific American, 276(4): 74-79.

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Sorlien, C.C., and N. Pinter, 1997. Faulting and folding on Santa Cruz Island, California. In J.R. Boles and W. Landry (eds.), Santa Cruz Island Geology Field Trip Guide, San Diego: San Diego Association of Geologists, pp. 72-90.

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Pinter, N., and E.A. Keller, 1995. Geomorphic analysis of neotectonic deformation, northern Owens Valley, California. Geologische Rundschau, 84: 200-212.

Pinter, N., E.A. Keller, and R.B. West, 1994. Relative dating of terraces of the Owens River, northern Owens Valley, California and correlation with moraines of the Sierra Nevada. Quaternary Research, 42: 266-276.

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Gardner, T.W., D. Verdonck, N. Pinter, R.L Slingerland, K.P. Furlong, T.F. Bullard, and S.G. Wells, 1992. Quaternary uplift astride the aseismic Cocos Ridge, Pacific coast, Costa Rica. Geological Society of America Bulletin, 104: 219-232.

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Pinter, N., and E.A. Keller, 1991. Comment on "Surface uplift, uplift of rocks, and exhumation of rocks." Geology, 19: 1053.

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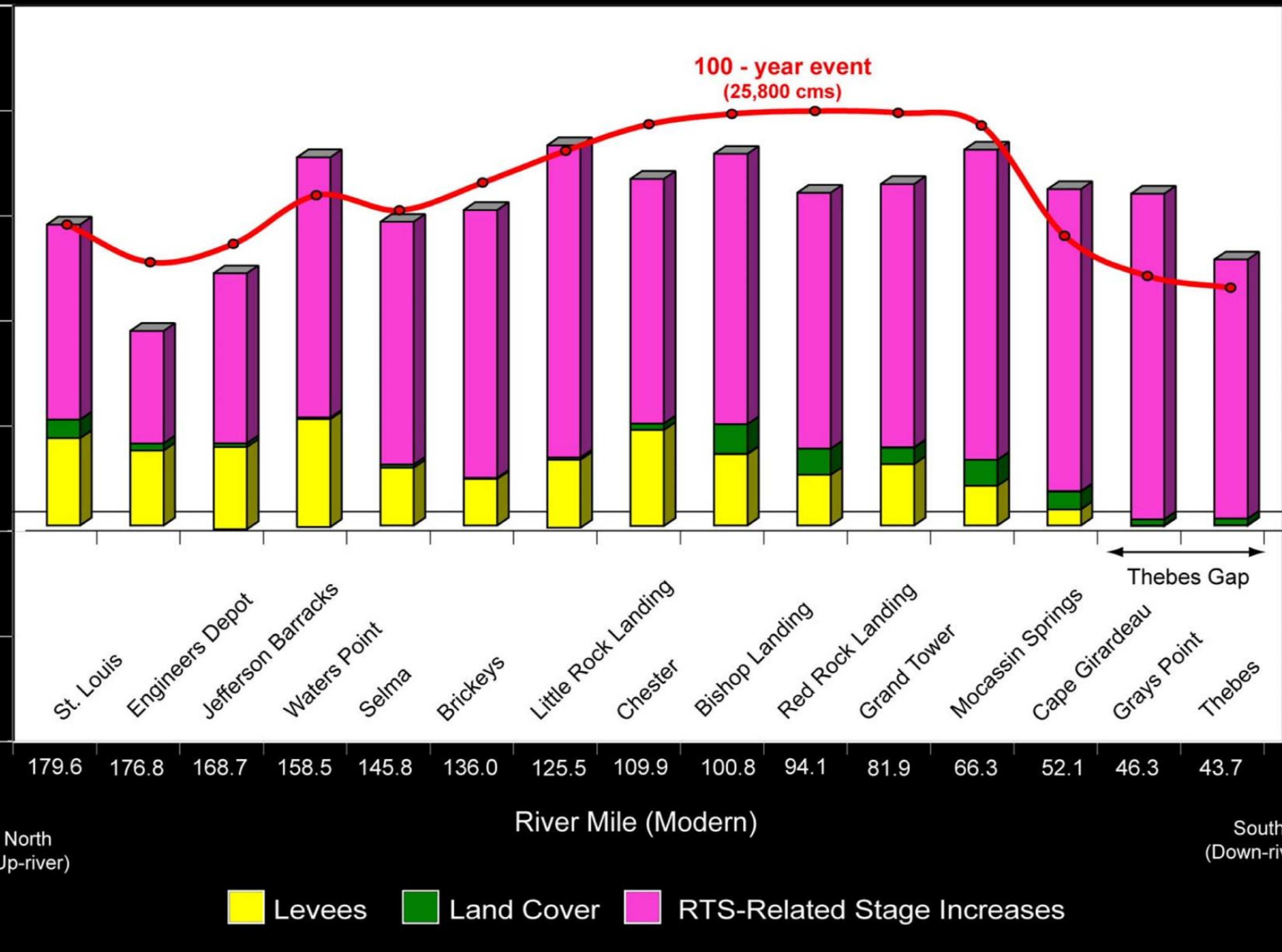
EXHIBIT
2


100 - year event
(25,800 cms)
Thebes Gap
St. Louis
Engineers Depot
Jefferson Barracks
Waters Point
Selma
Brickeys
Little Rock Landing
Chester
Bishop Landing
Red Rock Landing
Grand Tower
Mocassin Springs
Cape Girardeau
Grays Point
Thebes
179.6
176.8
168.7
158.5
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136.0
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109.9
100.8
94.1
81.9
66.3
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46.3
43.7
River Mile (Modern)
North
(Up-river)
South
(Down-river)
Levees
Land Cover
RTS-Related Stage Increases

EXHIBIT

3

doi:10.2489/jswc.68.4.89A

FEATURE

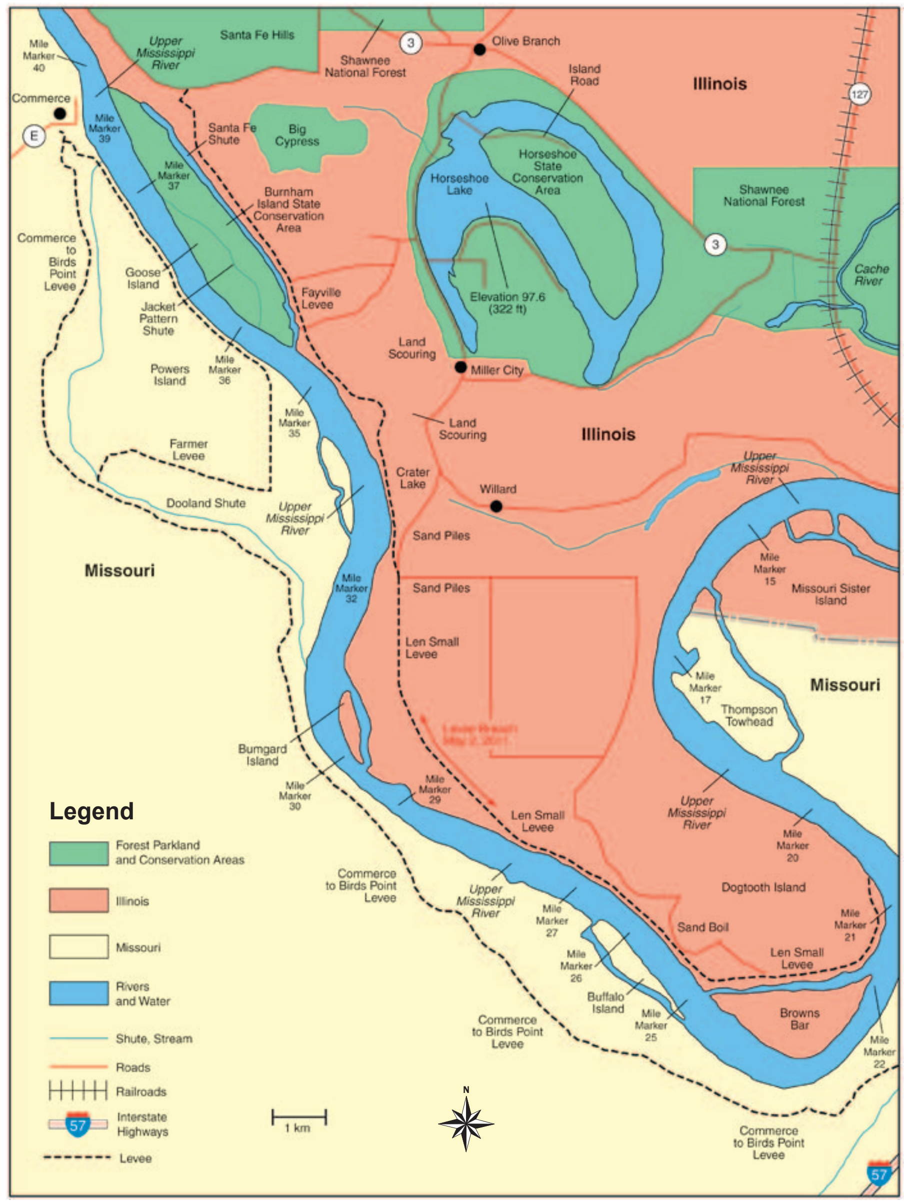
# Impacts of 2011 Len Small levee breach on private and public Illinois lands

Kenneth R. Olson and Lois Wright Morton

Agriculture, the dominant land use of the Mississippi River Basin for more than 200 years, has substantively altered the hydrologic cycle and energy budget of the region (NPS 2012). Extensive systems of US Army Corps of Engineers (USACE) and private levees from the Upper Mississippi River near Cape Girardeau, Missouri, southward confine the river and protect low-lying agricultural lands, rural towns, and public conservation areas from flooding. The Flood of 2011 severely tested these systems of levees, challenging public officials and landowners to make difficult decisions, and led to extensive damage to crops, soils, buildings, and homes. One of these critical levees (figure 1), the Len Small, failed, creating a 1,500 m (5,000 ft) breach (figure 2) where fast-moving water scoured farmland, deposited sediment, and created gullies and a crater lake. The Len Small levee, built by the Levee and Drainage District on the southern Illinois border near Cairo to protect private and public lands from 20-year floods, is located between mile marker 21 and mile marker 35 (figure 1). It connects to Fayville levee that extends to Mississippi River mile marker 39, giving them a combined length of 34 km (22 mi) protecting 24,000 ha (60,000 ac) of farmland and public land, including the Horseshoe Lake Conservation area. The repair of the breached levee, crater lake, gullies, and sand deltas began in October of 2011 and continued for one year.

**Figure 1**

Map of Alexander County, Illinois, including the Len Small levee and the northern part of the Commerce to Birds Point levee, Missouri, areas.




## HISTORICAL GEOLOGICAL FEATURES OF THE WESTERN ALEXANDER COUNTY

The Mississippi River is a meandering river of oxbows and cutoffs, continuously eroding banks, redepositing soil, and changing paths. Its willful historic meandering is particularly apparent in western Alexander County, Illinois, where a topographical map shows swirls and curves and an oxbow lake, Horseshoe Lake, where the river once flowed south of Thebes and east of the modern day Len Small levee. The loess-covered upland hills (Fehrenbacher et al. 1986) of the Shawnee National Forest just north of Route 3 (figure 1) give way to a low-lying plain between the Mississippi and Ohio rivers. The ancient Ohio River drained through the Cache River valley during the Altonian and Woodfordian glacial advances (60,000 to 30,000 years B.P.) and converged with the Mississippi River waters just northwest of Horseshoe Lake. The Cache River valley is 3 km (1.9 mi) wide and carried a substantive flow of water from the eastern Ohio River Basin

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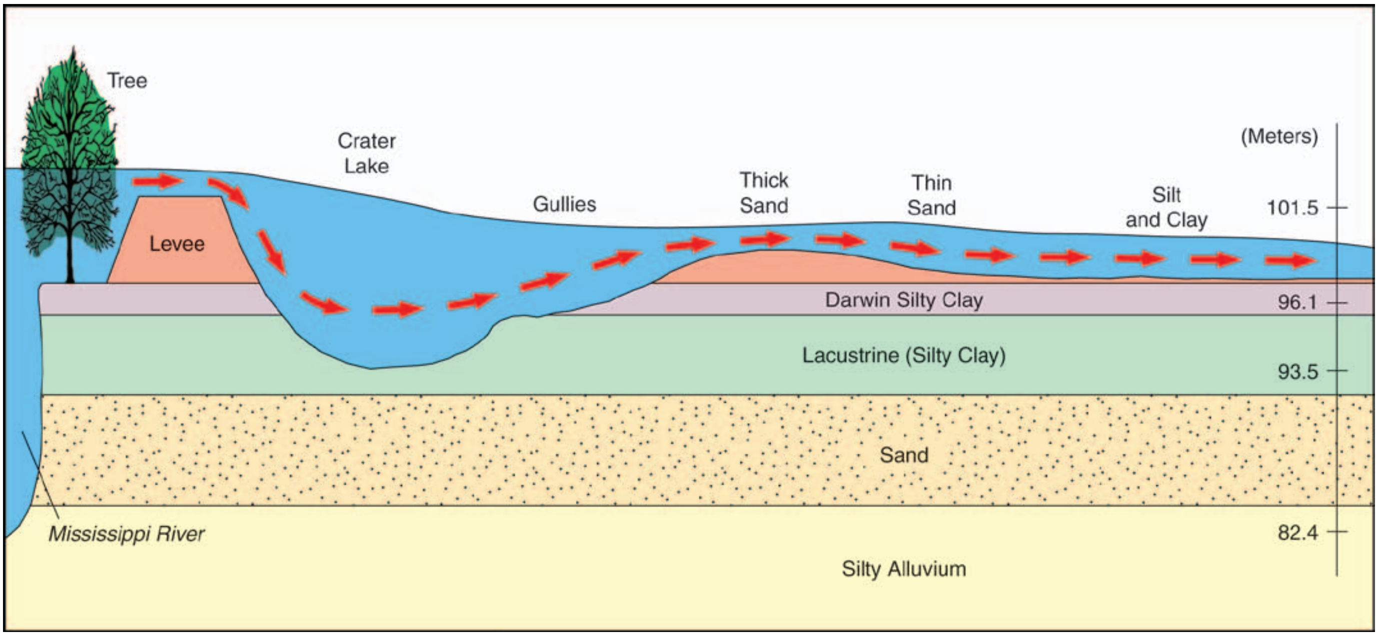
**Figure 2**

Diagram of Len Small levee failure and creation of crater lake, gullies, and sand delta.




in addition to the local waters from the Cache River valley into the Mississippi River valley. Historically, the region has been a delta, confluence and bottomlands dating back 30,000 to 800,000 years B.P., with many of the Illinois lands shown on the maps located on both sides of the Upper Mississippi River as its channel changed locations over time. As a result, the fertile farmland of western Alexander County soils formed in alluvial and lacustrine deposits.

Horseshoe Lake (figure 3), a former oxbow and remnant of a large meander of the Mississippi River, is now a state park of 4,080 ha (10,200 ac) (Illinois DNR 2012). This oxbow lake, formerly a wide curve in the river, resulted from continuous erosion of its concave banks and soil deposition on the convex banks. As the land between the two concave banks narrowed, it became an isolated body of water cutoff from the main river stem through lateral erosion, hydraulic action, and abrasion. With 31 km (20 mi) of shoreline, the 1.3 m (4 ft) deep lake is the northernmost natural range for Bald cypress (*Taxodium distichum* L.) and Tupelo (*Nyssa* L.) trees (figure 3) and has an extensive growth of American lotus (*Nelumbo lutea*), a perennial aquatic plant, and native southern hardwoods which grow well in lowlands and areas which are subject to seasonal flooding.

**Figure 3**

The bald cypress trees and American lotus at Horseshoe Lake conservation area.

The agricultural lands which surround this oxbow lake are highly productive alluvial soils —mostly Weinbach silt loam, Karnak silty clay, Sciotoville silt loam, and Alvin fine sandy loam. Almost two-thirds of the area (16,000 ha [40,000 ac]) protected by the Len Small and Fayville levees is privately owned. Corn (*Zea mays* L.), soybeans (*Glycine max* L.), and wheat (*Triticum* L.) are the primary crops, with some rice (*Oryza sativa* L.) grown in this area.

## THE COMMERCE TO BIRDS POINT, CAIRO, AND WESTERN ALEXANDER COUNTY LEVEES

In early May of 2011, the floodwaters at the Ohio River flood gage in Cairo, Illinois, had reached 18.7 m (61.7 ft) (NOAA 2012). The Ohio River was 6.7 m (22 ft) above flood stage and had been causing a back-up in the Mississippi River floodwater north of the Cairo confluence prior to the USACE opening of the Birds Point–New Madrid Floodway. For more than a month, the Mississippi River back-up placed significant pressure on the Len Small and Fayville levees (figure 1). As a result, approximately 1,500 m (5,000 ft) of the Len Small levee was breached (figure 2) near mile marker 29 (figure 1) on the morning of May 2, 2011.

The flood protection offered by the Len Small and Fayville levees is important to the landowners, homeowners, and farmers in southwestern Alexander County, Illinois. However, the Len Small and Fayville levees are not the mainline levees which control the width and height of the Mississippi River. The controlling mainline levees are the frontline Cairo levee located in Illinois (Olson and Morton 2012a) and the Commerce to Birds Point levee in Missouri (figure 4). These two frontline levees, by design, are much higher and stronger than the Len Small and Fayville levees. The Len Small and Fayville levees were built by the local levee district and are not part of the Mississippi River and Tributaries project for which USACE has responsibility (figure 5). The Cairo levee has a height of 19.4 m (64 ft), or 101.4 m (334.5 ft) above sea level, and levee failure would destroy the City of Cairo. The frontline Commerce to Birds Point levee has a height of 19.8 m (65.5 ft), and its failure would result in more than 1 million ha (2.5 million ac) of agricultural bottomlands in Missouri Bootheel and Arkansas on west side of the Mississippi River being flooded (figure 5). Commerce to Birds Point levee connects to a setback levee on the west side of the Birds Point–New Madrid Floodway, which extends the protection another 51 km (33 mi) to the south where it joins the frontline levee at New Madrid, Missouri, further extending the protection of the Bootheel bottomlands (Camillo 2012; Olson and Morton, 2012a, 2012b, 2013). The failure of the Hickman (Kentucky) levee on the east side of the Mississippi River would have resulted in the flooding of 70,000 ha (170,000 ac) of protected bottomlands in Tennessee and Kentucky (figure 5). The floodwater height and pressure on the Commerce to Birds Point and Birds Point to New Madrid levees has increased over the years during Mississippi River flooding events with the construction of the Len Small and Fayville levees and with a strengthening of the levee near Hickman, Kentucky, which had the effect of narrowing the Mississippi River Floodway corridor and removing valuable floodplain storage areas for floodwaters.

**Figure 4**

The Commerce to Birds Point mainline US Army Corps of Engineers levee.

## THE MISSISSIPPI RIVER COMMISSION AND ITS ROLE IN LEVEE CONSTRUCTION ALONG THE MISSISSIPPI RIVER AND TRIBUTARIES

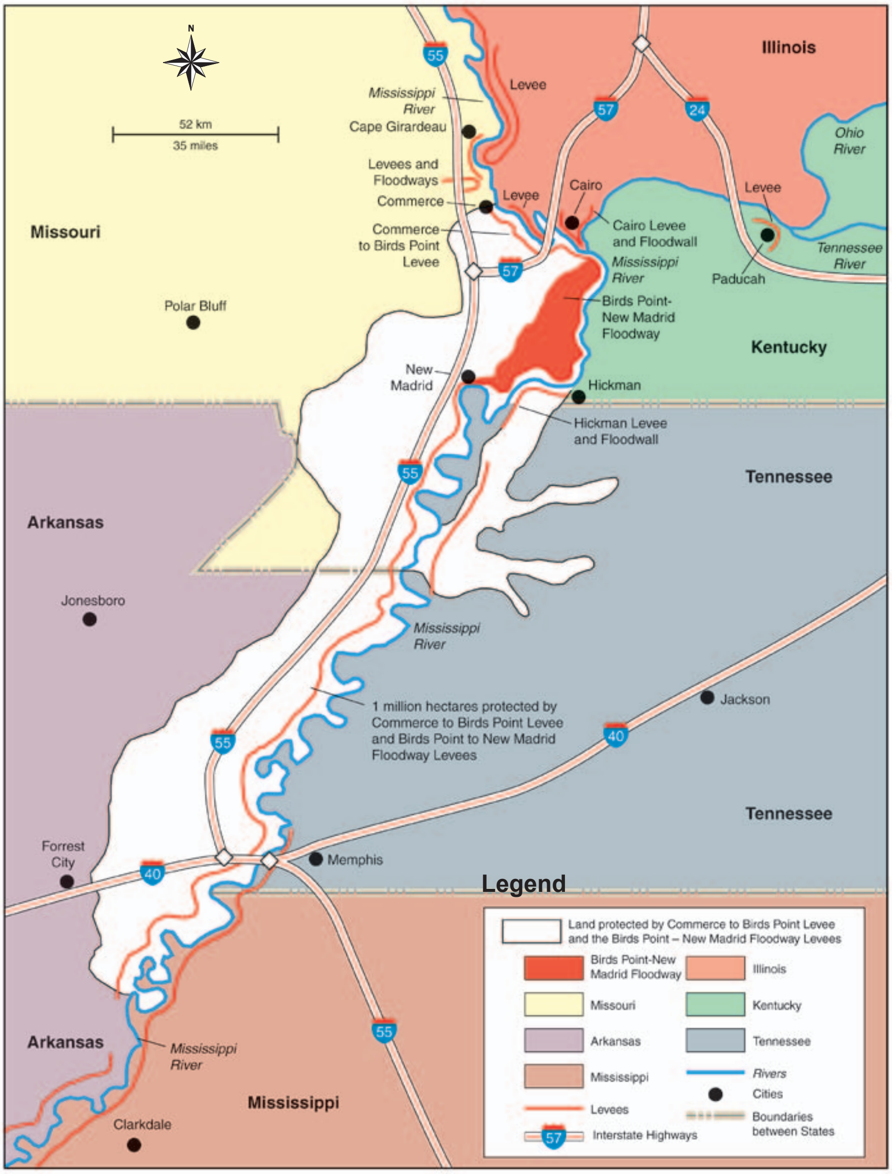
The Mississippi River Commission (MRC) was established by Congress in 1879 to combine the expertise of the USACE and civilian engineers to make the Mississippi River and tributaries a reliable shipping channel and to protect adjacent towns, cities, and agricultural lands from destructive floods (Camillo 2012). The Mississippi River Commission has a seven-member governing body. Three of the officers are from the USACE, including the chairman who is the final decision maker when it comes to decisions like opening the floodways. Another member is an Admiral from National Oceanic and Atmospheric Administration (NOAA), and the other three members are civilians, with at least two of the civilian members being civil engineers. Each member is appointed by the President of the United States. Senate confirmation is no longer necessary. The MRC is the lead federal agency responsible for addressing the improvement and maintenance of the Mississippi River and Tributaries project, including flow and transportation systems.

Between 1899 and 1907, MRC assisted local levee districts in Missouri with construction of a federal levee between Birds Point, Missouri, and Dorena, Illinois. At that time, the MCR jurisdiction was limited to the areas below the confluence of the Ohio and Mississippi rivers (Camillo 2012; Olson and Morton 2012a, 2012b), which is at the southern tip of Illinois (Fort Defiance State Park). This levee is located approximately where the current frontline levee of the Birds Point–New Madrid Floodway was constructed between 1928 and 1932 after Birds Point to Dorena levee failed in 1927.

In 1902, the MRC helped Kentucky construct a levee from the Hickman,

**Figure 5**

**The bottomlands in Missouri and Arkansas protected by the Commerce to Birds Point mainline levee and bottomlands in Tennessee and Kentucky protected by the Hickman levee.**




Kentucky, bluff to Tennessee, where it connected with another levee to extend the levee system 7.8 km (5 mi) to Slough Landings, Tennessee. During this time period, a portion of the natural floodplain near Cape Girardeau was walled off by a local Missouri levee to provide protection of farmland adjacent to the river (figure 1). These two levees narrowed the river channel and during high-water events on the Mississippi River increased floodwater back-up, placing tremendous pressure on the existing systems of levees and floodwalls above and below the Cairo confluence (Camillo 2012; Olson and Morton 2012a, 2012b).

The Commerce to Birds Point levee (figure 5) has long been considered by the MRC and the USACE to be the most critical levee in the Mississippi River valley since it protects nearly 1 million ha (2.5 million ac) of prime agricultural bottomlands in Arkansas and Missouri Bootheel. The Commerce to Birds Point levee, shown in figures 1 and 4, had two major threats (1973 and 1993) from past major flooding events. During the 1973 flood, a 455 m (1,500 ft) section of the Commerce to Birds Point levee fell into the Mississippi River. The caving extended to the top of the levee. The USACE Memphis District placed 21,600 t (18,000 tn) of riprap stone carried in by barges to prevent additional caving (Camillo 2012). The Len Small levee on the Illinois side of the Mississippi River (figure 1) and across from the Commerce to Bird Point levee, Missouri, had historically overtopped or failed during larger flooding events, thereby reducing the pressure on the Commerce to Birds Point levee. The local levee and drainage district and owners of the Len Small levee strengthened their levee during the 1980s, which increased pressure on the Commerce to Birds Point levee when the river flooded. As a result, in the 1993 flood event, the Len Small levee held and the Mississippi remained confined as it climbed to within 1 m (3 ft) of the top of the Commerce to Birds Point levee. Sand boils developed in the Commerce levee were treated until the underseepage stabilized. In 1995, USACE Memphis District raised the height and strengthened the Commerce to Birds Point levee and installed relief wells.

## LOCAL AND MISSISSIPPI RIVER FLOODING OF FARMLAND AND TOWNS LOCATED IN WESTERN ALEXANDER COUNTY

The 2011 flood and record peak on the Ohio River caused the Mississippi River near the confluence to back up for many kilometers to the north and affected all bottomlands in Alexander County, Illinois, that were located on the east side of Upper Mississippi River (figure 1). Since the gradient on the Mississippi River is between 12 and 25 cm km$^{-1}$ (0.5 to 1 ft mi$^{-1}$), the Mississippi River water rose an additional 5.5 m (18 ft) above the flood stage further north. This occurred at a time when the Ohio River was 6.7 m (22 ft) above flood stage and the Mississippi River north of Cape Girardeau, Missouri, was 3 m (9.9 ft) above flood stage. Cities farther to the north like St. Louis, Missouri, were only subjected to floodwaters 2 m (6.6 ft) above flood stage as a result of water flowing from the Upper Mississippi and Missouri rivers.

The May 2nd topping and breach of the Len Small levee occurred just a few hours before the pressure of record flood levels was relieved with the opening of the Birds Point–New Madrid Floodway at 10:00 p.m. Illinois farmers, landowners, and homeowners protected by the Len Small levee might have benefited if the floodway had been opened on April 28th or 29th (2011) when the first weather forecast was issued with a projected Ohio River peak level of 18.3 m (60.5 ft) or higher on the Cairo gage. This is the criteria set in 1986 USACE operational plan that needs to be met before the USACE can artificially breach the levee at Birds Point and use New Madrid Floodway to relieve river pressure and store excess floodwaters. There were a number of reasons why the USACE did not open the floodway on April 28, 2011, and waited until the evening of May 2, 2011. These reasons included the possibility that the forecasted peak would never happen and concern about the damage it would have caused to the 53,200 ha (133,000 ac) of farmland and buildings in the Birds Point–New Madrid Floodway. Consequently, the USACE continued to monitor the situation and waited a few more days before making the final decision to load the trinitrotoluene (TNT) (once loaded it would be difficult to remove if not exploded) into the Birds Point fuse plugs and blow it up on May 2, 2011 (Camillo 2012). The other reasons for the delay were the mega sand boil in Cairo, the heavy local rains in the area of the confluence of the Ohio and Mississippi rivers, and the new peak forecast of 19.2 m (63.5 ft) (Camillo 2012). All these events occurred on May 1, 2011, the day the Supreme Court rejected the Missouri Attorney General's lawsuit filed in an attempt to block the USACE from opening the Birds Point–New Madrid Floodway in an effort to protect Missouri citizens and property.

Flooding of Alexander County from the Ohio and Cache rivers resulted in some flooding in the town of Olive Branch in late April and on May 1, 2011. This was before the Len Small breach occurred on May 2, 2011, and there was some damage to private and public lands prior to the breach. Floodwater from the Mississippi River added to the local flooding caused by the middle Cache River in late April when the record high Ohio River returned to its historic path and poured through the 2002 unrepaired Karnak levee breach into the middle Cache River valley and flooded the Olive Branch and Horseshoe Lake area. These floodwaters eventually drained back into the Mississippi River near Route 3 and through the diversion near mile marker 15 (figure 1) and through the Len Small levee breach.

**Figure 6**

Land scouring, gullies, and erosion north of the Len Small levee breach.

As a result of Cache River valley floodwater flowing through the Karnak levee breach and the additional Mississippi River floodwaters pushing through the Len Small breach, 4,000 ha (10,000 ac) of farmlands lost the winter wheat crop or were not planted in 2011, and about half of that land (mostly Weinbach silt loam, Karnak silty clay, Sciotoville silt loam, and Alvin fine sandy loam) (Parks and Fehrenbacher 1968) had significant soil damages, including land scouring and sediment deposition, or was slow to drain. Crater lakes, land scouring (figure 6), gullies, and sand deltas were created when the Len Small levee breached and removed agricultural land from production (Olson 2009; Olson and Morton 2012b). Most of the other farmland in Alexander County dried out sufficiently to permit planting of wheat in fall of 2011. It appears that all of Alexander County soils dried sufficiently by spring of 2012 to allow the planting of corn and soybeans. It is not clear how much 2011 farm income replacement came from flood insurance since not all Alexander County, Illinois, farmers had crop insurance. In addition, roads and state facilities were impacted by floodwaters which passed through the Len Small breach.

Illinois agricultural statistics recorded that 1,800 fewer ha (4,500 ac) of corn and 2,600 less ha (6,500 ac) of soybeans were harvested in Alexander County in 2011 compared to 2010. The area produced 1,570,000 bu of corn in 2010 but only 710,000 bu in 2011. The soybean production level was 1,200,000 bu in 2010 but dropped to 865,000 bu in 2011 due to flooding, crop, and soil damage. The floodwaters also scoured the agricultural lands in some places and deposited sand at other locations.

## FLOODING OF PUBLIC AND PRIVATE BOTTOMLANDS WITH AND WITHOUT LEVEE PROTECTION IN WESTERN ALEXANDER COUNTY, ILLINOIS

All bottomlands north of the confluence between the Mississippi River and the western Alexander County levees with an elevation of less than 100.7 m

(332 ft) above sea level were flooded when the Mississippi River backed up. Approximately 24,000 ha (60,000 ac) of public and private alluvial lands, both levee protected and without levees, were flooded along the east and north sides of the Mississippi River (figure 1) between mile markers 12 and 39. The 1957 to 1963 soil maps of the area show alluvial soils consisting of recently deposited sediment that varies widely in texture (from clay to sand) with stratified layers. The natural vegetation on these alluvial bottomlands ranges from recent growth of willows (*Salix* L.) and other plants to stands of cottonwood (*Populus deltoides* L.), sycamore (*Platanus occidentalis* L.), and sweet gum (*Liquidambar styraciflua* L.).

The map (figure 1) shows the public and private lands of the southwest Alexander County, Illinois, area that were impacted by the flood of 2011. Approximately one third of the area (8,000 ha [20,000 ac]) is in public lands, including uplands (the Shawnee National Forest and Santa Fe Hills) and bottomlands (Burnham Island Conservation, Horseshoe State Conservation area, Goose Island, Big Cypress, and the land adjacent to the Len Small and Fayville levees). The unleveed bottomlands and public conservation areas sustained flood damage but were more resilient than the private agricultural and urban lands inside the levees. The Mississippi bottomlands are riparian forests (transition ecosystems between the river and uplands) with fertile, fine textured clay or loam soils that are enriched by nutrients and sediments deposited during flooding (Anderson and Samargo 2007). Bottomlands that experience periodic flooding have hydrophytic plants and hardwood forests that provide valuable habitat for resident and migratory birds. The Illinois Department of Natural Resources has an extensive research program monitoring migratory birds and waterfowl at Horseshoe Lake. Although these alluvial river bottomland species are well adapted to periodic flood cycles which can last several days to a month or more (Anderson and Samargo 2007), the impact of the 2011 flood duration (2 to 4 weeks) on these wetlands habitat and woodlands has not been assessed.

**Figure 7**

A farmstead protected by a farmer-built levee.

There are a number of towns and villages in western Alexander County, including Olive Branch, Miller City, and Cache. Floodwaters covered roads and railroads and damaged some bridges, homes, and other building structures. In western Alexander County, floodwater destroyed 25 Illinois homes and damaged an additional 175 homes and building structures located on Wakeland silt loam and Bonnie silt loam soils (Parks and Fehrenbacher 1968) or similar alluvial floodplain soils. The Olive Branch area (figure 1) was one of the hardest hit according to Illinois Emergency Management Agency.

Agricultural and forest lands on the riverside of the Len Small levee are not protected from flooding and store significant amounts of floodwater with minimal damage to the crops such as soybeans, which can be planted later in the spring or early summer. This farmland was under water prior to planting for the entire months of April and May, 2011. After both the Ohio and Mississippi rivers dropped and drained by late June of 2011, these fields were planted to soybeans. Late May and early June is the normal planting time for soybeans in the area, so a small soybean yield reduction was noted.

## REPAIR OF LEN SMALL LEVEE IN WESTERN ALEXANDER COUNTY

In the fall of 2011, local farmers and members of the Len Small Levee District patched the Len Small levee. They created a sand berm 1 m (3 ft) lower than the original levee. They hoped the USACE would cover the levee with a clay cap and restore it at least to the original height. The USACE agreed to do this in August of 2012 after receiving additional funds from Congress. The project was completed in 90 days. Some individual farmers created berms around their farmsteads (figure 7) to protect their farmsteads from any future flooding that might occur.

In June of 2012, the USACE received US$802 million in emergency Mississippi River flood-repair funding for up to 143 high-priority projects to repair levees, fix river channels, and repair other flood-control projects in response to the spring of 2011 flood, which set records from Cairo, Illinois, to the Gulf of Mexico. Both the Birds Point–New Madrid Floodway levee repair and the Cairo area restoration projects were high on the list with the USACE targeting US$46 million to repair the damage to Cairo area, including the Alexander County area flood-control systems (Camillo 2012; Olson and Morton

2012a, 2012b). Improvements were completed throughout Alexander County, including work on pump stations, drainage systems, and small levees, some of which failed in April of 2011. These projects were funded by the county matching funds with the USACE and a combination of grants from the Delta Regional Authority and the State of Illinois (Koenig 2012). The creation of a larger drainage system running through northern Alexander and Union counties included large culverts and levees designed to better protect Illinois communities such as East Cape Girardeau, McClure, Gale, and Ware, and help keep water from collecting in low-lying bottomland areas.

## CONCLUSIONS

In 2011, the record Ohio River flood resulted in the USACE blasting open the Birds Point levee fuse plug as waters reached a critical height on the Cairo gage. However, this unprecedented flood level at the confluence put tremendous pressure on and under the Mississippi levees to the north in western Alexander County. The delay in the decision to blow up the Birds Point fuse plugs and frontline levees had significant consequences for rural Illinois landowners, farmers, and residents in Alexander County near the Len Small levee that failed the morning of May 2, 2011, at a time when the peak flow on the Ohio River caused the Mississippi River water to back up many kilometers to the north. Local flooding and damage to building structures, crops, and soils initially occurred in late April of 2011when the Ohio River at flood stage poured through the Post Creek cutoff and a previously unrepaired Karnak levee breach and rushed to the west through the middle Cache River valley. Consequently, the town of Olive Branch would have flooded even if the Len Small breach had not occurred. The Len Small levee situation does not seem to have been a factor in the USACE decision-making process or have affected the time of the opening of the Birds Point–New Madrid levee fuse plug. The USACE did consider the need to protect the Cairo mainline levee and floodwall and the Commerce to Birds Point main line levee from a breach, as well as potential impact on landowners in the Birds Point–New Madrid Floodway. The mega sand boil in Cairo, the heavy local rains on May 1st in the Mississippi River watershed, and the new peak forecast of 19.2 m (63.5 ft) on the Cairo gage proved opening the Floodway was the correct decision. The frontline Commerce to Birds Point levee did not fail, and more than 1 million ha (2.5 million ac) of agricultural bottomlands in Missouri Bootheel and Arkansas were protected from flooding. Even if the Birds Point–New Madrid levee had been opened four days sooner at a time when the record level floodwaters were 1.3 m (4 ft) lower, the prolonged record Mississippi River floodwater levels and pressure on the Len Small levee, which continued for weeks, would likely have still resulted in the Len Small levee breach a few days later.


## ACKNOWLEDGEMENTS

This project was funded in part by the USDA National Institute of Food and Agriculture Integrated Water Program under agreement 2008-51130-19526, Heartland Regional Water Coordination Initiative.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CERTIFICATE OF SERVICE

I hereby certify that on July 3, 2014, I electronically filed the Declaration of Nicholas Pinter, Ph.D. in Support of Plaintiffs' Motion for Preliminary Injunction and Exhibits 1, 2 and 3 thereto with the Clerk of the Court using the CM/ECF system which will send notification of such filings to all registered counsel participating in this case. There are no non-registered participants in this case.

Respectfully submitted,

s/ Stephan C. Volker

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IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF ILLINOIS

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| NATIONAL WILDLIFE FEDERATION, PRAIRIE RIVERS NETWORK, MISSOURI COALITION FOR THE ENVIRONMENT, RIVER ALLIANCE OF WISCONSIN, GREAT RIVERS HABITAT ALLIANCE, and MINNESOTA CONSERVATION FEDERATION,<br><br>Plaintiffs,<br><br>vs.<br><br>UNITED STATES ARMY CORPS OF ENGINEERS; LT. GENERAL THOMAS P. BOSTICK, Commanding General and Chief of Engineers, LT. GENERAL DUKE DELUCA, Commander of the Mississippi Valley Division of the Army Corps of Engineers,<br><br>Defendants. | CASE NO. 14-00590-DRH-DGW<br><br>**REPLY DECLARATION OF NICHOLAS PINTER, Ph.D. IN SUPPORT OF PLAINTIFFS' MOTION FOR PRELIMINARY INJUNCTION**<br><br>HEARING: TBD<br>TIME: TBD |

I, Nicholas Pinter, declare as follows:

1. The facts set forth in this Declaration are based upon my personal knowledge. If called as a witness, I could and would testify to these facts. As to those matters that present an opinion, they reflect my professional opinion and judgment on the matter. I make this Declaration in support of plaintiffs National Wildlife Federation *et al*.'s reply memorandum of points and authorities in support of their motion for preliminary injunction halting construction of any new river training structures as part of the U.S. Army Corps of Engineers' ("Corps'") management of the Upper Mississippi River System, including those planned as part of the Dogtooth Bend, Monsenthein/Ivory Landing, Eliza Point/Greenfield and Grand Tower projects.

2. I am a Professor in the Geology Department and Environmental Resources and Policy Program at the Southern Illinois University ("SIU"), and Director of the SIU's Integrative Graduate Education, Research and Training ("IGERT") program in "Watershed Science and Policy." I have over 20 years' experience in the fields of geology, geomorphology, fluvial geomorphology and flood hydrology. My qualifications, professional experience and background are set forth in my original June 24, 2014 (filed July 3) declaration ("Original Declaration" or "Pinter Declaration"), and Exhibit 1 thereto. Pinter Dec. ¶¶ 1-5 & Exh. 1.

**Documents Reviewed for this Declaration**

3. In preparing this Declaration, I reviewed the following documents in addition to the documents listed in paragraphs 6 and 7 of my original declaration: (1) Defendants' Opposition to Plaintiffs' Motion for a Preliminary Injunction ("Opposition Brief"), (2) the Declaration of Edward J. Brauer ("Brauer Declaration"), (3) the Declaration of Michael G. Feldman ("Feldman Declaration") and Attachments 1 and 2 thereto, and (4) the Declaration of Jody H. Schwarz in Support of Defendants' Opposition to Plaintiffs' Motion for a Preliminary Injunction ("Schwarz Declaration") and Exhibits 1 through 6 thereto.

**Analysis**

4. I was asked prior to preparing my Original Declaration to form an independent professional opinion as to whether building new river training structures, including those planned by the Corps in the Dogtooth Bend, Monsenthein/Ivory Landing, Eliza Point/Greenfield Bend and

Grant Tower projects, may pose a significant risk of irreparable harm to the natural environment and to people and the property of people who live, work, attend school and/or recreate in the floodplain, including by raising flood stage heights on the Mississippi River. As discussed below, my original conclusion remains the same after reviewing the Opposition Brief and the Brauer, Feldman and Schwarz declarations. I conclude that the Corps' proposed projects, and river training structures generally, *do* pose a significant risk of irreparable harm to the natural environment, human safety and human property. As discussed in detail below, neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations provides evidence that river training structures do *not* raise flood levels.

5. I was also asked prior to preparing this Reply Declaration to review the Feldman Declaration and, to the extent he discusses topics within my area of expertise, to form an independent professional opinion as to his claims regarding the benefits of river training structures and the costs of delaying or permanently tabling the Dogtooth Bend, Monsenthein/Ivory Landing and Eliza Point/Greenfield Bend projects. As discussed in detail below, I conclude after reviewing Mr. Feldman's Declaration that he overstates some of benefits of river training structures as well as the costs of delaying or permanently tabling the proposed the Dogtooth Bend, Monsenthein/Ivory Landing and Eliza Point/Greenfield projects.

## A. The Information and Conclusions in My Original Declaration Remain Accurate and Unchanged.

6. As I attested in paragraph 9 of my Original Declaration, damages from floods worldwide have risen dramatically over the past 100 years (Munich Re Group, 2007). While much of this increase is due to economic development in floodplains (Pinter, 2005; Pielke, 1999), it is also clear that flooding itself has physically increased in magnitude and frequency on many rivers, including the Mississippi River. (Pinter et al., 2006a; Pinter et al., 2006b; Helms et al., 2002). Historical time series of stage data, which are unequivocally homogenous over time (Criss and Winston, 2008), show strong and statistically significant increases of flood heights on portions of

the Mississippi River over time. Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations rebuts these facts.

7. As I attested in paragraph 10 of my Original Declaration, a number of processes can lead to flood magnification or otherwise alter flood response on a river. These include climate change, agricultural practices, forestry practices, urbanization and construction of other impervious surfaces, loss of wetlands, decreases in floodplain areas, construction and operation of dams, and modifications and engineering of river channels. The range of these changes can alter the volume and timing of runoff (discharge or flow of water) entering and moving through river systems. In addition, other natural or human-induced changes to river channels and their floodplains can alter the conveyance of flow within the river channel, resulting in increases or decreases in water levels (including flood stages) for the same discharge. Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations rebuts these facts.

8. As I attested in paragraph 11 of my Original Declaration, the Mississippi River has been intensively engineered by the Corps over the past 50 to 150-plus years (depending on the reach), and some of these modifications are associated with large decreases in the river's capacity to convey flood flows. Numerous scientific investigations, including Corps reports, some dating back to the early 1900s or earlier, have noted large increases in flood levels in association with wing-dike construction. For example, investigators recognized as early as 1933 that "bankful [sic] carrying capacity [of the Missouri River] would be permanently reduced by existing works, such as dikes and revetments used in shaping and controlling the stream for modern barge transportation" (Hathaway, 1933 (quote); Schneiders, 1996 at 346 (same)). Harrison (1953) likewise found that at discharges greater than 50,000 cubic feet per second the "controlled [channel of the Missouri River] has [a] smaller capacity, having 35% less discharge at bankfull stage," one "principal reason" for which was the "increase in roughness" caused by "[t]raining dikes protruding into the flow." These findings that river training structures increase flood levels have been confirmed worldwide and are considered accepted knowledge elsewhere. In the Netherlands, for example, the government has begun modifying river training structures on the Rhine River to lower flood levels (U.S. Government Accountability Office, "Mississippi River: Actions Are Needed to Help Resolve

Environmental and Flooding Concerns about the Use of River Training Structures, December 2011; "GAO Report") at 41. To date, however, the Corps has never addressed in an EIS the vast body of peer-reviewed, independent research showing that river-training structures increase flood heights. *Id.* These facts are unrebutted by both the Corps in its Opposition Brief and Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations.

9. The Corps and Mr. Brauer do both contend, however, that contrary to the weight of the published studies discussed above and below, the "results of . . . independent expert external reviews all lead to the conclusion that river training structure construction has *not* resulted in an increase in flood levels." Brauer Dec. ¶ 8 (emphasis added); Opposition Brief at 13. But Mr. Brauer fails to describe or cite to the alleged "external reviews," and thus provides no evidence on which to judge his assertion. Mr. Brauer also provides no evidence refuting, among other things, the aforementioned evidence discussed in Hathaway (1933) and Schneiders (1996) that "the carrying capacity of the [Missouri] river has been decreased so materially by the [river training] work that floods have occurred at such points as Waverly, Boonville and Hermann, Mo., at lower gauge readings with smaller volumes of water than the 1929 flood stage." Mr. Brauer asserts that Schneiders (1996) does not "draw any conclusions on the impact of river training structure construction on flood levels." Brauer Dec. ¶ 12. But his assertion is directly refuted by the quoted passage from Schneiders (1996). It is only by ignoring or improperly discrediting the evidence I have cited that Mr. Brauer is able to claim that none of the "additional 11 references cited by Dr. Pinter . . . would lead the Corps to a different conclusion on the impacts of river training structure construction on flood levels and public safety than what was established in the EAs." Brauer Dec. ¶ 13.

10. Mr. Brauer and the analysis in Appendix A to the environmental assessments ("EAs") for the Dogtooth Bend, Monsenthein/Ivory Landing and Eliza Point/Greenfield projects are also wrong in concluding that 51 studies attached to the comments of the National Wildlife Federation, Izaak Walkton League of America, Missouri Coalition for the Environment, Prairie Rivers Network and Sierra Club on the draft EAs, including many of my own studies, do *not* "support[] the conclusion that flood levels have . . . been increased as a result of construction of

river training structures." Brauer Dec. ¶ 9. For example, in discrediting many of "the 51 studies provided to the Corps" as only discussing "flow frequency, physical modeling and model scale distortion [or] levee construction" rather than "the construction of river training structures and/or increases in flood levels," Mr. Brauer makes the unfounded and erroneous conclusion that any research study without "river training structure" in its title is not relevant to the effect of such structures on flood levels. Brauer Dec. ¶ 10. To the contrary, all of the topics covered by those studies are necessary for understanding the processes by which river training structures interact with flow and affect flood levels. Increases in flood frequency, for example, are merely a statistical transformation of – meaning they are essentially the same as – increases in flood levels. As discussed further below, Mr. Brauer is also wrong that the all of my research and others' studies that "link river training structures to an increase in flood levels" contains "[m]ajor errors" that "put[] into question [the studies'] conclusion that the construction of river training structures impacts flood levels and consequently public safety." Brauer Dec. ¶ 16.

11. As I attested in paragraph 12 of my Original Declaration, my research has looked extensively at the extent and causes of flood magnification, particularly on the Mississippi River. This research documents that climate, land-use changes, and river engineering have contributed to statistically significant increases in flooding along portions of the Mississippi River system. However, the most significant cause of flood height increases on the Middle Mississippi River and Lower Missouri River can be traced to the construction of wing dikes and other river training structures. Indeed, flood height increases on those river segments exceed by a factor of ten the largest possible flood-stage increases due to observed increases in climate-driven and land-cover-driven flow (e.g., Pinter et al., 2008). In addition, the large multivariate study by Pinter et al. (2010) identified the age, location, and extent of every large levee system added to the Mississippi-Lower Missouri system during the past century, documenting that levees do contribute some but not all of the observed flood-level increases on the Middle Mississippi and elsewhere (confirming modeling by Remo et al., 2009; see Exhibit 2 to my Original Declaration). As discussed further below, Mr. Brauer wrongly discredits my research and others' studies that reach similar conclusions for having allegedly "[m]ajor flaws," including "use of inaccurate early discharge," "use of

estimated daily discharge data," "statistical errors," "not counting for other physical changes within the channel," and "the use of non-observed interpolated synthetic data points."

12. As I attested in paragraph 13 of my Original Declaration, recent theoretical analysis has shown that increased flood levels caused by wing-dike construction are "consistent with basic principles of river hydro- and morphodynamics" (Huthoff et al., 2013). This study concluded that even with extremely conservative parameters used in modeling, "the net effect of wing dikes will be higher flood levels." *Id.* Mr. Brauer criticizes Huthoff et al. (2013) as having "major errors" that "lead[] to incorrect conclusions on the magnitude of change in water surface by the author." Brauer Dec. ¶ 22. Mr. Brauer is not only wrong, he overstates his own criticisms in his (Brauer and Duncan) comment letter to Journal of Hydraulic Engineering, in which Huthoff et al. (2013) was published after peer review. Huthoff et al. (2013) presents fluid dynamical calculations showing that increases in flood levels are consistent with wing-dike construction in river channels. Brauer and Duncan submitted a comment letter to the journal suggesting that Huthoff et al.'s method was "oversimplified" and "simplistic," on which Mr. Brauer bases his criticism of the paper in his declaration. Huthoff et al., however, have submitted for publication a detailed rebuttal of Brauer and Duncan's critique, concluding that "reasonable assumptions *do* lead to significant surcharges [stage increases due to wing dikes] . . . and Huthoff et al. (2013) reach the modest conclusion that wing-dike-induced stage increases 'are consistent with basic principles of river hydro- and morphodynamics'" (Huthoff et al., 2014, submitted) (emphasis added).

13. As I attested in paragraph 14 of my Original Declaration, the theoretical analysis of Huthoff et al. (2013) is supported by empirical studies that have utilized hydrologic analyses; rigorous statistics; geospatial analyses; and 1D, 2D, and 3D hydraulic modeling to confirm, empirically as well as theoretically, the potential for significant increases in flood levels in response to the dense emplacement of wing-dike structures, such as employed on the Middle Mississippi River. Among this body of research, my research group was funded by the National Science Foundation to construct two large river-related databases to rigorously test for trends in flood magnitudes over time on over 4000 kilometers (over 2400 miles) of the Mississippi and Missouri

Rivers, and to quantify the impacts on flood levels from each unit of channel and floodplain infrastructure construction or other change.

14. As I attested in paragraph 15 of my Original Declaration, our hydrologic database consists of more than 8 million discharge and river stage values, including new synthetic discharges generated for 41 stage-only stations. This hydrologic database was used to test for significant trends in discharges, stages, and ‘‘specific stages.’’ We also conducted an extensive review of the validity of using discharge data taken from different types of measurement devices (float meters vs. other types of meters). Pinter (2010) tested whether it was appropriate to utilize older discharge measurements by examining 2150 historical discharge measurements digitized from the three principal stations on the Middle Mississippi River (“MMR”), including 626 float-based discharges and 1516 meter-based discharges, and including 122 paired measurements. All statistical tests we performed demonstrated that it was appropriate to utilize both older historical discharge data and newer discharge data as those different types of measurement tools produced accurate discharge measurements.

15. Mr. Brauer asserts that our conclusion in Pinter (2010) that older and newer discharge data alike produce accurate discharge measurements is invalid because “Pinter (2010) fails to go further in comparing [the pre-1933 discharge measurements] with the post-1933 [U.S. Geological Survey (‘USGS’)] data to confirm that the two data sets can be used together.” Brauer Dec. ¶ 18. Mr. Brauer misrepresents Pinter (2010). The explicit purpose and methodology of the paper was to compare float-based discharge measurements with meter-based measurements, which the Corps has repeatedly singled out as the source of purported bias in the older discharge measurements.

16. Mr. Brauer further contends that “[e]arly discharge data collected before the implementation of standard instrumentation and procedures by the USGS in 1933 has been proven to be inaccurate (Ressegieu 1952, Dyhouse 1976, Dyhouse 1985, Dieckmann and Dyhouse 1998, Huizinga 2009, Watson el al. 2013a).” Brauer Dec. ¶ 18 (quote); Opposition Brief at 14 (same). Mr. Brauer is wrong. None of these sources prove that early discharge measurements – measurements made by the Corps’ St. Louis District – are incorrect. To the contrary, and as

outlined above, Pinter (2010) completed a detailed statistical analysis of side-by-side measurements (using velocity meters as well as floats, which is the point of contention here) and found that the early measurements are as reliable as and fully comparable with the later measurements. This conclusion reiterates the conclusions of a study in the 1970s by the Corps itself (Stevens, 1979). Mr. Brauer's purportedly dispositive citations are not analyses and provide little or no new information on this subject. Ressegieu (1952) is an internal Corps memo. Dyhouse (1976) is an opinion letter critiquing an academic study. Dyhouse (1985) is an unpublished opinion article, without any analysis. Dieckmann and Dyhouse (1998) is an intergovernmental presentation that that asserts flaws in early discharges without any supporting evidence. Huizinga (2009) and Watson et al. (2013) are both Corps-funded studies that question early discharge values without providing evidence that they are invalid. Pinter (2014) details thorough responses to Watson et al. (2013) demonstrating its shortcomings.

17. Mr. Brauer's focus on and criticism of our use of pre-1933 discharge data is further undermined by the fact that the large majority of the 67 stations analyzed in Pinter et al. (2008, 2010) utilized only the later, post-1933 USGS discharge values. Analyses of these numerous USGS-only measurement gages show stage increases fully consistent with gages consisting of both early and later measurements.

18. In addition to Mr. Brauer's erroneous claims that much of our hydrologic data is too early to be accurate, he also wrongly contends that our hydrologic database and subsequent analyses are flawed because they "use . . . daily discharge data" and data "fabricated using interpolation schemes." Brauer Dec. ¶¶ 19 (first quote), 20 (second quote); Opposition Brief at 14 (same). I rebut each of these two erroneous claims in turn below.

19. Mr. Brauer asserts that a "major error in Dr. Pinter's analyses is the use of daily discharge data." Brauer Dec. ¶ 19. Our use of daily discharge data is not in error. Daily discharge values are published and used by the Corps, USGS and many other agencies and scientists worldwide, and are the accepted technical standard for a wide range of analyses and modeling, including by the Corps. With specific respect to their use in determining flood-level trends, daily discharge values (derived from daily stage measurements, combined with accepted rating curves)

produce the same overall results as do the much more limited number of direct measurements. Disqualifying all Corps and USGS daily discharge datasets as Mr. Brauer suggests would do *nothing* to prove that flood level trends have not increased. Instead of demonstrating some contrary trend, disqualifying these datasets would merely reduce the number of discharge values and thereby lower the statistical significance of the increasing flood level trends already found (see Pinter, 2014).

20. Mr. Brauer claims that a "majority of the hydrologic data" in our hydrologic database "(data at 49 of the 67 stations on the Mississippi River and Lower Missouri River) were fabricated using interpolation schemes developed by Jemberie et al. (2008), and they are not real data points." Brauer Dec. ¶ 20. Mr. Brauer misrepresents the data used in Jemberie et al. (2008). That study created a numerical algorithm for utilizing nearby stations and the year-to-year pattern of hydrologic behavior in order to interpolate the shape of trends for the largest flows, which occur only every few years. As Jemberie et al. (2008) makes clear, the overall trends and conclusions therefrom are determined only by the *measured* values in *large flood years*, which are most events for assessing the relationship between flood stage and river training structures. The *interpolations* based on measurements for smaller floods help suggest the likely patterns during the *intervening years*. Jemberie et al. (2008) also uses flow measurements from nearby stations to infer discharges during select years, which improves the accuracy of the overall data. For example, one station may lack direct flood measurements in 1940, but another station just a few miles upstream may have full measurements for that year. On a river as large as the MMR, neighboring sites have nearly identical flows. Jemberie et al. (2008) creates these neighboring discharge estimates by scaling each site proportional to its drainage basin area, and explicitly excluding any pair of measurement sites separated by a major tributary input. Jemberie et al. (2008) and its discharge data and estimates are methodologically sound. Mr. Brauer offers no specifics to show otherwise, or demonstrate any flaws in our use of the study's data.

21. As I attested in paragraph 16 of my Original Declaration, we developed a geospatial database alongside our hydrologic database. Our geospatial database consists of the locations, emplacement dates, and physical characteristics of over 15,000 structural features constructed along

the study rivers over the past 100 to 150 years. In developing this database we utilized: more than 4000 individual map and survey sheets; structure-history databases from six Corps Districts; databases from other agencies including the Coast Guard; and archival maps and surveys, all digitized and calibrated into a modern coordinate system and frame of reference. Within this database we parameterized 130 bridges, 54 dam structures, 25 artificial meander cut-offs, 1093 levees, and 13,231 wing-dam segments, among many other structures. Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations disputes these facts.

22. As I attested in paragraph 17 of my Original Declaration, we used our hydrologic and geospatial databases together to generate reach-scale statistical models of hydrologic response. These models quantify changes in flood levels at each station in response to construction of wing dikes, bendway weirs, meander cutoffs, navigational dams, bridges, and other river modifications. Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations disputes these facts.

23. As I attested in paragraph 18 of my Original Declaration, our analyses show that while climate and other land-use changes did lead to increased flows, *the largest and most pervasive contributors to increased flooding on the Mississippi River system were wing dikes and related navigational structures*. In contrast, large reaches of the Mississippi and Missouri Rivers with little or no dike construction showed *no* significant increases in flood levels. System-wide, the hydrologic pattern was that large-scale increases in flood levels occurred when and where large numbers of dikes and dike-like structures have been built. Progressive levee construction was the second largest contributor. While, as discussed elsewhere in this Declaration, the Corps and Mr. Brauer make several erroneous criticisms of our hydrologic data and analyses thereof, they do not contend that we did not make the stated conclusions from our analyses.

24. As I attested in paragraph 19 of my Original Declaration, our analyses demonstrate that wing dikes constructed downstream of a location were associated with increases in flood height (“stage”), consistent with backwater effects upstream of these structures. Backwater effects are the rise in surface elevation of flowing water upstream from, and as a result of, an obstruction to water

flow. These backwater effects were clearly distinguishable from the effects of upstream dikes, which triggered simultaneous incision and conveyance loss at sites downstream. On the Upper Mississippi River, for example, stages increased more than four inches for each 3,281 feet of wing dike built within 20 RM (river miles) downstream. These values represent parameter estimates and associated uncertainties for relationships significant at the 95 percent confidence level in each reach-scale model. The 95-percent level indicates at least a 95% level of certainty in correlation or other statistical benchmark presented, and is considered by scientists to represent a statistically verified standard. Our study demonstrated that the presence of river training structures can cause large increases in flood stage. For example, at Dubuque, Iowa, roughly 8.7 linear miles of downstream wing dikes were constructed between 1892 and 1928, and were associated with a nearly five-foot increase in stage. In the area affected by the 2008 Upper Mississippi flood, more than six feet of the flood crest is linked to navigational and flood-control engineering. While, as discussed elsewhere in this Declaration, the Corps and Mr. Brauer make several erroneous criticisms of our hydrologic data and analyses thereof, they do not contend that we did not make the stated conclusions from our analyses.

25. In addition, the Corps and Mr. Brauer wrongly contend that my Original Declaration is “fatally flawed” because I “discuss[] [my and others’ research on] many rivers and river reaches [not on the MMR] in an attempt to imply that dikes on the MMR . . . are increasing flood levels.” Opposition Brief at 14 (first quote); Brauer Dec. ¶ 24(a) (second quote). Different reaches of the Mississippi River do vary in some of their characteristics, but the same laws of physics apply to the MMR as to the other rivers and river reaches I discuss and allow for valid comparisons. Contrary to the Corps’ and Mr. Brauer’s opposite contention, understanding the impacts of Middle Mississippi River training structures can *not* be limited to looking only at the Middle Mississippi River. Understanding how different rivers and river reaches are managed (e.g., whether river training structures are used) and the resulting impacts from those management practices are *critical* to assessing how river training structures impact flood stage height. Our research and studies by other researchers show that while there are little or no increasing flood trends on stretches of the Mississippi and other rivers with few or no river training structures, there are large increases in

flood trends at locations (like on the MMR) where and at times when many new river training structures are built.

26. As I attested in paragraph 20 of my Original Declaration, more than 143 linear miles of wing dikes have been constructed on the Middle Mississippi River over the past 100 years (Remo and Pinter 2007; Remo et al. 2008). This represents about 3,960 feet of wing dikes per mile (or about 2,460 feet per kilometer) of channel. Wing dikes have also been heavily utilized on the Lower Missouri River, with over 383 linear miles constructed since 1890. This represents nearly 3,700 feet of wing dike per mile (or about 2,300 feet per kilometer) of channel in the Lower Mississippi River. These and similar river training structures are utilized to assist in river bank protection and stimulate channel scour which can reduce the amount of dredging required to maintain adequate navigation depths (e.g. COPRI 2012). Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations rebuts these facts.

27. As I attested in paragraph 21 of my Original Declaration, the effects of wing dikes and other structures during flooding should not be confused with effects during periods of low flow. There is general agreement that during low in-channel flows, wing dikes lead to lowered water levels at most locations. This happens because the dikes cause channel incision, in which flow removes sediment from the stream bed and ultimately establishes a lower bed elevation. Channel incision is a process that has been well documented after dike construction in many (but not all) areas of the alluvial Mississippi and Missouri Rivers (e.g., Pinter and Heine 2005; Maher 1964). Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations rebuts these facts.

28. As I attested in paragraph 22 of my Original Declaration, incision has caused water levels during periods of low flow (not floods) to decrease over time at the St. Louis, Chester, and Thebes measurement stations, as well as at other, intermediate locations. For all flood flows (flows equal to four or more times the average annual discharge level), however, water levels have increased *by three to ten feet or more* at all of these locations along the MMR. At Grand Tower, Illinois, water levels for just average flows have increased by almost three feet due to dike and weir construction. Near Grand Tower, bedrock underlies parts of the Middle Mississippi channel and

limits incision (Jemberie et al. 2008). The majority of these facts are unrebutted by both the Corps in its Opposition Brief and Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations. However, as discussed and rebutted below, Mr. Brauer erroneously claims that there is no bedrock near the proposed Grand Tower project location. Brauer Dec. ¶ 24(g).

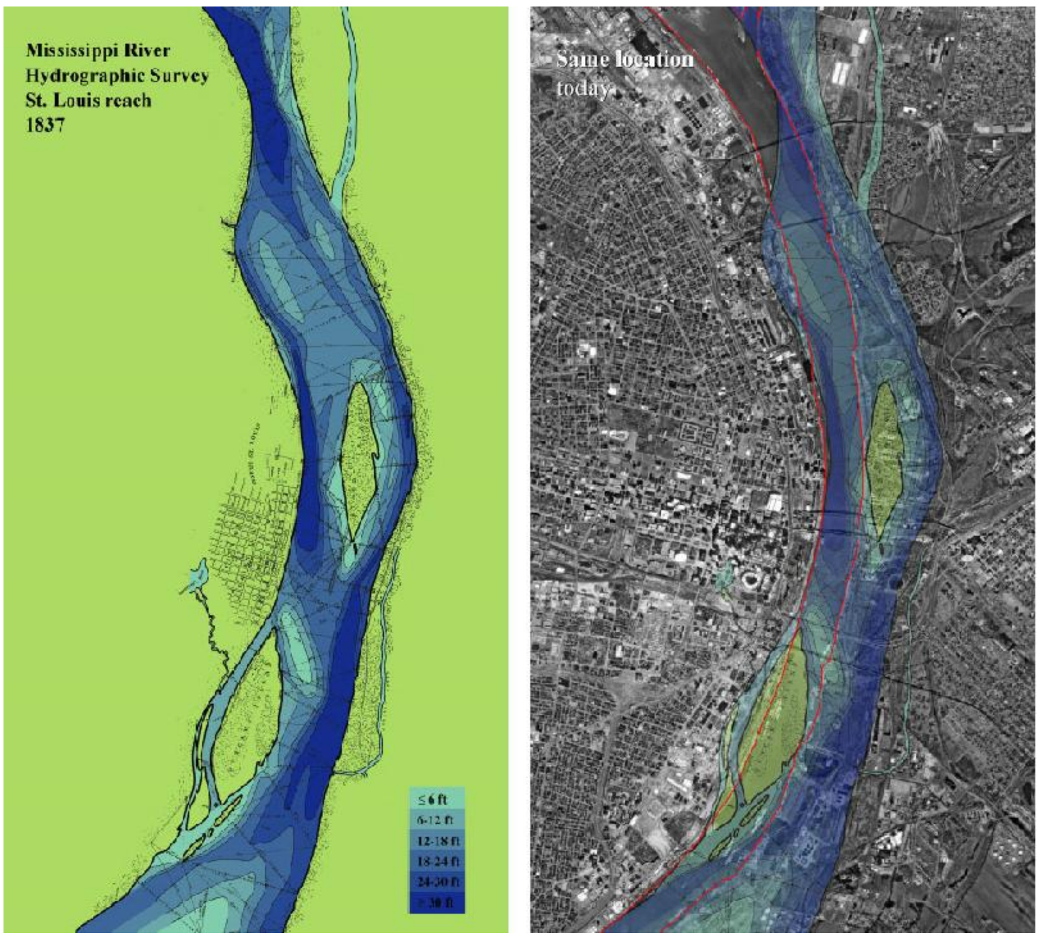
29. As I attested in paragraph 23 of my Original Declaration, many other studies confirm and corroborate these findings on the flow-dependent effects of river training structures. Particularly after the record-breaking floods on the Middle Mississippi, researchers sought to answer why such large increases in flood levels had occurred for the same discharges (volumes of flow) that had been observed in the past. (e.g., Belt 1975; Stevens et al. 1975). Since then, multiple studies involving hydrologic time-series analyses, statistical analyses, geospatial analyses, and hydraulic modeling have correlated the timing and spatial distribution of dike construction with increases in flood stages (e.g., Criss and Shock 2001; Wasklewicz et al. 2004; Jemberie et al. 2008; Pinter et al. 2008; Remo et al. 2009; Pinter et al. 2010, and others).

30. As I attested in paragraph 24 of my Original Declaration, wing dikes and other river training structures increase flood heights during high water because of the way they interact with river flow and the way they change the shape and form of the river channel. Since the beginning of historical "training" (engineering of the river to facilitate navigation) of the Mississippi and Missouri rivers, construction of dikes has narrowed large portions of these river channels to one-half or less of their original width. In addition, construction of dikes, bendway weirs, and other in-channel navigational structures has increased the "roughness" of the channel, leading to decreased flow velocities during floods.

31. Mr. Brauer responds by suggesting that I "may be referring to a river other than the MMR" in my statement that dike construction on the Mississippi and Missouri rivers has narrowed large portions of their channels to one-half or less of their original width. Brauer Dec. ¶ 24(c). I am not. And my original statement is correct. Wing dikes can reduce flow conveyance during floods and thereby increase flood levels either by reducing a river's cross-sectional area, by increasing the roughness of the channel or both. Extensive width reductions occurred on the MMR

during the late 19th and early 20th centuries, with little long-term change thereafter. As shown by Figure 1 below, some portions of the MMR were narrowed to half or less of their original width.

**Figure 1.** Mississippi River at St. Louis, as surveyed by Robert E. Lee in 1837 (left), and compared with the modern width of the channel (right). The original survey has been superimposed on the right panel. The current channel is shown by the red lines on the right panel. The red-lined channel boundaries shown in the right panel demonstrate that, indeed, this portion of the MMR is half or less the width today as it was in 1837. Historical channel geometry, including depths, digitized from original survey maps.




32. Mr. Brauer also asserts that although the MMR channel "has been narrowed due to river training structure construction," studies "have shown (Maher 1964, Biedenharn et al. 2000)" that "the cross sectional area of the deeper channel is preserved and the [channel's] ability to pass flow (conveyance) is the same or in some cases increased." Brauer Dec. ¶ 24(c). He claims that

"[f]ield data taken on the MMR have shown that the narrower and deeper channel will have the same cross sectional area and average velocity as before the placement of the structure." Brauer Dec. ¶ 14. But his assertion contradicts published analyses demonstrating that the actual response of the MMR to river training structures over time has been a reduction in both cross-sectional area and velocity during large flood events due to, among other things, increased channel "roughness" (e.g. Pinter et al., 2000; Remo et al., 2009). Mr. Brauer's contention that the MMR channel's conveyance has either remained the same or increased is true only for *small non-flood* flows.

33. As I attested in paragraph 25 of my Original Declaration, channel roughness is a measure of objects and processes that cumulatively resist the flow of water through a given reach of a river, including drag effects of sedimentary grains, bedforms (e.g., ripples and dunes on the bed), vegetation, turbulence, eddy circulation, and many others. A rough river bed exerts more resistance than a smooth river bed, resulting in slower flow of water. All other factors being equal, a flood that passes through a river reach with half the average flow velocity will result in average water depths that are double what they would otherwise be. Mr. Brauer claims that my "description of the relationship between velocity and depth" is "oversimplified and misleading" because in "rivers that are natural, compound channels, all factors are not equal." Brauer Dec. ¶ 24(d). But Mr. Brauer ignores the fact that the velocity-depth relationship I describe is a physical law of hydrodynamics. Before analyzing how other factors affect that relationship, it is essential to start with a description and understanding of first principles, which is precisely what I have done.

34. As I attested in paragraph 26 of my Original Declaration, recent modeling studies demonstrate the significant effects of river training structures during flood events on flow turbulence and large-scale vertical and horizontal eddy circulation (Huthoff et al., 2013). Other recent studies have focused on flow dynamics around submerged wing dikes and their impact on channel flow resistance (e.g., Yossef 2005; Yossef and de Vriend 2011; Azinfar and Kells 2011). These studies show that submerged wing dikes create flow mixing in their wake zones (e.g., Yossef 2005; Yeo and Kang 2009; Jamieson et al. 2011). These recirculating flows consume energy from the bulk flow field, causing increases in effective resistance near wing dikes and through wing-dike fields. The impact of wing dikes on flow resistance was quantified by Yossef (2004, 2005), whose

proposed relationship allows for an initial assessment of wing-dike impact on water levels (e.g., Azinfar 2010). According to Yossef's laboratory experiments, the effective cumulative hydraulic roughness of the bank zone relates to the size and longitudinal distance between the wing dikes.

35. Neither the Corps nor Mr. Brauer disputes that river training structures cause flow resistance. Brauer Dec. ¶ 24(e). Mr. Brauer does, however, contend that "the flow resistance is greatest at stages in which the dikes are the least submerged (stages below flood stages)." *Id*. Mr. Brauer's contention states his interpretation of hydraulic theory; in fact no laboratory, numerical, or field study has comprehensively tested if such a relationship exists or quantified how the depth of flow over overtopped dikes alters the effective resistance. Contrary to such theory, empirical studies show that the stage increases caused by new wing dike fields are proportionally greater for larger flows (e.g., Belt 1975; Criss and Shock 2001; Wasklewicz et al. 2004; Jemberie et al. 2008; Pinter et al. 2008; Remo et al. 2009; Pinter et al. 2010, and others). Additional data-based research is needed to reconcile hydraulic theory with observations. Reasonable hypotheses for the observed pattern include effects of flow velocity, which increases dramatically with increasing discharge, on net resistance. The Corps and Mr. Brauer consistently turn the scientific method on its head by beginning with a conclusion – the assumption that river training structures do not increase flood levels – and fashioning arguments to fit that assumption.

36. The Corps and Mr. Brauer also attempt to discount the applicability of a small subset of the studies demonstrating that river training structures increase channel roughness, reduce conveyance and increase flood stage levels on the grounds that they are "fixed bed physical flume studies (Azinfar and Kells 2009, 2008, 2007, and Azinfar 2010)." Brauer Dec. ¶ 23 (quote); Opposition Brief at 14. But they ignore the fact that experimental studies in controlled circumstances are still relevant evidence that river training structures can increase flood stage heights, along with hydrologic analyses, statistical analyses, geospatial analyses, fluid dynamical calculations, and 1D, 2D and 3D hydraulic modeling. Each of these types of research has its advantages and limitations, which is why accurate scientific synthesis looks at the conclusions from the full corpus of scientific research. Fixed-bed physical models are imperfect simulations of water flow over river training structures, but they are nonetheless relevant. Indeed, physical modeling

like that done in the Azinfar and Azinfar and Kells studies that the Corps and Mr. Brauer criticize as irrelevant is the *primary tool* used by the Corps' St. Louis District, albeit with a sedimentary bed, for the design and prototyping of all new river training structures.

37. As I attested in paragraph 27 of my Original Declaration, the role of river training structures in increasing flood heights is well recognized. For example, in the Netherlands, the impacts of wing dikes (navigational "groynes") on flood levels have both been recognized and taken into account in flood protection strategies. The government of the Netherlands recently completed a €45 million program to lower 450 wing dikes (groynes) on the Rhine system as part of its strategy to reduce flood levels.

38. Mr. Brauer questions the relevancy of the Dutch example to the Mississippi River, contending that the "structures used on the MMR are much different in size, spacing, and top elevation than those used by the Dutch." Brauer Dec. ¶ 24(f). Yet while Dutch groynes do differ from MMR dikes in some details, Mr. Brauer fails to cite a single study showing that the Dutch groynes are more likely to cause flood stage increases that the MMR dikes.

39. As I attested in paragraph 28 of my Original Declaration, changes in channel geometry and roughness related to river engineering tools employed for improved navigation and flood control appear to be the principal drivers behind changes in flood stage on the Mississippi River. The increases in flood stage are caused by both the direct effects of wing dikes, meaning interaction with flow, and the indirect effects of wing dikes, meaning the effects of the wing dike in changing the shape or form of the river bed. Hydrodynamic simulations of indirect and direct effects of wing dikes show decreases in velocity, increases in roughness, and corresponding increases in flood stage. Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations specifically addresses paragraph 28 of my Original Declaration. I rebut elsewhere in this Declaration the Corps' and Mr. Brauer's general criticisms of my research and the other studies supporting my conclusion that river training structures increase flood stage heights and that the new dike construction projects here – at Dogtooth Bend, Monsenthein/Ivory Landing, Eliza Point/Greenfield Bend, and Grand Tower – will do the same and threaten public safety.

40. As I attested in paragraph 29 of my Original Declaration, river training structures constructed by the Corps to help maintain the nine-foot navigation channel have caused large-scale increases in flood levels, including increases of six to ten feet over broad stretches of the river where these structures are prevalent. Such large increases in flood heights in these rivers have occurred when and where – and only when and where – wing dikes, bendway weirs, and other river training structures have been built. These structures have led to significant increases in the frequency and magnitude of large floods. Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations specifically addresses paragraph 29 of my Original Declaration. I rebut elsewhere in this Declaration the Corps' and Mr. Brauer's general criticisms of my research and the other studies supporting my conclusion that river training structures increase flood stage heights and that the new dike construction projects here – at Dogtooth Bend, Monsenthein/Ivory Landing, Eliza Point/Greenfield Bend, and Grand Tower – will do the same and threaten public safety.

41. As I attested in paragraph 30 of my Original Declaration, the projects now proposed on the Middle Mississippi River are particularly problematic for several reasons. First, as mentioned above, bedrock underlies parts of the Middle Mississippi channel near the Grand Tower project, which limits incision (Jemberie et al. 2008). In such locations, the ameliorating effect of new wing dikes in causing bed incision is reduced or eliminated, leading in the past to the largest observed increases in flood levels.

42. Mr. Brauer asserts that "[t]here is no support for the claim by Dr. Pinter" that there is bedrock underlying parts of the channel near the Grand Tower Project. Brauer Dec. ¶ 24(g). He contends that the "nearest bedrock formation (at an elevation capable of having an impact) to the Grand Tower work area is approximately five and a half miles upstream and over twenty miles downstream." *Id*. Mr. Brauer is wrong. Bedrock *is* present in this river reach, and it is alarming that the Corps' St. Louis District has designed and modeled (in their table-top physical model) the proposed new Grand Tower dikes in apparent ignorance of such a fundamental and important characteristic of the MMR channel. Specifically, historical surveys show that bedrock crops out at the channel-bottom surface, or in the shallow subsurface just beneath, forming a ledge along the

western margin of the channel around river mile ("RM") 68.7, and between RM 70.0-70.3 and RM 71.1-72.7 – *i.e.* through a significant portion of the Grand Tower project area. Mr. Brauer contends to the contrary that "bed samples taken in the Grand Tower reach confirm that the bed material is a combination of medium to coarse sands and pebbles up to one inch in diameter." *Id*. He is mistaken. In a river like the MMR, which transports an active sedimentary bed load at all times throughout its length, isolated channel grab samples will *always* yield sand and gravel, even on river reaches with an underlying bedrock substrate. Such samples in no way "confirm" that the channel is only underlain by sediment.

43. The presence of bedrock in the Grand Tower project area helps explain why observed flood stage increases have been so severe along this portion of the MMR. As discussed above, new wing dikes raise flood levels, but they also induce scour of the bed, which creates additional cross-sectional area within the central portion of the channel and reduces the net increases. However, where, as in the section of the MMR in the Grand Tower project area, a bedrock substrate inhibits scour, there is less or no cross-sectional area increase to reduce the flood stage increases. In these circumstances, the risk of large flood stage increases and the corresponding risk to public safety are at their peak.

44. As I attested in paragraph 31 of my Original Declaration, the new dike construction projects now proposed on the Middle Mississippi are also problematic because they threaten nearby levees that already have identified deficiencies. The Dogtooth Bend Project is immediately downstream of one of the sites where the Len Small levee failed during floods in 2011 (Dogtooth Bend EA at E2). This 5,000-foot breach yielded to fast-moving water that "scored farmland, deposited sediment, and created gullies and a crater lake" (K.R. Olson and L.W. Morton, "Impacts of 2011 Len Small levee breach on private and public Illinois lands," *Journal of Soil and Water Conservation*, Vol. 68:4, attached as Exhibit 3 to my Original Declaration). Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations rebuts these facts.

45. As I attested in paragraph 32 of my Original Declaration, the proposed Grand Tower project spans approximately 7 River Miles along the Big Five Levee Drainage and Levee Districts,

including the Preston, Clear Creek, East Cape, and Miller Pond levees, together protecting over 49,000 acres of Illinois floodplain. The proposed Grand Tower wing dike project also lies just downstream of the Degognia/Fountain Bluff and Grand Tower Drainage and Levee Districts, protecting a further 56,000 acres. Currently, all segments of these levee systems have "Unacceptable" ratings following Corps inspections and assessment. The Dogtooth Bend Project likewise poses an unusually high potential for flood damage. The Cairo levee system ("Mississippi and Ohio Rivers Levee System at Cairo & Vicinity") is located a few miles downstream of the Dogtooth Bend Project. Although the greatest effects of wing dikes occur upstream, statistically significant increases in flood levels have also been identified downstream. Corps inspections have identified major deficiencies in the Cairo levee system, leading to its current "Unacceptable" rating in the National Levee Database. The majority of these facts are unrebutted by both the Corps in its Opposition Brief and Mr. Brauer, Mr. Feldman and Ms. Schwarz in their declarations.

46. The one thing in paragraph 32 of my Original Declaration that Mr. Brauer disputes is my conclusion that statistically significant increases in flood levels have also been identified downstream. Brauer Dec. ¶ 24(b). My conclusion is based on two of my published studies, Pinter et al. (2008) and (2010), which identify both large increases in flood levels *upstream* of new river training structures and smaller, but statistically significant, increases *downstream* of new structures. Mr. Brauer declares this to be impossible, but he bases his opinion solely on his interpretation of hydraulic theory, not any published research. In fact, turbulence and eddy circulation downstream of wing dikes represent a plausible mechanism for empirical increases in flood stages after dike construction. Mr. Brauer cannot wish away observed empirical trends based on his understanding of hydraulic theory.

47. As I attested in paragraph 33 of my Original Declaration, my work with local levee commissioners and other informed officials has revealed deep concern and widespread discussion about levee safety and performance during future floods, even without additional stresses. For at least the past decade, local stakeholders have repeatedly called for the St. Louis District of the Corps of Engineers to rigorously and independently assess the cumulative impacts of wing-dike construction in the Middle Mississippi River. Instead, a new wave of dike construction has been

undertaken, with each new project evaluated – perfunctorily – on an individual basis and without regard to cumulative effects. Neither the Corps in its Opposition Brief nor Mr. Brauer, Mr. Feldman or Ms. Schwarz in their declarations rebuts these facts.

### B. Reply to the Feldman Declaration

48. As discussed in detail below, I conclude after reviewing the Feldman Declaration that Mr. Feldman overstates some of benefits of river training structures as well as the costs of delaying or permanently tabling the proposed the Dogtooth Bend, Monsenthein/Ivory Landing and Eliza Point/Greenfield projects.

49. Mr. Feldman asserts that "under the Upper Mississippi River Biological Opinion issued by the U.S. Fish and Wildlife Service and the Upper Mississippi River Restoration-Environmental Management Program, new river training structures are constructed for the purpose of providing environmental benefits for fish and wildlife." Feldman Dec. ¶ 4. Yet little or no benefit of river training structures to endangered fish species on the MMR has ever been demonstrated. The Corps has touted many of its navigational dike projects as having environmental benefits (*e.g.* DuBowy, P.J., 2012 and cover of same magazine issue), but rigorous monitoring has shown no actual species benefits associated with these activities (e.g., Papanicolaou et al., 2011).

50. Mr. Feldman claims that, "[a]s the Mississippi River is a dynamic system due to natural variances that affect sedimentation, impacts associated with delay of not awarding the contracts or constructing the features provided in those contracts will increase the length of that delay." Feldman Dec. ¶ 8. Mr. Feldman is mistaken that any large change in the Mississippi River's sediment flux or geomorphic conditions would occur if the proposed river training structure projects are delayed. For many decades, the Corps' St. Louis District has maintained the 9-foot navigation channel through dredging. In the absence of new river training structures, the Corps could continue to maintain the navigation channel through dredging. And outside factors being equal, no large change in the river's sediment flux would occur, nor, contrary to Mr. Feldman's conclusion, would there be any increased costs due to sediment accumulation.

51. Mr. Feldman contends that "[s]ignificant delays in awarding contracts and/or not constructing any new training structures will delay the overall Regulating Works Project completion date." Feldman Dec. ¶ 17. But in assuming that the construction of additional river training structures could eliminate the need for future dredging, Mr. Feldman ignores growing anecdotal evidence suggesting that recent river training structure construction is largely just *shifting locations* of the required dredging instead of *reducing* or *eliminating* the *long-term need* for dredging.

52. Mr. Feldman asserts that the "benefit to cost ratio for the Regulating Works Project construction completion is 18 to 1," and that the project "is one of the most valuable projects in the nation in terms of returns on investment." Feldman Dec. ¶ 17. But Mr. Feldman's claim is based on the erroneous assumption that new river training structures have zero impact on flood levels. As discussed thoroughly above and in my Original Declaration, and as document by Pinter et al. (2012), even small increases in flood levels cause large increases in flood risk that can overwhelm any purported cost-savings from reduced dredging. Furthermore, as just discussed, Mr. Feldman ignores the growing anecdotal evidence suggesting that recent river training structure construction is largely just shifting locations of the required dredging instead of reducing or eliminating the long-term need for dredging.

**Conclusion**

53. The new dike construction projects here – at Dogtooth Bend, Monsenthein/Ivory Landing, Eliza Point/Greenfield Bend, and Grand Tower – pose significant threats of increased flooding and flood risk. They are the latest manifestations of a flawed process that has allowed construction of hundreds of new dikes and dike-like structures that are causing elevated flood stages throughout the Middle Mississippi River. Unless these new dike construction projects are halted to allow their reconsideration based on a comprehensive and independent Supplemental Environmental Impact Statement that takes the foregoing studies and analyses into consideration, needless and potentially severe flooding will likely occur. The costs of halting the projects would be much less than Mr. Feldman claims in his declaration. Indeed, halting the projects would

significantly reduce taxpayer expenditures – along with societal and environmental hardship – by reducing long-term flood risk and flood damages.

54. I declare under penalty of perjury that the foregoing facts are true of my personal knowledge, that the foregoing expressions of professional judgment are honestly held in good faith, that I am competent to and if called would so testify, and that I executed this declaration on August 13, 2014 in Chicago, Illinois.

Nicholas Pinter

Nicholas Pinter, Ph.D

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CERTIFICATE OF SERVICE

I hereby certify that on August 13, 2014, I electronically filed the Reply Declaration of Nicholas Pinter, Ph.D. in Support of Plaintiffs' Motion for Preliminary Injunction with the Clerk of the Court using the CM/ECF system which will send notification of such filings to all registered counsel participating in this case. There are no non-registered participants in this case.

Respectfully submitted,

s/ Stephan C. Volker

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# Attachment E

Conservation Organization Comments
On The
Regulating Works Project
Draft Supplemental Environmental Impact Statement (November 2016)

7-2004

# Habitat Use by Middle Mississippi River Pallid Sturgeon

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Published in *Transactions of the American Fisheries Society*, Vol. 133, Issue 4 (July 2004) at doi: 10.1577/T03-042.1

*Transactions of the American Fisheries Society* 133:1033–1041, 2004


# Habitat Use by Middle Mississippi River Pallid Sturgeon

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*Abstract.*—Little is known about the habitat preferences and needs of pallid sturgeon *Scaphirhynchus albus*, which was federally listed as endangered in 1990. To learn more about habitat use and selection by pallid sturgeon, sonic transmitters were surgically implanted in 27 individuals from the middle Mississippi River. Study fish were located 184 times (1–23 times/individual) from November 1995 to December 1999. Of the seven macrohabitats identified, pallid sturgeon were found most often in main-channel habitats (39% of all relocations) and main-channel border habitats (26%); the between-wing-dam habitats were used less often (14%). Strauss's linear selectivity index ($L_i$) values indicated that study fish exhibited positive selection for the main-channel border, downstream island tips, between-wing-dam, and wing-dam-tip habitats; they showed negative selection for main-channel, downstream of wing dams, and upstream of wing dam habitats. Comparison of $L_i$ values for four temperature ranges and three daily mean discharge ranges revealed little change in habitat selection due to temperature or discharge. Habitat use patterns also were similar across seasons and discharge regimes, except during spring months when between-wing-dam habitats saw greater use and main-channel and main-channel border habitat use declined. These changes may have been a response to high river stages associated with spring flooding, which may create favorable feeding areas in the between-wing-dam habitats. Enhancement and restoration of habitat diversity, particularly downstream island tip and between-wing-dam habitats, may be necessary for the recovery of pallid sturgeon in the middle Mississippi River.

The pallid sturgeon *Scaphirhynchus albus* is one of three river sturgeons of the genus *Scaphirhynchus* that is endemic to North America. Bailey and Cross (1954) characterized the pallid sturgeon as ''nowhere common.'' Pallid sturgeon numbers have since decline markedly (Kallemeyn 1983; Carlson et al. 1985; Dryer and Sandvol 1993), resulting in the species being federally listed as endangered in 1990. Management of pallid sturgeon populations has been hindered by the lack of scientific information about their life history and habitat requirements (Kallemeyn 1983). This lack of biological information was identified by the Pallid Sturgeon Recovery Plan (Dryer and Sandvol 1993), and the scientific investigation of the life history and habitat needs of all life stages of the species was included in plan's objectives (Dryer and Sandvol 1993). A 1997 survey of biologists working on North American sturgeon and paddlefish, also noted a lack of knowledge about the biology and life history of the pallid sturgeon and a need for additional research (Beamesderfer and Farr 1997).

The primary macrohabitat of pallid sturgeon is reported to be the main channels of the Missouri and Mississippi rivers and their largest tributaries (Bailey and Cross 1954; Carlson and Pflieger 1981; Erickson 1992); pallid sturgeon were not found in backwater areas, submerged islands, or riparian areas (Erickson 1992). Little is known about the microhabitat needs of pallid sturgeon and almost no quantitative data are available on its habitat use (Bramblett and White 2001). Bramblett and White (2001) identified individual home ranges for pallid sturgeon of up to 250 km. Large home ranges such as this increase the difficulty of identifying microhabitat needs beyond general habitat use.

Modification of the middle Mississippi River to maintain a 2.7-m navigation channel has resulted

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Received February 18, 2003; accepted January 21, 2004

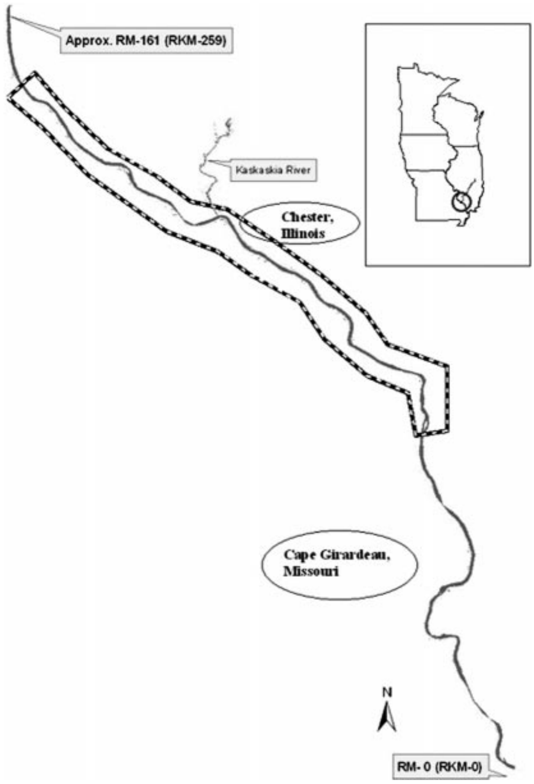


FIGURE 1.—Study area of the middle Mississippi River in which pallid sturgeon were radio-tagged; the area within the dotted outline is the area that received the most telemetry effort.

in longitudinal and cross-sectional changes in channel morphometry. These changes are suspected to have reduced habitat diversity, availability, and value for large river organisms, including the pallid sturgeon. The Pallid Sturgeon Recovery Plan suggested that destruction and alteration of habitats by human modification were the primary threat to the species. However, these modifications have continued under a federal program to operate and maintain the navigation system. Information on habitat use and selection is necessary to evaluate the effect of this program on pallid sturgeon and to suggest modifications to support recovery of the species. The goal of this study was to examine the habitat use and selection of adult sturgeon in the middle Mississippi River. The middle Mississippi River stretches 314 km from the mouth of the Missouri River near St. Louis, Missouri, to the mouth of the Ohio River near Cairo, Illinois (Figure 1). This region of the river is highly channelized and has few secondary or abandoned channels, sandbars, or islands. The Pallid Sturgeon Recovery Plan identified the middle Mississippi River as a recovery-priority area (Dryer and Sandvol 1993).

## Methods

Pallid sturgeon were obtained from commercial fishers, the Missouri Department of Conservation, and by sampling conducted by Southern Illinois University at Carbondale (SIUC). Character index (CI) values (Wills et al. 2002) were calculated to quantify the strength of the pallid sturgeon characteristics exhibited by the fish. Character index values with increasingly negative numbers represent fish with stronger pallid sturgeon characteristics, whereas increasingly positive numbers represent fish with stronger shovelnose characteristics.

Sonic transmitters were surgically implanted into their body cavity, and study fish were released as close to their capture site as logistically possible. Transmitters used for the study (18 mm in diameter, 90 mm long, and weighing 12 g) transmitted at 40 kHz, were uniquely pulse-coded, and had an estimated life of 13 months. Fish were located with a Sonotronics USR-91 receiver with a dual hydrophone array. Location coordinates were then taken using a differential global positioning system, and the position was recorded on U.S. Army Corps of Engineers navigation charts. Macrohabitat type was determined from a list of habitat classifications (Table 1; Figure 2) in reference to habitat structures such as islands, channels,

TABLE 1.—Standard distances used in delineating borders between different middle Mississippi River macrohabitats used in habitat availability analysis for pallid sturgeon.

| Habitat | Standards for delineation |
|---|---|
| Wing dam upstream | 74.9 m upstream and inside of tip of wing dam |
| Wing dam downstream | 170.9 m downstream and inside of tip of wing dam |
| Wing dam tip | 43.8-m radius around tip of wing dam |
| Between wing dams | All area between and inside tips of consecutive wing dams not otherwise delineated |
| Downstream island tip | 163.6-m radius around downstream tip of islands |
| Main-channel border | 253.2 m from shore lacking wing dams |
| Main channel | All area not otherwise delineated |

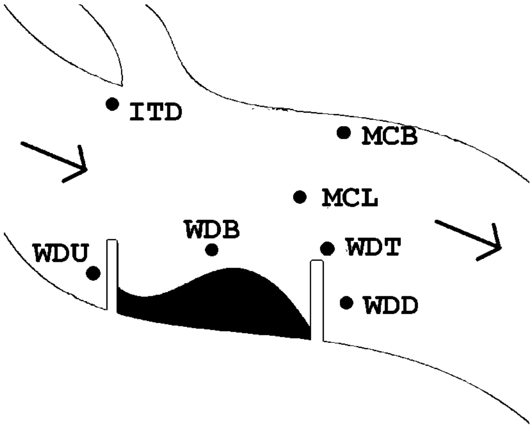


FIGURE 2.—Schematic of macrohabitat classifications of areas where radio-tracking effort for pallid sturgeon was focused. Abbreviations are as follows: MCL = main channel, MCB = main-channel border, WDU = wing dam upstream, WDD = wing dam downstream, WDT = wing dam tip, WDB = between wing dams, and ITD = downstream island tip.

shorelines, and wing dams (i.e., jetty-like rock structures extending laterally from the shore into the river that are used to redirect current from the shoreline to the main channel). These habitat classifications included main channel (MCL), main-channel border (MCB; i.e., any associated shoreline lacking current-obstructing features), immediate upstream of a wing dam (WDU), immediate downstream of a wing dam (WDD), the wing dam tip (WDT), between two consecutive wing dams (WDB), and the downstream side of an island tip (ITD).

Macrohabitat associations were expressed as a percentage of total relocations per habitat type. Additionally, habitat associations were characterized according to surface water temperature at point of relocation. Surface water temperature at point of contact was used to separate macrohabitat associations into four groups: less than 4°C, 4°C to 10°C, 10°C to 20°C (during both spring and fall months), and greater than 20°C. Increased mortality and decreased swimming ability have been shown in some fishes at temperatures below 4°C (Sheehan et al. 1990; Bodensteiner and Lewis 1992). The other temperature ranges were chosen to represent the remainder of the winter season, spring and fall, and summer, respectively.

Habitat availability data were obtained from U.S. Army Corps of Engineers navigation charts. Twenty, 1.6-km stretches were randomly chosen from the river stretch occupied by the study fish. To ensure up-to-date accuracy the navigation charts of these 20 stretches were ground-truthed (i.e., physical examination of each 1.6-km stretch to determine whether the habitats shown on the charts had been modified, added, or removed). Changes typically included the addition or removal of wing dams and the disappearance of small islands, presumably due to erosional processes. Changes were then corrected on the navigation charts, and charts were then enlarged to a scale of 89 mm = 914.4 m.

Each occurrence of a macrohabitat type in the 1.6-km stretch was outlined according to a predefined set of standards (Table 1). These standards were derived from a mean of field measurements of representative habitat types via a prismatic rangefinder. Three different sites of each macrohabitat were arbitrarily selected; at three arbitrary locations at each site, two measurements were taken from the edge of that particular habitat feature. The delineated areas on the charts were then measured three times using a planimeter and averaged. Results were summed by macrohabitat type, and the percentage of all available habitats was calculated for each macrohabitat. Strauss's (1979) linear selectivity index ($L_i$) was chosen to examine habitat selection by pallid sturgeon because it is not as susceptible to sampling bias when the habitat type represents a small or minute proportion of all available habitats (Lechowicz 1982). A chi-square goodness-of-fit test was used to determine whether significant selection was occurring. To determine direction of selection for each habitat, $L_i$ values were graphed with their 95% confidence intervals.

To examine the effects of temperature, $L_i$ values were calculated for each habitat for the four temperature ranges (0–4°C, 4–10°C, 10–20°C, and >20°C). A chi-square goodness-of-fit test was used to determine whether significant selection was occurring within each temperature range. To examine changes in selection for individual habitats due to temperature, $L_i$ values were grouped by temperature and habitat and graphed with their 95% confidence intervals.

To examine the effects of discharge, $L_i$ index values were calculated for each habitat for three daily mean discharge ranges: low (0–4,669 $m^3/s$), medium (4,670–7,641 $m^3/s$), and high (>7,641 $m^3/s$). These break points correspond to the 33.3% and 66.6% daily mean discharge for all days during the sampling period (Figure 3). All discharge data were obtained from the U.S. Geological Survey for the Chester, Illinois, gauging station at river kilometer

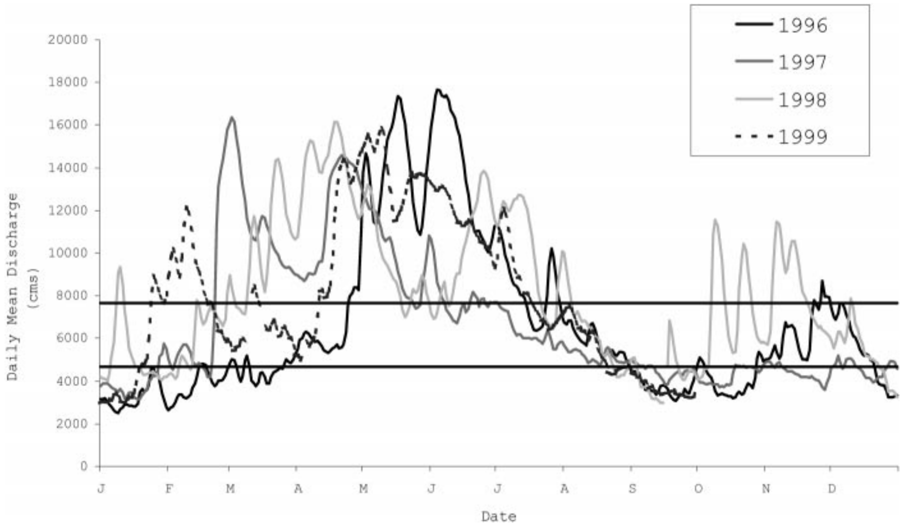


FIGURE 3.—Daily mean discharge values ($m^3/s$) obtained from the U.S. Geological Survey for the Chester, Illinois, gauging station on the Mississippi River from January 1, 1996, through September 30, 1999. Months are abbreviated by their first letters; the solid horizontal lines represent the break points between the low-, middle-, and high-discharge regimes.

177. A chi-square goodness-of-fit test was used to determine if significant selection was occurring within each discharge range. To examine changes in selection for individual habitats due to discharge, $L_i$ values were grouped by discharge range and habitat and graphed with their 95% confidence intervals.

TABLE 2.—Number of locations and days at large for pallid sturgeon implanted with sonic transmitters and released into the middle Mississippi River. Number of locations does not include initial capture or release location. Days at large is the time from date of release to date of last location.

| Transmitter number | Number of locations | Days at large |
|---|---|---|
| 7–8 | 1 | 5 |
| 2,273 | 1 | 20 |
| 239 | 1 | 8 |
| 276 | 1 | 24 |
| 456 | 2 | 43 |
| 5–10 | 2 | 200 |
| 3,334 | 3 | 263 |
| 339 | 5 | 106 |
| 2,264 | 6 | 337 |
| 384 | 6 | 217 |
| 2,237 | 8 | 588 |
| 348 | 9 | 170 |
| 465 | 10 | 228 |
| 375 | 12 | 395 |
| 267 | 15 | 519 |
| 2,588 | 18 | 417 |
| 366 | 19 | 1,488 |
| 294 | 20 | 499 |
| 249 | 22 | 527 |
| 357 | 23 | 506 |

## Results

Twenty pallid sturgeon (614–888 mm standard length, 950–3,273 g) were surgically implanted with ultrasonic transmitters between November 1995 and December 1999. Percent weight of transmitters to body weight ranged from 0.4% to 1.3%. Character index values ranged from +0.1345 to −2.08. Although 6 of the 27 sturgeon exhibited characteristics of hybrid sturgeon, all but one of the CI values fell into the range that Carlson and Pflieger (1981) identified as pallid sturgeon, and all 27 values were below CI values of shovelnose sturgeon collected from the middle Mississippi River. Character index values for the radio-tagged fish were similar to those for other pallid sturgeon captured during the study period but not radio-tagged due to their small size or other considerations.

A total of 184 locations of study fish were made between November 1995 and December 1999. These 184 contacts were all made during daytime hours. Individual fish were located 1 to 23 times (Table 2). Approximately 4,273 km of tracking effort was exerted during the 3 years of this study. To maximize contact with the study fish, tracking effort was mostly focused between river kilometers 130 and 243 (Figure 4) because that was the

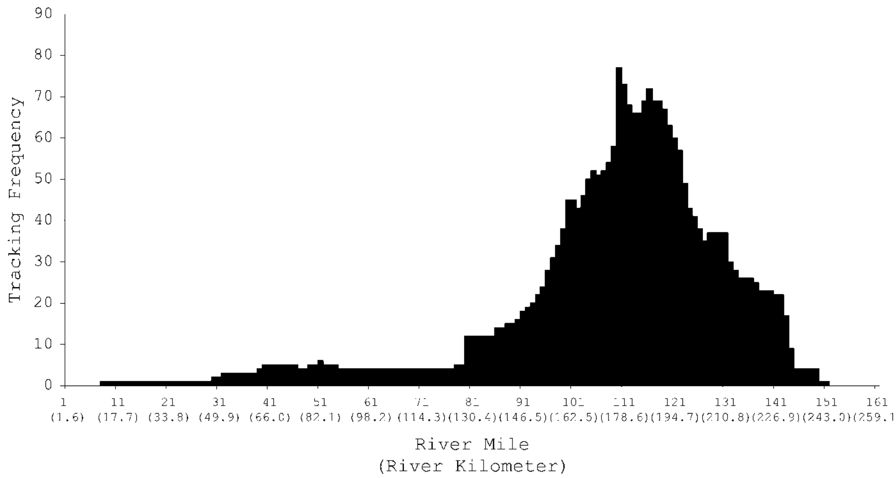


FIGURE 4.—Tracking frequency (the total number of days that a given river kilometer was radio-tracked divided by the total radio-tracking days conducted to locate radio-tagged pallid sturgeon in the middle Mississippi River), November 1995 to December 1999.

portion of the study area where fish were located most often. However, effort was also expended in other parts of the study area in attempts to find missing study fish.

Study sturgeon were located in MCL habitats 39% of the time. The MCB and WDB habitats made up 26% and 14% of all contacts, respectively (Table 3). Habitat associations for the winter season were broken down into two different temperature ranges: less than 4°C, and 4–10°C. At less than 4°C the study sturgeon were found in association with current-disrupting habitat features such as the ITD (12%) and WDD (10%) than at other times during the study. However, the MCL (49%) was still used most often. The diversity of habitat associations at less than 4°C were similar to other seasons, six of the seven habitats being used. Once winter temperatures rose above 4°C, habitat use became more restricted. The MCL (54%) and the MCB (28%) together composed 82% of all relocations in this temperature range.

Habitat associations during the spring months (10–20°C) deviated from those found during the rest of the year. The MCL habitat, which was used heavily during the rest of the year, contributed only 11% of the locations during spring, whereas spring use of the WDB habitats increased greatly (36%). It is notable, however, that the number of contacts during spring was low ($N$ = 19) because of difficulties in detecting fish during spring flooding. During fall months at the same temperatures, habitat associations were similar to those during the

TABLE 3.—Percentage occurrence and, in parentheses, number of pallid sturgeon occurrences or locations in each macrohabitat, by season (based on temperature) and relative availability of each habitat type within the middle Mississippi River study area (river kilometers 1.6 to 265.7), November 1995 to September 1998. Abbreviations are as follows: MCL = main channel, MCB = main-channel border, WDD = wing dam downstream, WDB = between wing dams, WDU = wing dam upstream, WDT = wing dam tip, and ITD = downstream island tip.

| | | Percent occurrence (number of locations) | | | | | |
|---|---|---|---|---|---|---|---|
| Habitat type | Percent of available habitat | All seasons | Extreme winter (<4°C) | Winter (≥4 to <10°C) | Spring (≥10 to <20°C) | Fall (≥10 to <20°C) | Summer (≥20°C) |
| MCL | 64 | 39 (73) | 49 (21) | 54 (17) | 11 (2) | 56 (16) | 27 (17) |
| MCB | 11 | 26 (48) | 14 (6) | 28 (9) | 26 (5) | 28 (8) | 32 (20) |
| WDD | 9 | 4 (7) | 10 (4) | 3 (1) | 11 (2) | 0 (0) | 0 (0) |
| WDB | 8 | 14 (25) | 10 (4) | 9 (3) | 36 (7) | 3 (1) | 16 (10) |
| WDU | 4 | 1 (1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (1) |
| WDT | 3 | 7 (13) | 5 (2) | 0 (0) | 0 (0) | 10 (3) | 13 (8) |
| ITD | 1 | 9 (17) | 12 (5) | 6 (2) | 16 (3) | 3 (1) | 10 (6) |
| Total $N$ | | 184 | 42 | 32 | 19 | 29 | 62 |

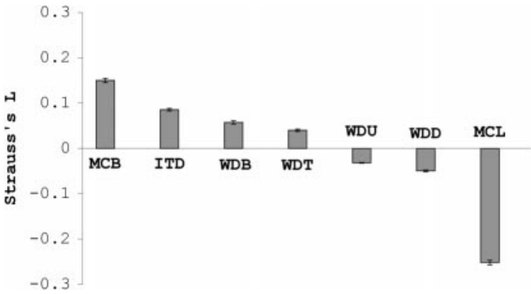


FIGURE 5.—Strauss's (1979) linear selectivity index ($L_i$) values for each macrohabitat radio-tracked for pallid sturgeon use in the middle Mississippi River. Positive values represent positive selection, negative values negative selection; error bars represent 95% confidence intervals. Abbreviations are given in the caption to Figure 2.

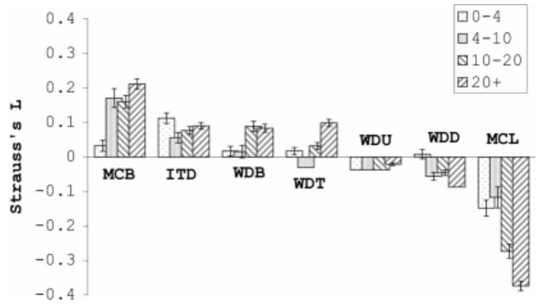


FIGURE 6.—Strauss's (1979) linear selectivity index ($L_i$) values by temperature regime (°C; four categories) for each macrohabitat radio-tracked for pallid sturgeon use in the middle Mississippi River. See the caption to Figure 5 for additional information.

rest of the year. The MCL contributed 56% of the fall contacts and the MCB contributed 28%, totaling 84% of the contacts for these two habitat types (Table 3).

Summer (surface water temperatures >20°C) habitat associations were diverse and closely resembled the overall habitat associations (Table 3). The use of WDT macrohabitats was heavier during the summer months than during other seasons.

Habitat availability analysis indicated that the study area was approximately 64% MCL and 11% MCB. The ITD habitat contributed the smallest amount of the study area at only 1%. The other macrohabitat types, WDD, WDB, WDU, and WDT, contributed 9%, 8%, 4%, and 3%, respectively (Table 3).

The $L_i$ ranged from −0.22 to +0.15 (Figure 5). A chi-square goodness-of-fit test indicated that the distribution of habitat use differed significantly from habitat availability ($\chi^2 = 154.90$, critical value with 6 df = 12.59). Radio-tagged sturgeon showed decreasingly positive selection for MCB, ITD, WDB, and WDT habitats; they exhibited increasingly negative selection for MCL, WDD, WDU (Figure 5).

Chi-square goodness-of-fit tests indicated that significant habitat selection was occurring within temperature ranges (Table 4). However, only two habitats showed a change from positive to negative selection, or vise versa across temperatures. The WDT habitats were positively selected for during each temperature range except 4–10°C (Figure 6).

A chi-square goodness-of-fit test indicated that the distribution of habitat use was significantly different from the habitat availability at the low, medium, and high discharge regimes (Table 4). Selection direction did not change for any habitat across discharge regimes (Figure 7).

## Discussion

In the context of this study, the term ''habitat use'' refers to the habitats with which the study

TABLE 4.—Chi-square goodness-of-fit results of Strauss's linear selectivity index values for pallid sturgeon habitat selection in the middle Mississippi River, by temperature range and discharge range. Low, medium, and high discharge ranges were 0–4,669; 4,670–7,641; and greater than 7,641 $m^3/s$, respectively. A $\chi^2$ value greater than 12.59 indicates that significant selection occurred at $\alpha = 0.05$, df = 6.

| Variable | Range | $\chi^2$ |
|---|---|---|
| Temperature (°C) | 0–4 | 187.96 |
| | 4–10 | 33.95 |
| | 10–20 | 230.80 |
| | >20 | 194.99 |
| Discharge | Low | 99.08 |
| | Medium | 102.58 |
| | High | 297.18 |

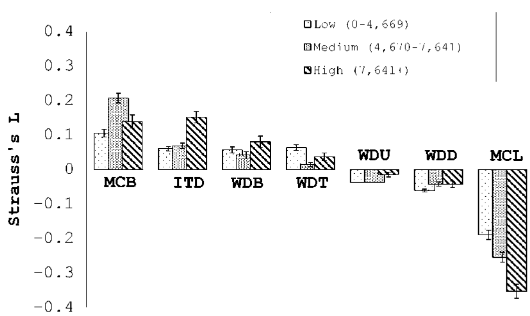


FIGURE 7.—Strauss's (1979) linear selectivity index ($L_i$) values by discharge regime ($m^3/s$) for each macrohabitat radio-tracked for pallid sturgeon use in the middle Mississippi River. See the caption to Figure 5 for additional information.

sturgeon were associated. High-use areas are important to pallid sturgeon because these are the habitats where they were most commonly found. Water-use changes or habitat modifications in these areas need to be carefully examined for their effects on pallid sturgeon. Habitat selection takes into account the availability of the habitat and compares that availability with the amount of use each habitat receives. Habitats that are negatively selected may represent areas that are undesired, unavailable, or simply used less frequently. Habitats that are positively selected may represent areas preferred by or important to pallid sturgeon and may represent the types of habitat that should be created, maintained, and protected for the benefit and recovery of the species.

Radio-tagged fish were found most often in the MCL habitat, followed by MCB and WDB habitats. However, MCB, ITD, BWD, and WDT were important areas of positive habitat selection. These areas would seem to be preferred by middle Mississippi River pallid sturgeon and may represent important pallid sturgeon habitat. Bramblett and White (2001) found that pallid sturgeon were more often located in reaches with diverse habitats, channels, and islands rather than single, uniform channels.

Although the radio-tagged sturgeon were found most often in the MCL, they exhibited stronger negative selection for MCL than for any other habitat. This is not surprising considering the MCL contributed 64% of available habitat. The MCL habitat would seem to be an area where pallid sturgeon are commonly found, yet it may not be a preferred habitat for the species. This may be explained by the fact that movement among different macrohabitat types would dictate movement through MCL habitats. Snook et al. (2002) never found sturgeon directly in the channel of the Platte River but often adjacent to it, along transitions from shallower, sandbar habitats. Similarly, pallid sturgeon in the middle Mississippi River during our study showed high use of MCB areas and positive selection for main-channel borders and ITD habitats.

The ITD represented less than 1% of the habitat available in the middle Mississippi River. Although this is not a common habitat, the radio-tagged fish did seem to positively select this area. Bramblett and White (2001) found that pallid sturgeon in the upper Missouri and lower Yellowstone rivers preferred reaches with a high density of islands and suggested these reaches provided better availability of prey fishes and invertebrates. Snook et al. (2002) found pallid sturgeon to be associated with the sharp change in depths and transition areas between the downstream edges of sandbars and the main channel of the Platte River. Snook et al. (2002) noted that these areas were often just downstream from habitats that were ideally suited for a number of small prey species of fish. In the middle Mississippi River flows cut away at the rich embankments of side channels releasing benthic macroinvertebrates that are swept back to the main stem in the ITD habitats. Macroinvertebrates were found to contribute a large part of pallid sturgeon diets (Carlson et al.1985). Sturgeon may use these habitats as breakwater structures that provide lower water velocities that facilitates feeding on invertebrates and small fish being swept out of the side channels.

Temperature and water velocity are two environmental factors that greatly affect behavior and habitat use of many riverine fishes. Extreme winter water temperatures ($<4$°C) can severely affect swimming ability and mortality of riverine fishes (Sheehan et al. 1990). Habitat associations during winter (water temperature $<4$°C) did not differ from those found during the rest of the year. Habitat associations also were as diverse as those during any other season, the radio-tagged fish being found in six different habitats. Likewise, no shifts between habitat selection and avoidance were noticed during these temperatures, so it appears that winter temperatures did not have an effect on habitat selection and use.

In fact, habitat use and selection by pallid sturgeon did not seem to be affected by any temperature or discharge regime in the middle Mississippi River, except for spring months when the temperature ranged between 10°C and 20°C. During this period, the WDB areas composed the area of greatest habitat use, at the expense of MCL and MCB habitats. Pallid sturgeon are generally thought to be late spring spawners, and one conclusion is that the shift to using WDB habitats over MCL and MCB habitats may represent areas used for spawning or staging by pallid sturgeon. Although no direct information is known about pallid sturgeon reproductive biology (Dryer and Sandvol 1993), interpretation of certain data indicates that pallid sturgeon are hybridizing with shovelnose sturgeon (Carlson et al. 1985; Wills et al. 2002) such that similar areas are probably being used by both species for spawning. Examination of literature concerning shovelnose sturgeon reproductive biology indicates that the species typically spawn over rock, rubble, and gravel in the main channel or on rip-rap wing dams at water temperatures of 18–19°C (Helms 1974; Moos 1978). Shovelnose sturgeon spawning habitat seems to be distinctly different than that in the WDB areas, which consist of mostly sandy substrates. Additionally, no evidence was found during surgical implantation of the transmitters to suggest that the study specimens were sexually mature. The increased use of WDB habitats during the spring does not appear to be consistent with inferred spawning migrations.

An alternative explanation is that pallid sturgeon may have used the WDB habitats as feeding stations during the high spring flows. Snook et al. (2002) found that pallid sturgeon were often located in the Platte River just downstream of shallow sandbar habitats favorable to possible sturgeon prey items. The WDB habitats in the middle Mississippi River may function in much the same manner during high spring flows when most of the sandbar depositions in the WDB areas are underwater. The water current cuts away at the sand substrate and this may help expose benthic invertebrates common in the pallid sturgeon diet (Carlson et al. 1985), creating favorable feeding areas in WDB habitats during the spring. Additionally, the WDB areas may provide lower velocities than the MCL and MCB areas, which were more commonly used than the WDB habitat during the other seasons at lower flows. It should be noted, however, that if this is the case, radio-tagged fish were not seeking zero-current habitats, such as the WDD areas, but areas of reduced current. Other reduced-current habitats, such as the ITD (16%), were also being used to a greater extent during the spring.

With very little natural, unaltered habitat still available, it is difficult to determine critical habitat needs for pallid sturgeon. Therefore, habitat use and habitat selection by pallid sturgeon are both important pieces of information. Infrequent use does not indicate that a habitat is not important to pallid sturgeon because positive habitat selection may occur for habitats of low use. Areas of high use should therefore be viewed as areas to be protected for the benefit of pallid sturgeon commonly located there, and areas of positive habitat selection should be the type of areas considered for habitat enhancement and restoration projects.

In the middle Mississippi River, pallid sturgeon were often found in the MCL and MCB habitats. The high use of these areas by pallid sturgeon makes any negative changes to these habitats potentially harmful to pallid sturgeon. Any changes in use of these habitats or alterations to them should be examined before future projects are undertaken. Conversely, the three of the four wing-dam habitats represent the low-use habitats examined in this study. Any alterations or changes to these habitats would have a reduced chance of harming pallid sturgeon populations due to their infrequent use of these areas.

Although the MCL is the area of highest use by middle Mississippi River pallid sturgeon, the habitat selectivity analysis presented here indicates that the ITD, MCB, and WDB areas may actually represent preferred habitats. Much like results found in other studies (Bramblett and White 2001; Snook et al. 2002), habitats may be selected by pallid sturgeon to maximize forage opportunities. These habitats should be given consideration for any future projects aimed at creating pallid sturgeon habitat because they may be necessary for the recovery of this species. Enhancement and restoration of these habitats would represent an increase in habitat diversity, which could benefit many species in addition to the endangered pallid sturgeon.

## Acknowledgments

I would like to thank Michael Schmidt, Joe Hennessy, Miguel Nuevo, Greg Conover, and others from the Fisheries and Illinois Aquaculture Center at Southern Illinois University Carbondale for their help in the field. All work done for this project was conducted under U.S. Fish and Wildlife Service Federal Fish and Wildlife Permit number PRT-697830A2, subpermit 98–01 and Illinois Natural Resource Permit number 95-12S. The U.S. Army Corp of Engineers and the U.S. Fish and Wildlife Service provided funding to conduct this research.

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*Transactions of the American Fisheries Society* 134:548, 2005

DOI: 10.1577/T03-042e.1

# Erratum: Habitat Use by Middle Mississippi River Pallid Sturgeon

*K. L. Hurley, R. J. Sheehan, R. C. Heidinger, P. S. Wills, and B. Clevenstine*

Volume 133(4), July 2004: 1033–1041.

Page 1039. Pallid sturgeon with sonic tags were incorrectly described as radio-tagged.

The first sentence of the second paragraph should read as follows:

Tagged fish were found most often in the MCL habitat, followed by MCB and WDB habitats.

The first sentence of the third paragraph should read as follows:

Although the tagged sturgeon were found most often in the MCL, they exhibited stronger negative selection for MCL than for any other habitat.

June 27, 2017

Via Email: RegWorksSEIS@usace.army.mil

Mr. Kip Runyon
U.S. Army Corps of Engineers - St. Louis District
1222 Spruce Street
St. Louis, MO 63103-2833

Re: Comments on the Regulating Works Project Final Supplemental Environmental Impact Statement

Dear Mr. Runyon:

The undersigned XXX organizations, appreciate the opportunity to comment on the Final Supplemental Environmental Impact Statement for the Middle Mississippi River Regulating Works Project (Final SEIS).

## Introduction

Our organizations call on the U.S. Army Corps of Engineers to reject the Final SEIS and its recommended alternative. We urge the Corps to prepare a new SEIS that examines the direct, indirect, and cumulative impacts of the full suite of actions used to maintain navigation on the Middle Mississippi River; and select an alternative that protects people and wildlife. As the first step in this new SEIS process, the Corps should initiate—and carefully listen to—a National Academy of Sciences study on the impact of river training structures on flood heights.

### A. The Final SEIS Should Be Rejected

The Final SEIS should be rejected because it fails to meaningfully evaluate impacts and alternatives in violation of the National Environmental Policy Act (NEPA). Rather than taking advantage of NEPA's important framework to develop, evaluate, and select an alternative that would cause less harm to the environment, the Final SEIS appears to have been formulated to justify continuation of the status quo.

Among other problems, the Final SEIS: (1) does not adequately evaluate impacts from the construction of river training structures; (2) does not provide any evaluation of impacts from constructing additional revetment, maintaining and rehabilitating existing river training structures, dredging the river channel, and disposing of dredged material; (3) does not assess impacts on numerous fish and wildlife species, including migratory species; (4) does not assess impacts on numerous important habitat types, including wetlands, floodplains, and braided river habitat; (5) does not comply with the Corps' statutory mitigation requirements; (6) does not comply with important and mandatory requirements of the Fish and Wildlife Coordination Act; (7) does not comply with the National Water Resources Policy; and (8) does not establish that new river training structure construction is needed or authorized. The Corps' current plan vastly exceeds the plan authorized by the Rivers and Harbors Act of 1927. The 1927 authorization explicitly states (pursuant to the authorized Chief of Engineers' Report) that the channel should be constricted to a conservative width of 2,500 to 2,000 feet that would cause little change to the original condition of the river, and that dredging should be used if necessary to maintain the navigation channel once that width was achieved.[1] The Final SEIS recommends a plan to achieve a significantly more aggressive and environmentally damaging contraction width of 1,500 feet.

## B. The Recommended Alternative Should Be Rejected

The alternative recommended by the flawed Final SEIS should be rejected because it will increase flood risks for river communities and cause wide-spread and highly significant harm to the Middle Mississippi River and the fish and wildlife that rely on that vital resource.

The recommended continued construction of river training structures will increase flood risks for communities. As the Corps is aware, extensive peer-reviewed science demonstrates that river training structures have increased flood levels by up to 15 feet in some locations and 6 to 10 feet in broad stretches of the Middle Mississippi River where these structures are prevalent.[2] The impacts of river training structures are cumulative; the more structures placed in the river, the higher the flood stages. Peer-reviewed science also shows that the Middle Mississippi River has been so constricted by river training structures and levees that it is now exhibiting "the flashy response" to flooding "typical of a much smaller river,"[3] with extremely troubling implications for public safety. In addition to increasing human suffering, additional flooding would increase the costs of flood insurance payments, federal emergency assistance, and state, local, and private recovery efforts.

The recommended continued construction of river training structures will harm fish and wildlife by causing significant and widespread loss of vital habitat, as fully recognized by the U.S. Fish and Wildlife Service and the Missouri Department of Conservation. The Final SEIS acknowledges that the recommended alternative will destroy at least 1100 acres of vitally important border channel habitat—bringing to 40% the total loss of this vital habitat in the Middle Mississippi River since just 1976. The Final SEIS fails to examine the ecological and biological implications of the direct, indirect and cumulative losses of this important border channel habitat; and fails to examine the impacts of the many other activities carried out under the Regulating Works Project. In addition to causing significant environmental harm, the recommended alternative will undermine extensive taxpayer investments in habitat protection and restoration.

## C. The Corps Should Prepare a New SEIS that is Scientifically and Legally Sound

Our organizations call on the Corps to reject the Final SEIS and its recommended alternative and take the following steps to prepare an SEIS that is scientifically and legally sound:

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[1] Rivers and Harbors Act of 1927; December 17, 1926 Chief of Engineers Report (69th Congress, 2d Session, Doc. No. 9 at paragraphs 55-57, 80, 84)....

[2] *See, e.g.,* Pinter, N., A.A. Jemberie, J.W.F. Remo, R.A. Heine, and B.A. Ickes, 2010. Empirical modeling of hydrologic response to river engineering, Mississippi and Lower Missouri Rivers. River Research and Applications, 26: 546-571; Remo, J.W.F., N. Pinter, and R.A. Heine, 2009. The use of retro- and scenario- modeling to assess effects of 100+ years river engineering and land cover change on Middle and Lower Mississippi River flood stages. Journal of Hydrology, 376: 403-416; Numerous other studies and analyses provided to the Corps through public comments on the scope of the SEIS and on the Draft SEIS.

[3] Robert E. Criss, Mingming Luo, *River Management and Flooding: The Lesson of December 2015–January 2016, Central USA*, Journal of Earth Science, Vol. 27, No. 1, p. 117–122, February 2016 ISSN 1674-487X (DOI: 10.1007/s12583-016-0639-y).

1. **Initiate a National Academy of Sciences study on the effect of river training structures on flood heights to inform development of the new SEIS.** A National Academy of Sciences review is critical for ensuring that: (a) the SEIS is based on the best possible scientific understanding of the role of river training structures on increasing flood heights; (b) the SEIS produces recommendations that will provide the highest possible protection to the public; and (c) the public will have confidence in this aspect of the Corps' evaluation and recommendations.

2. **Impose a moratorium on the construction of new river training structures pending completion of the National Academy of Sciences Study and new SEIS.** As noted above, extensive peer-reviewed science demonstrates that river training structures have significantly increased flood levels and flood risks in the Middle Mississippi River. In light of these findings, it is critical that additional river training structures not be built unless, and until, the National Academy of Sciences study and new SEIS establish that such construction will not increase flood risks. The stakes are simply too high for the Corps to continue to build new river training structures without input from the National Academy of Sciences.

3. **Fully evaluate the impacts of all reasonable alternatives—including the alternative outlined in paragraph 6 below.** The new SEIS must evaluate all reasonably foreseeable site-specific impacts of the full range of activities used to maintain navigation in the Middle Mississippi River. This includes the direct, indirect, and cumulative impacts of: building and maintaining new river training structures; maintaining and rehabilitating existing river training structures; constructing and maintaining revetment on the river's banks; dredging the river channel; and disposing of the dredged material. The new SEIS must carefully examine the biological implications of these activities (and not simply the engineering outcomes) on the full range of habitat types and fish and wildlife resources in the river and the river floodplain. The new SEIS should carefully examine the cumulative impacts of the project on the ability of fish, wildlife, and human communities to thrive in the face of more frequent and extreme weather events. The new SEIS should also be expanded to evaluate the full suite of operations and maintenance activities for the Upper Mississippi River – Illinois Waterway navigation system.

4. **Formally consult with the U.S. Fish and Wildlife Service and state agencies as required by the Fish and Wildlife Coordination Act (FWCA), and incorporate the resulting comments and recommendations into the new SEIS.** The formal consultation process provides important information critical to ensuring that wildlife conservation receives equal consideration to all other project purposes and that water resource projects protect and restore fish and wildlife resources, as required by the FWCA. 6 U.S.C. §§ 661, 662. The Corps' claim that the FWCA does not apply is incorrect because the Regulating Works Project has been significantly modified at least twice since the FWCA was enacted in 1958. The Regulating Works Project originally authorized in 1927 was substantially modified in 1937 (adopting a more damaging contraction plan of 1,800 feet versus the originally authorized 2,500 to 2,000 feet), in 1965 (requiring maintenance of a year round navigation channel), and in 1972 (adopting an even more damaging contraction plan of 1,500 feet). Under these circumstances, the FWCA and the Corps' own engineering regulations require formal FWCA consultation. 16 U.S.C. 662(b); ER 1105-2-100 (22 Apr 2000) at C-22.

5. **Appoint a new and fully independent external peer review panel (IEPR) and respond fully to the concerns raised by the IEPR panel that reviewed the 2016 Draft SEIS.** The new IEPR panel should evaluate: (a) the adequacy and appropriateness of the models, science, and methodology used in the new SEIS; (b) whether the selected alternative will protect communities; and (c) whether the selected alternative will protect and restore the natural functions of the Mississippi River system. While the IEPR panel that reviewed the 2016 Draft SEIS raised important concerns, the panel provided only an extremely limited review of the project. That panel also lacked the independence required for a meaningful independent review, as collectively its members have worked directly for the Corps for 63 years.

6. **Select an alternative that protects people and wildlife.** To comply with longstanding Congressional directives, including the National Water Resources Policy, the Corps must select an alternative that will protect and restore the natural functions of the Mississippi River system and mitigate any unavoidable damage. For the Middle Mississippi River, such an alternative would: (a) abandon construction of new river training structures, unless it has been demonstrated that they will not increase flood risks; (b) abandon construction of new revetment that will further harm the river's nature functions by creating additional areas where the river will be locked in place; (c) remove and/or modify some of the existing river training structures and revetment to reduce flood risks and restore habitat; (d) restore habitat that has been lost to navigation activities over at least the past four decades; and (e) fully mitigate the adverse impacts of navigation maintenance activities that cannot be avoided.

## Conclusion

For the reasons discussed above, our organizations urge the Corps to reject the Final SEIS and its recommended alternative. The Corps should prepare a new scientifically and legally sound SEIS that examines the full suite of actions used to maintain navigation on the Middle Mississippi River, relies on input from the National Academy of Sciences regarding river training structures and flood heights, and selects an alternative that protects people and wildlife.

Should you have any questions or require additional information, please contact Marisa Escudero, Water Protection Network Manager, at 202-797-6644 or escuderom@nwf.org.

Sincerely,

American Rivers

Arkansas Wildlife Federation

Apalachicola Riverkeeper

Atchafalaya Basinkeeper

Audubon Arkansas

Bluestem Communications

Citizens Against Widening the Industrial Canal

Committee on the Middle Fork Vermilion River

Conservation Federation of Missouri

Delta Chapter Sierra Club

Florida Wildlife Federation

Friends of Our Riverfront

Friends of Black Bayou, Inc.

Great Egg Harbor Watershed Association

Great Rivers Environmental Law Center

Great Rivers Habitat Alliance

Holy Cross Neighborhood Association

IL Chapter of Sierra Club

Missouri Coalition for the Environment

National Wildlife Federation

Prairie Rivers Network

Quad Cities Waterkeeper

Tennessee Clean Water Network

The MN Division - Izaak Walton League

## Conservation Organization Action Center Comments

10,426 email comments on the Final SEIS were received through conservation organization action center websites with the following content:

| | |
|---|---|
| **From:** | National Wildlife Federation Action Fund on behalf of _______________ |
| **To:** | RegWorksSEIS |
| **Subject:** | [Non-DoD Source] Protect Mississippi River wildlife and communities (Final SEIS Regulating Works) |
| **Date:** | Tuesday, June 27, 2017 7:45:51 PM |

Jun 27, 2017

Regulating Works Final SEIS

Dear SEIS,

I urge the Corps of Engineers to redo the Regulating Works Final SEIS. To protect people and wildlife, the Corps should stop building new river training structures, abandon use of revetment, remove some existing structures, and restore habitat lost to decades of navigation activities.

Extensive peer-reviewed science shows that hundreds of miles of river training structures already built by the Corps have increased flood heights by six to ten feet and more in broad stretches of the middle Mississippi River. These structures, built solely to reduce navigation dredging costs, have also decimated vital fish and wildlife habitat.

The Final SEIS recommends building even more river training structures with 4.4 million tons of rock and burying even more of the river's banks under concrete revetment. This will increase flood risks for communities, destroy 1100 additional acres of vital habitat, and add to the already significant losses of wildlife habitat quality, quantity, and diversity.

The Corps should reject the Final SEIS and its recommended alternative. To ensure adoption of a plan that protects people and wildlife, the Corps should first obtain a National Academy of Sciences study on river training structures and flooding, and then use that information to inform a new SEIS.

Sincerely,

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