UPPER MISSISSIPPI RIVER RESTORATION

FEASIBILITY REPORT

WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

CRAINS ISLAND
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

October 2017

Open River

Miles 103.5 - 105.5

Randolph County, Illinois

Project Partner: U.S. Fish and Wildlife Service

US Army Corps of Engineers ®
St. Louis District

Acknowledgments

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DRAFT FEASIBILITY REPORT
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CRAINS ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
MIDDLE MISSISSIPPI RIVER MILES 103.5 THROUGH 105.5
RANDOLPH COUNTY, ILLINOIS

EXECUTIVE SUMMARY

Purpose of Report. The purpose of this draft Feasibility Report with Integrated Environmental Assessment (EA), including the draft unsigned Finding of No Significant Impact, is to evaluate and document the decision-making process for the proposed Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation and Enhancement Project (HREP) at Crains Island. This report is being developed by the U.S. Army Corps of Engineers (USACE) with U.S. Fish and Wildlife Service (USFWS) serving as the Federal project partner. This report provides planning (including National Environmental Policy Act (NEPA) compliance), engineering, and sufficient construction details of the Tentatively Selected Plan (TSP) to allow final design and construction to proceed subsequent to document approval by the Mississippi Valley Division, USACE.

Project Location. The *Crains Island Habitat Rehabilitation and Enhancement Project* (Project) is located on the right descending bank of the Mississippi River between river miles 103.5 and 105.5, approximately 4 miles southeast of the City of Chester, in Randolph County, IL. The Project Area is comprised of 553 acres of aquatic side channel, floodplain forest, and wetland habitat.

Problem Identification. Human activity over the past two centuries within the Middle Mississippi River (MMR) basin, floodplain, and channel has altered the hydrology and biotic communities historically present in the Project Area. These alterations have reduced the diversity and quality of aquatic flowing side channels, which are limited in the region, floodplain forest habitat that has severely declined since settlement, and wetland habitat, which has been reduced and continues to degrade. These stressors are likely to continue, as would the decline of the quality of aquatic side channel, floodplain forest, and wetland habitats. This Project provides an opportunity to improve the quality and diversity of critical habitats.

Project Goal and Objectives. The goal of the Project is to restore and improve the quality and diversity of aquatic side channel, floodplain forest, and wetland ecosystem resources within the Project Area. The objectives identified to meet this goal are to:

1. Increase connected aquatic side channel habitat with depth diversity for enhanced fisheries habitat benefits
2. Restore wetland ecosystem resources as measured in acres
3. Increase acreage and promote favorable fine sediment deposition in the Project Area as measured in acres
4. Restore floodplain forest communities as measured in acres

Plan Formulation, Evaluation, and Comparison. The following restoration measures were considered to achieve the Project goal and objectives:

- No Action
- Sediment deflection berm
- Sediment deflection berm with additional tree planting area at higher elevations
- Increase side channel depth and width, no benching on side channel slopes
- Increase side channel depth and width, opportunistic benching on side channel slopes
- Reforestation throughout study area
- Reforestation throughout study area with additional sediment deflection berm plantings
- Depressional wetlands

The team reviewed the individual restoration features to determine what measures or variations of features would be carried forward. Several restoration features were further refined based on additional information and analysis of the potential features. The project delivery team worked through each restoration measure and used best professional judgment to ensure each alternative plan would meet at least one of the project objectives. The final array of restoration measures were combined into distinctly different alternatives based on feature dependencies and exclusivities. This resulted in 10 alternatives including the No Action alternative, which were moved forward for detailed analysis. Each alternative was evaluated through an environmental benefits analysis to determine the magnitude of ecosystem benefits to be expected if the alternative was implemented. The benefits were then combined with cost estimates for each alternative and then incremental cost analysis (ICA) was conducted to determine cost effectiveness. Habitat benefits were estimated using the Habitat Evaluation Procedures (HEP). Cost-effectiveness and incremental cost analyses were conducted to identify cost effective plans and reveal changes in cost for increasing levels of environmental outputs (i.e., average annual habitat unit). These analyses resulted in 4 "Best Buy" alternatives, including the No Action Alternative. These 4 alternatives were then compared and assessed on their ability to meet project objectives, NEPA compliance, and achieving the USACE Planning and Guidance evaluation criteria of acceptability, completeness, effectiveness, and efficiency (ER 1105-2-100).

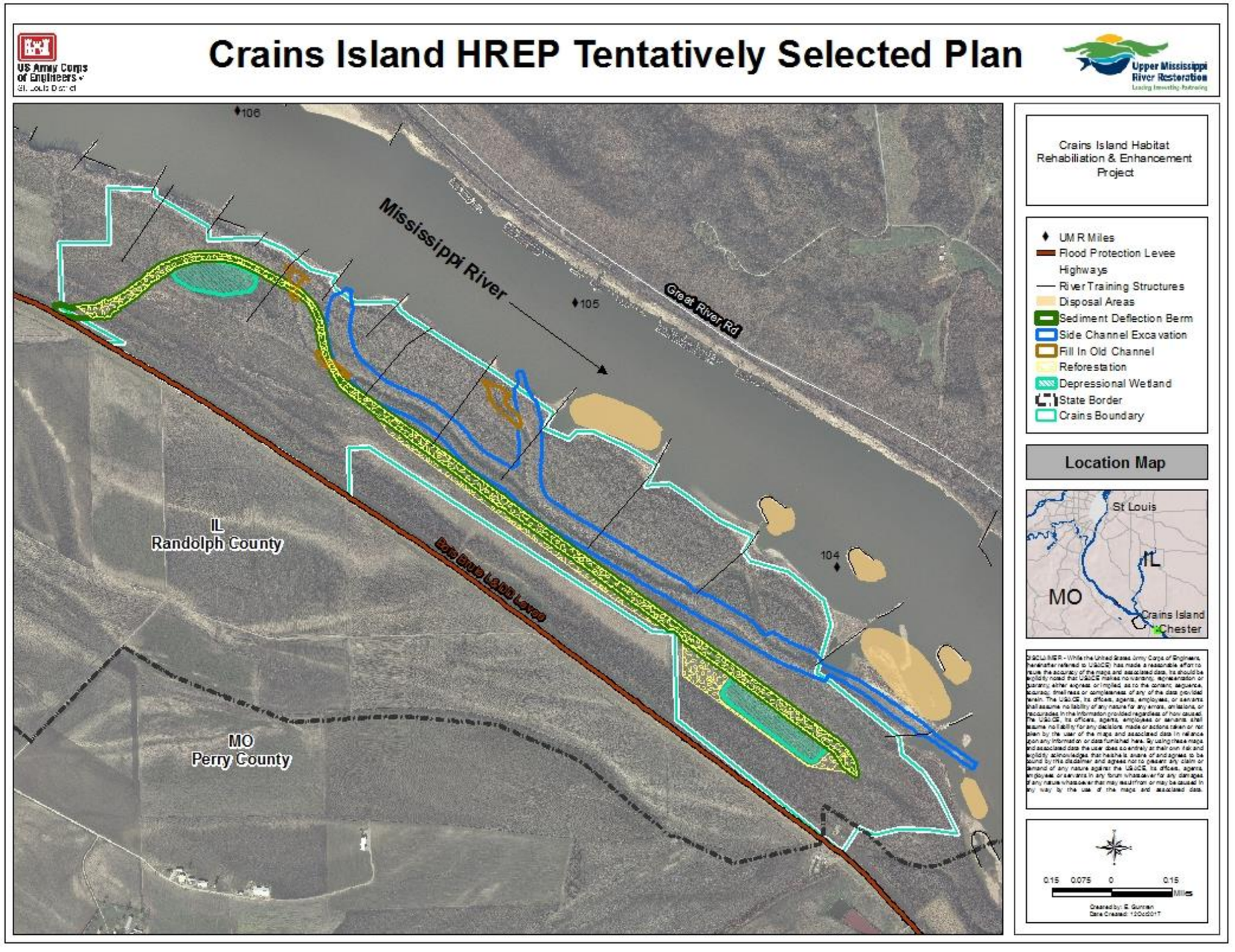
Plan Selection. The TSP (Alternative 2A), shown in Figure ES-1, for the Crains Island HREP consists of multiple measures to restore and improve the aquatic ecosystem structure and function by implementation of the following restoration measures:

- Sediment deflection berm
- Increase side channel depth and width, benching on either side where opportunistic
- Reforestation throughout the study area
- Depressional wetlands

The TSP is the National Environmental Restoration Plan (NER) and is a best buy alternative that yields 151 net average annual habitat units (AAHUs) at an average cost of $9,539 per AAHU (FY2016 price level; FY2016 federal discount rate of 2.875%). It best meets the study objectives and has sponsor support from USFWS. Implementation of the TSP would increase the quality and quantity of ecosystem resources and meet the needs for a large variety of native aquatic species. Restoring flow and connectivity of the side channel to the main channel of Mississippi River would contribute to overwintering fish habitat as well as feeding areas for migratory wildlife. This would also provide bathymetric diversity and flow within the side channel which would provide important side channel habitat within the MMR. Floodplain forest and wetland habitat restoration would create vital missing habitat for fish and wildlife for the Project Area and the Middle Mississippi River. The Project outputs are also consistent with the goals and objectives of the UMRR.

All Project measures would be located within the lands and waters of the United States, managed by the USFWS as part of the Middle Mississippi River National Wildlife Refuge. As such, project first cost funding for restoration measures would be 100 percent federal; responsibility for the operation, maintenance, rehabilitation, replacement, and repair of the Project would be the responsibility of USFWS. The sediment deflection berm would tie into the Bois Brule levee, which is not federally owned. This project feature is being coordinated with the St. Louis District and Bois Brule Levee District.

The St. Louis District Engineer has reviewed the Project outputs, a gain of 151 net AAHUs, and determined that the implementation of the TSP is in the Federal interest. Therefore, the District Engineer recommends construction approval for the Crains Island HREP. The current estimated project first cost (FY2018 price level) of the Project (including contingencies) is estimated at $36,562,000 which includes monitoring ($193,200) and adaptive management ($343,896). The average annualized total project costs based on the project first cost is $1,440,336. USFWS would be responsible for Project operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) at an estimated average annual cost of $11,050 (including contingencies).



Executive Summary Figure 1. Crains Island HREP TSP.

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CRAINS ISLAND

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

1 INTRODUCTION*

1.1 Purpose and Scope of Investigation

The scope of this study focuses on proposed project features that would improve side channel habitat, restore floodplain forest and wetland habitat, and improve overall ecosystem resources within the Middle Mississippi River (MMR) Crains Island Habitat Rehabilitation and Enhancement Project (HREP). This study follows the Corps of Engineers' six-step planning process specified in Engineering Regulation (ER) 1105-2-100 and is consistent with agency management goals. The process identifies and responds to problems and opportunities identified; provides a flexible and rational framework to make decisions; and allows the interested public and decision makers to be fully aware of the basic assumptions employed, data analyzed, risks and uncertainties identified, and significant implications of each alternative plan, including the "No Action" alternative. The development and comparison of alternatives allow for the ultimate identification of the National Ecosystem Restoration (NER) Plan, which would be the Tentatively Selected Plan (TSP). The NER plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options. The NER also considers information that cannot be quantified, such as environmental significance and scarcity.

1.2 Authority

The UMRR was authorized in the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), Section 1103, the Upper Mississippi River Plan. Section 1103(e) of WRDA 1986 outlines the following undertakings:

(A) a program for the planning, constructing, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement (UMRR-HREP);
(B) implementation of long-term resource monitoring program (UMRR-LTRM); and
(C) implementation of a computerized inventory and analysis system.

The original authorizing legislation has been amended several times since its enactment. The 1990 WRDA, Section 405, extended the original UMRR HREP and UMRR-LTRM authorization an additional five years to fiscal year 2002. The 1992 WRDA, Section 107, amended the original authorization by allowing limited flexibility in how funds are allocated between the HREP program and the UMRR-LTRM element. The sole responsibility for Operation and Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) of habitat projects is assigned to the Federal, State, or local agency owner that is responsible for management activities for fish and wildlife on such lands, in accordance with 1992 WRDA. The 1999 WRDA, Section 509, reauthorized UMRR HREP and UMRR-LTRM as a continuing authority with reports to Congress every 6 years and changed the cost sharing percentage from 25 percent to 35 percent. The 1999 Water Resources Development Technical Corrections, Section 2, corrected

paragraph deletions/additions. The 2007 WRDA, Section 3177, allowed for the inclusion of water quality research in the applied research program for development of remediation strategies on the Mississippi River.

Crains Island is located on federally-owned lands managed as part of the USFWS Middle Mississippi River National Wildlife Refuge; therefore, pursuant to 1986 WRDA, Sections 906(e)(3), as amended, the Project first costs are 100-percent Federal funded..

The proposed planning and design of the Project, as well as construction, would be funded under this authorization. The full authorization can be found in Appendix L – Authorizations.

1.3 Federal Sponsor

The Federal Sponsor is the U.S. Fish and Wildlife Service (USFWS).

1.4 Study Area Description

The Middle Mississippi River National Wildlife Refuge (MMRNWR) is managed by the USFWS and covers 195 miles of the Mississippi River between St. Louis, Missouri and the confluence with the Ohio River. The MMRNWR includes approximately 7,000 acres of river islands, side channels, wetlands, and bottomland forest. The portion of the MMRNWR included in this Upper Mississippi River Restoration Program (UMRR) Habitat Rehabilitation and Enhancement Project (HREP) is the Crains Island Division (553 Acres).

Crains Island is located on the right descending bank of the MMR between river miles 103.5 and 105.5, approximately 4 miles southeast of the City of Chester, in Randolph County, IL. Figure 1 and Figure 2 provide a vicinity map and a specific location map for the Crains Island HREP. The MMR is often referred to as the “Open” or “Unimpounded” river because it is the first section of free-flowing river below the lock-and-dam navigation system on the Upper Mississippi River (UMR).

Crains Island is adjacent to the Bois Brule levee, which was originally constructed in 1937 and completed to its current state in 1968. It is located along the right bank of the Mississippi River between river miles 84 and 111 above the Ohio River. The levee district protects about 26,060 acres, which is nearly all in agricultural production. The levee is currently operated and maintained by the Bois Brule Levee & Drainage District.

1.5 Purpose & Need

USACE proposes to rehabilitate Crains Island through construction of measures which would increase: floodplain forest community diversity, restore function of flowing side channels, increase emergent wetland habitat, and improve the overall structure and function of Crains Island habitat. The purpose of the study is to restore and improve the quality and diversity of aquatic side channel, floodplain forest, and wetland ecosystem resources. The purpose of this Draft Feasibility Report with Integrated Environmental Assessment (EA), including the draft unsigned Finding of No Significant Impact (FONSI), is to evaluate the proposal for the UMRR-HREP at Crains Island. The Draft Feasibility Report and Integrated EA meet Corps of Engineers planning guidance and meet NEPA requirements. This report presents a detailed account of the planning, engineering, construction details, and environmental considerations, which resulted in the TSP and is being developed by the USACE with the USFWS serving as the Federal project partner.

The need for rehabilitation of the Project is based on the following factors:

- The *Upper Mississippi River System Habitat Needs Assessment* (Theiling, et al., 2000) emphasizes the need for restoring secondary side channel and contiguous backwater

every 5 to 7 miles along the MMR. Existing side channel habitat on Crains Island is generally shallow, turbid, and has limited connectivity with the main channel, which are important habitat characteristics required for functional year-round aquatic habitat. Without action, the existing side channel habitat would continue to decline impacting the survival and recruitment of riverine fish species. Utilizing past bathymetric survey data from 1999 and 2014, where water access is only available within the lower 1/3 of Crains Island side channel, the average depth of the Crains Island side channel was reduced from 9 feet to 7.5 feet. Using these data, the sediment deposition rate is estimated to be 1.2 inches per year. Using this rate for Crains Island side channel would suggest that the remaining portion of the side channel would fill in completely in approximately 75 years; however, based on aerial imagery analysis comparing 1976 to 2011, the side channel has seen a decrease in surface water area by 29% and an increase in areas with sediment from 0% to 43%. Additionally, the in-channel area with excessive woody debris has increased by 41% from 1976 to 2011. Further, it is known that sediment loads increase with flood events; therefore, if a series of more severe flood events were to occur, the life expectancy could be much less than that projected. The result of this sedimentation is a rapid conversion of water cover to land cover. This conversion translates to a quantitative loss of habitat for migratory and resident wildlife. In a similar manner, riverine fish are impacted by a loss of backwater spawning and rearing habitat.

- The restoration and rehabilitation of wetland habitats would provide resting, feeding, nesting, breeding, and predator-escape cover for many forms of migrating and resident wetland wildlife. It would improve aquatic habitat for fishes and reptiles/amphibians, which require a diversity of interconnected habitats within a landscape context to provide for habitat needs at every stage of their life cycle (Phillips et al. 1999). Restoring wetland habitat at the MMNWR, which encompasses Crains Island, has been identified in the *Illinois Wildlife Action Plan* as a Tier 3 (highest priority). Further, the *Upper Mississippi River System Habitat Needs Assessment* (Theiling, et al., 2000), has identified the restoration of wetlands as a habitat need for the MMR (Theiling, et al., 2000).
- The restoration and rehabilitation of floodplain forest on Crains Island would provide valuable resting, nesting, foraging, and breeding habitat for resident and migrant wildlife species. Floodplain forests serve as some of the most densely populated and diverse avian habitat in North America with high species richness and high abundances, and habitat loss is negatively impacting these species (Best 1996, Knutson 1995, Twedt and Portwood 1997). In addition, the *Upper Mississippi River System Habitat Needs Assessment* (Theiling, et al., 2000) has identified restoration of floodplain forest as a habitat need for the MMR (Theiling, et al, 2000).

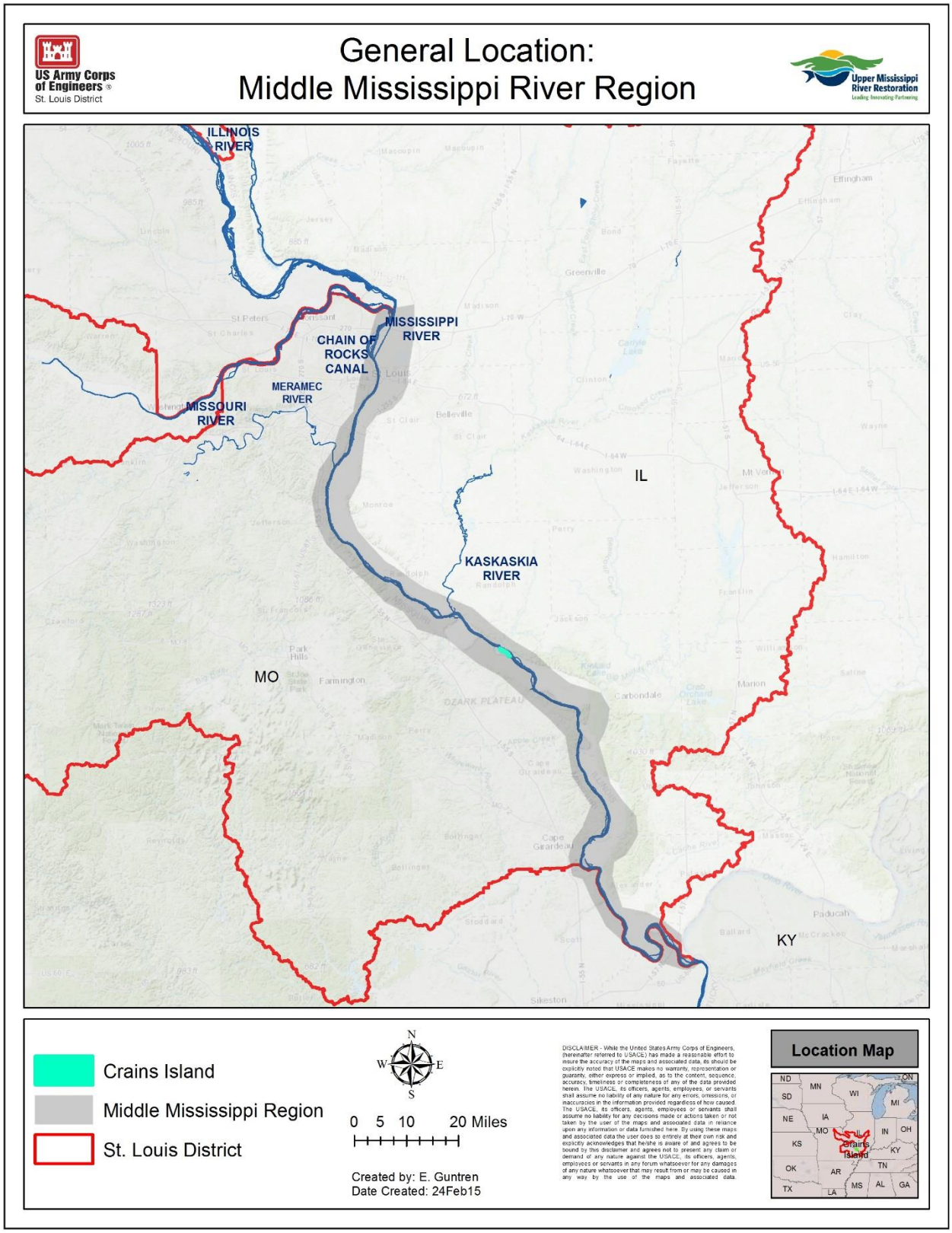

Figure 1. Middle Mississippi River Region.

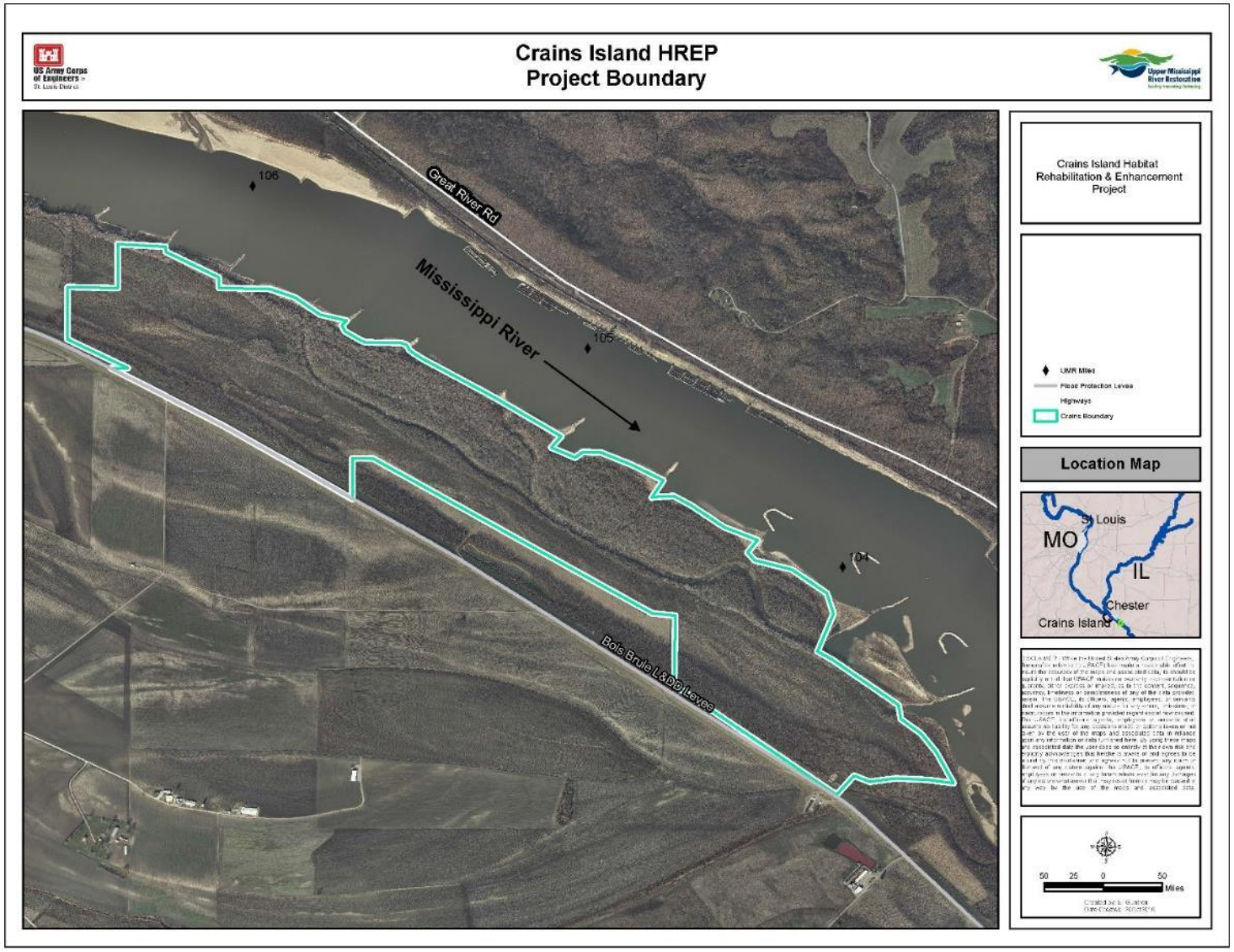

Figure 2. Project Area Crains Island

1.6 Site Selection

The USFWS identified the site for potential inclusion in the UMRR Program. The River Resources Action Team (RRAT) is a coordinating team consisting of federal, state, and non-governmental agencies that are involved in the planning of ecosystem restoration in the Upper Mississippi River. The team met several times beginning in Spring 2009 to identify unique characteristics, stressors, and objectives for the region. The team utilized information from the 2000 Habitat Needs Assessment as well data from prior planning studies. After considering resource needs and deficiencies by reach, the RRAT supported the study because it supports the objectives as outlined in the document and provides opportunities for significant aquatic side channel, wetland, and floodplain ecosystem benefits. The project has been briefed multiple times to the UMRR Coordinating Committee and received strong support.

1.7 Resource Significance*

The Planning Guidance Notebook (2000) ER 1105-2-100 defines significance in terms of institutional, public, and technical recognition. See Table 1 for additional information.

Institutional Significance

Institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. Sources of institutional recognition include public laws, executive orders, rules and regulations, treaties, and other policy statement of the Federal Government; plans, laws, resolutions, and other policy statements of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

The formal recognition of the UMR Basin in laws, adopted plans, and other policy statements of public agencies and private groups illustrate the significance of the basin. The U.S. Congress recognized the UMR as a unique, "…nationally significant ecosystem and a nationally significant commercial navigation system…" in Section 1103 of the WRDA of 1986.

The UMR and Great Lakes Region Joint Venture was established under the North American Waterfowl Management Plan (NAWMP). Joint Ventures are comprised of a coalition of Federal, state, private agencies, and individuals that cooperate and pool resources to achieve the objectives of the NAWMP. Because the UMR Basin is part of an approved Joint Venture under NAWMP, it is recognized as institutionally significant from a national/international perspective. The Project is expected to support the NAWMP's goals for conservation and management of waterfowl species and habitat by protecting migratory waterfowl species populations through restoration and maintenance of emergent and forested wetland habitat in Crains Island.

Public Recognition

Public recognition means that some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, and providing volunteer labor and correspondence regarding the importance of the resource.

Ecosystem restoration and monitoring of the Upper Mississippi River System (UMRS) provide substantial benefits to the river communities, the UMRS region, and the nation. An HREP may restore fish and wildlife habitat, and by doing this attracts visitors to fish, hunt, bird watch, and simply enjoy the restored area. The significance to the public is documented in Table 1.

Technical Recognition

Technical recognition means that the resource qualifies as significant based on its "technical merits", which are based on scientific knowledge or judgement of critical resource characteristics. Whether a resource is determined to be significant may of course vary based on differences across geographical areas and spatial scale. While technical significance of a resource may depend on whether a local, regional, or national perspective is undertaken, typically a watershed or larger context should be considered. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity.

Scarcity is a measure of a resource's relative abundance within a specified geographic range. Generally, scientists consider a habitat or ecosystem to be rare if it occupies a narrow geographic range (i.e. limited to a few locations) or occurs in small groupings. Unique resources, unlike any others found within a specified range, may also be considered significant, as well as resources that are threatened by interference from both human and natural causes. *Representativeness* is a measure of a resource's ability to exemplify the natural habitat or ecosystem within a specified range. The presence of a large number and percentage of native species, and the absence of exotic species, implies representation as does the presence of undisturbed habitat. *Status and Trend* measures the relationship between previous, current and future conditions. *Connectivity* is the measure of the potential for movement and dispersal of species throughout a given area or ecosystem. A resource's connection to survival, or recovery of one or more species. *Biodiversity* is a measure of the variety of distinct species and the genetic variability within them. *Limiting Habitat* is the measure of resources present supporting significant species.

Numerous scientific analyses and long-term evaluations of the UMRS have documented its significant ecological resources. Since the early 20th century, researchers, government agencies, and private groups have studied the larger river floodplain system and proposed ecosystem restoration in the UMRS.

In a 1995 report, the U.S. Department of Interior (DOI) listed large streams and rivers as endangered ecosystems in the United States. The DOI documented an 85 to 98 percent decline in this ecosystem type since European settlement. In particular, large floodplain-river ecosystems have become increasingly rare worldwide. Two of the large floodplain-river ecosystems lay within the UMRS, namely the Upper Mississippi and Illinois Rivers. These two ecosystems still retain some seasonal flood pulses, and half of their original floodplains remain unleveed and open to the rivers (Sparks et al. 1998). The UMRS is one of the few areas in the developed world where ecosystem restoration can be implemented on large floodplain-river ecosystems (Sparks 1995).

In addition, technical resource agencies (federal, state, and non-profit) view the resources in MMR as significant and are reflected in the ongoing habitat restoration efforts in the region including the proposed projects at Harlow Island, Wilkinson Island, and Oakwood Bottoms. The *Upper Mississippi River System Habitat Needs Assessment* (Theiling, et al., 2000) has also technically recognized the need to restore side channel, contiguous backwater, emergent wetlands, and floodplain forest habitats within MMR.

Additionally, the MMRNWR was identified by the *2015 Implementation Guide to the Illinois Wildlife Action Plan* as being a Tier 3 – Highest Priority area for restoration and management through the Wetlands Campaign. Not all sites received Tier 3 ranking due to potential wetland quality, habitat value, management capability, wildlife use, and other considerations. Tier 3 sites typically offer moderate to high quality wetland habitat, have significant wetland wildlife use, wetland constituent use, and can significantly impact wetland dependent wildlife, particularly species in greatest need of conservation. In the case of Crains Island, it has high wetland habitat potential.

Table 1 Resource Significance for Crains Island

		Sources of Significance		
Resource	**Location**	**Institutional Recognition**	**Public Recognition**	**Technical Recognition**
Aquatic Habitat (including side channel)	Crains Island is part of the MMR National Wildlife Refuge.	Fish and Wildlife Conservation Act of 1980 Clean Water Act Mark Twain National Wildlife Refuge Comprehensive Conservation Plan (USFWS 2004). National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy	In 1986, Congress designated the UMRS as both a nationally-significant ecosystem and a nationally-significant navigation system. The UMR Basin Association advocates for restoration of habitat on the UMR. The UMRCC, made up of UMR resource professionals, is also a strong advocate for habitat restoration on the river. America's Watershed Initiative, collaboration with hundreds of business, government, academic, and civic organizations to find solutions for the challenges of managing the Mississippi River and its more than 250 tributaries, graded the UMR ecosystems as a C-. American Rivers, a non-governmental organization dedicated to protecting and restoring healthy, natural rivers, listed the Mississippi River in America's Top Ten Endangered Rivers for 2004 and added the Mississippi River as a "special mention" on the 2011 list. Sport fishing and commercial fishing are common throughout the MMR.	*Representativeness:* Many of the important recreational and commercial fish species (e.g., Gizzard Shad, Channel Catfish, Freshwater Drum, Red Shiner (Cyprinella lutrensis), Emerald Shiner, Channel Shiner, River Carpsucker, Bluegill (Lepomis macrochirus), and Shortnose Gar) are most commonly found in side channels of the MMR during different times of the year. *Limiting Habitat:* 32 side channels exist within the MMR (RM 0 to 195), of which only 10 flow year-round. *Connectivity:* Side channels provide extremely important habitat in the MMR for fish and invertebrates. They provide refuge for fish escaping navigation disturbances, as well as important feeding, spawning, nursery, and overwintering fish habitat (Scheaffer and Nickum 1986).
Threatened and Endangered Species	Crains Island is part of the MMR National Wildlife Refuge	Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661) Endangered Species Act (ESA) of 1973, as amended Mark Twain National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2004). National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy	Congress has recognized the Nation's rich natural heritage is of "esthetic, ecological, educational, recreational, and scientific value to our Nation and its people."	*Representativeness:* The USFWS has identified the Indiana bat; northern long-eared bat; small whorled pogonia; least tern; and pallid sturgeon as federally-endangered or threatened species that have the potential to occur within Randolph County, IL. *Scarcity:* The Revised Recovery Plan for the Pallid Sturgeon (USFWS 2014). The federally-endangered pallid sturgeon has been found directly adjacent to the Project Area in seven locations between 1995 and 2000.

Resource	Location	Institutional Recognition	Public Recognition	Technical Recognition
Migratory Birds	Crains Island is part of the MMR National Wildlife Refuge	Migratory Bird Conservation Act of 1929, and associated treaties Migratory Bird Treaty Act of 1918 EO 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds Bald and Golden Eagle Protection Act of 1940 North American Waterfowl Management Plan	Migratory birds provide the public with recreational opportunities, such as bird watching and waterfowl hunting. National Audubon's Mississippi River Campaign has been working to raise awareness of the importance of the Mississippi River as an internationally significant resource since 1998. The Upper Mississippi River Waterfowl Conservation Region (Region 19) is a level III Ducks Unlimited conservation priority area, providing a migration corridor for hundreds of thousands of dabbling ducks and significant numbers of divers.	*Representativeness:* Numerous migratory birds utilize Crains Island; the following as the most relevant in the area: Bald Eagle, Great Blue Heron, Waterfowl, and neotropical migratory birds. *Representativeness:* Knutson et al. (1998) found relative abundances of all birds and total numbers of neotropical migratory birds were almost twice as high in the UMR floodplain as in the adjacent uplands. *Status and Trend:* Changes in the MMR forest community have contributed to a reduction in diversity of habitat over time. These trends are likely to continue, and without intervention, Crains Island will cease to provide migration, dispersal, breeding, nesting, and cover habitat for a wide range of migratory birds.
Floodplain Forests	Crains Island is part of the MMR National Wildlife Refuge	Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661) ESA of 1973, as amended Mark Twain National Wildlife Refuge Comprehensive Conservation Plan (USFWS 2004). National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy	The UMRCC recognized the importance of the floodplain forest to the fish and wildlife of the UMR in the report, *Upper Mississippi and IL River Floodplain Forests* (Urich et al., 2002). Knutson et al. (1996) described the importance of floodplain forest in the conservation and management of neotropical migratory birds.	*Representativeness:* Crains Island contains approximately 110 acres of floodplain forest habitat. *Biodiversity:* The largest concern is without intervention, the Project Area is likely to continue to experience forest fragmentation and limited species and structural diversity. Consequently, neotropical and other migratory birds, Indiana bats, and the other floodplain species that rely on the forest resources will be severely impacted.
Wetlands	Crains Island is part of the MMR National Wildlife Refuge	The 2015 *Implementation Guide to the Illinois Wildlife Action Plan* Tier 3 – Highest Priority area for restoration and management through the Wetlands Campaign. Executive Order No. 11990 of May 1977 (Protection of Wetlands) Water Resources Development Act of 1990, Section 307(a) Mark Twain National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2004). National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy	Wetlands are of unique ecological value as natural biological filters and serve as sources and sinks for multiple biological, chemical, and physical processes locally as well as on a landscape scale. Wetlands are valuable resources for fish and wildlife, of which most species depend on in one way or another throughout their lifecycle.	*Scarcity:* In the United States, over a period of 200 years, between the 1780s and the 1980s, the lower 48 states have lost an estimated 53% of the 221 million acres of original wetlands. *Scarcity:* Through land use changes, approximately 90% of presettlement wetlands were lost by the 1980's in Illinois. *Status and Trend:* Without Crains Island HREP, the site will continue to lack ephemeral wetlands, needed to support a variety of wildlife species.

1.8 Proposed Federal Action*

The HREP focuses on the proposed restoration measures that would improve ecosystem resources (aquatic side channel, wetland, and floodplain ecosystem benefits) within the MMR.

The federal action of selecting one of the alternatives for potential implementation will be determined by the USACE St. Louis District Engineer. The District Engineer will also determine, based on the facts and recommendations contained herein, whether this Environmental Assessment (EA) is adequate to support a Finding of No Significant Impact (FONSI) or whether an Environmental Impact Statement (EIS) will need to be prepared. This information will be updated with the TSP. The Mississippi Valley Division Commander has the final approval of the Feasibility Report and the recommended plan.

1.9 Scoping and Coordination*

Scoping is an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. Scoping was conducted during the planning process using a variety of communication methods with the affected public, agencies, and organizations.

Scoping and coordination has been conducted with the following State and Federal agencies, and other interested parties:

- U.S. Fish and Wildlife Service
- Illinois Department of Natural Resources
- Missouri Department of Conservation
- Illinois State Historic Preservation Office
- The Nature Conservancy
- U.S. Environmental Protection Agency
- Bois Brule Levee District
- RRAT Reach Planning Meeting

The RRAT Reach Planning Meeting and annual RRAT boat trips include both state and federal agencies as well as members from the river industry, NGOs, and the general public. The input received during scoping was incorporated in the process of making decisions for the project. Appendix A – *Coordination* documents the coordination.

Coordination Meetings

Numerous coordination and stakeholder meetings were held with the Project cooperators to discuss problems, opportunities, project goals and objectives, potential restoration measures, and expected outcomes with and without the proposed project.

A Functional Analysis Value Engineering Workshop was held (27-31 July 2015) prior to the development of this report. Fourteen technical experts from the Missouri Department of Conservation, Illinois Department of Natural Resources, USFWS, and USACE attended the workshop. The team provided input on project objectives, potential project features, future conditions of the site, and to identify resource issues. A copy of the executive summary is provided in Appendix A - *Coordination*. A full copy of the Value Engineering Functional Analysis report is available upon request. In addition, development of this report was actively coordinated throughout the planning process with the project partner, USFWS, as well as other natural resource agencies.

Coordination was made with the Bois Brule Levee District Commission via telephone, emails, and face to face meetings. Additional coordination meetings will be scheduled prior to the

finalization of this feasibility report and during construction to discuss the features of the NER plan, the UMRR Program, and overall project schedule.

Refer to Appendix A – Coordination for more information about Project sponsor meetings and coordination.

Public Review and Comments

In accordance with NEPA, the report with integrated environmental assessment and unsigned draft FONSI will be made available to interested members of public during a 30-day public review period, yet to be scheduled. The report will be made available on the St. Louis District's website along with a letter mailed to interested members of the public addressing where to find the report, how to provide comments, and the date of the public meeting/open house (provided in Appendix A - *Coordination*). A public meeting/open house will be held. Comments received during public review will be incorporated into the report where appropriate, and copies of written comments received will be provided in Appendix A - *Coordination.*

Tribal Scoping

The United States government has a unique legal relationship with federally recognized American Indian tribes based on recognition of inherent powers of Tribal sovereignty and self-government. Communication with federally recognized tribes was initiated with a USACE letter dated 24 August 2015. Copies of all tribal correspondence are provided in Appendix A - *Coordination*.

1.10 Prior Studies, Reports, and Existing Water Projects

The following references provide further detail on the UMRS, in terms of formation over geological time; physical, environmental, and cultural characteristics; social and economic conditions; and multi-purpose management:

Johnson, B.L., and K.H. Hagerty, eds. 2008. Status and Trends of Selected Resources of the Upper Mississippi River System. U.S. Geological Survey, La Crosse, WI. Technical Report LTRMP 2008-T002. This report describes the UMRS and includes discussions on the historic and existing conditions, river monitoring and management, and ecosystem goals and indicators. It also discusses the status and trends of biological, physical, and chemical indicators of system health developed through UMRR-LTRM.

Heitmeyer, M.E. 2008. An Evaluation of Ecosystem Restoration Options for the Middle Mississippi River Regional Corridor. Advance, MO: Greenbrier Wetland Services. This report provides this Hydrogeomorphic-based assessment with the following objectives: 1) Identify the pre-European settlement ecosystem condition and ecological processes in the MMR; 2) Evaluate differences between pre-European settlement and current conditions in the vegetation community structure and distribution, and 3) Identify restoration and management approaches and habitats and conditions with the MMR.

McGuiness, D. 2000. A River that Works and a Working River: A Strategy for the Natural Resources of the Upper Mississippi River System. Upper Mississippi River Conservation Committee (UMRCC), Rock Island, IL. This report describes the critical elements of a strategy for the OMRR&R of the natural resources of the UMRS and its tributaries including the setting of restoration goals and objectives. The report suggests nine objectives for successful resource management of the UMRS: 1) improve water quality, 2) reduce erosion, sediment, and nutrient impacts, 3) return natural floodplain, 4) restore seasonal flood pulse and periodic low flow conditions, 5) restore backwater connectivity, 6) manage sediment transport and deposition in floodplain and side channels, 7) manage dredging and channel maintenance, 8) sever pathways for exotic species, and 9) provide for passage at dams.

*Theiling, C.H., C. Korschgen, H. DeHann, T. Fox, J. Rohweder, and L. Robinson. 2000. Habitat Needs Assessment for the Upper Mississippi River System: Technical Report. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI. Contract report prepared for U.S. Army Corps of Engineers, St. Louis District, St. Louis, MO***.** This report summarizes the first Habitat Needs Assessment of the UMRS and is designed to help guide future ecosystem restoration projects. It describes and compares historical, existing, forecasted, and desired future conditions to identify habitat needs within the UMRS.

Upper Mississippi River Restoration Environmental Design Handbook. 2012. USACE, Rock Island District, Rock Island, IL. The design handbook of the UMRR evaluates project features and incorporates lessons learned throughout the lifetime of the program.

Upper Mississippi and Illinois River Floodplain Forests: Desired Future and Recommended Actions. 2002. Upper Mississippi River Conservation Committee. This report highlights the ecological importance of floodplain forests in the Upper Mississippi (from the head of navigation at Minneapolis, MN to the confluence with the Ohio River at Cairo, IL) and Illinois Rivers (entire Illinois River) and provides management recommendations to achieve desired future conditions for those forests.

Report to Congress, Upper Mississippi River System Environmental Management Program. 2004 USACE, Rock Island District, Rock Island, IL. This report is the first formal evaluation of the UMRR. This report evaluates the program; describes its accomplishments, including development of a systemic habitat needs assessment; and identifies certain program adjustments.

2010 Report to Congress, Upper Mississippi River System Environmental Management Program. USACE, Rock Island District, Rock Island, IL. This report is the most recent formal evaluation of the UMRR that evaluates the program; describes its accomplishments, including development of a systemic habitat needs assessment; and identifies certain program adjustments.

2004 Mark Twain National Wildlife Refuge Complex Comprehensive Conservation Plan. USFWS. This plan covers five National Wildlife Refuges (Port Louisa NWR, Great River NWR, Clarence Canon NWR, Two Rivers NWR, and Middle Mississippi River NWR) and nearly 500 miles of the Mississippi River corridor. The primary purpose of the plan is to be a guide for current and future refuge managers.

Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study, Feasibility Report 2004. USACE, St. Paul, Rock Island, and St. Louis Districts. This feasibility study examines multiple navigation and environmental restoration alternatives, and contains the preferred integrated plan as a framework for modifications and operational changes to the UMR and the IWW System to provide for navigation efficiency and environmental sustainability.

Environmental Science Panel Report: Establishing System-wide Goals and Objectives for the Upper Mississippi River System. D. Galat, J. Barko, S. Bartell, M. Davis, B. Johnson, K. Lubinski, J. Nestler, and D. Wilcox, UMRS Navigation and Ecosystem Sustainability Program, NESP ENV Report 6, Rock Island, IL 2007. The report presents suggested refinements to system-wide ecosystem goals and objectives and proposed steps to take in the further development of objectives for the system.

Upper Mississippi River System Ecosystem Restoration Objectives, USACE, 2009. This report is the final product of a planning process initiated in 2008 for the purpose of identifying areas for new restoration projects and identifying knowledge gaps at a system scale. The Report serves

as a backdrop for the formulation of specific restoration projects and their adaptive ecosystem management components.

America's Watershed Initiative Report Card for the Mississippi River, America's Watershed Initiative, 2015. America's Watershed Initiative (AWI) is a collaboration including public and private-sector leaders from the 31 states comprising the Mississippi River Watershed, working together to find solutions for the challenges we face managing the Mississippi River; and the more than 250 rivers that eventually flow into it.

2 AFFECTED ENVIRONMENT*

Chapter 2 assesses the existing conditions of resources, organized by resource topic, within the Project Area. Resource topics analyzed in detail include natural resources (floodplain habitat, aquatic resources), hydrology and hydraulics, geology and soils, fish and wildlife, Illinois resources of concern, federally threatened and endangered species, invasive species, water quality, air quality, greenhouse gas emissions, hazardous, toxic and radioactive waste, historic and cultural resources (tribal and state historic preservation coordination), socioeconomic resources, aesthetic resources, noise levels, and environmental justice. This is not a comprehensive discussion of every resource within the study area, but rather it focuses on those aspects of the environment that were identified as relevant issues during scoping or may be affected by the considered alternatives. The environmental consequences on these resources are described in Chapters 8 and 9 of this report.

2.1 Resource History of the Study Area

Prior to European settlements in the late 1700s and early 1800s, the MMR contained some of the first native people to populate North America, including one of the largest Mississippian era communities at Cahokia (Heitmeyer 2008). As a whole, the MMR has a diversity of ecological communities ranging from prairie-dominated floodplains in the north to lowland bottomland hardwood forests in the south.

Since early settlement, the MMR has been modified by humans. Starting in the late 1800s, large areas of forest and prairie were cleared and coupled with drainage modifications for agricultural production. Ridges and swales were leveled to provide a flat landscape suitable for agriculture.

The MMR is now confined by major levees, drainage ditches, roads, and floodplain development.

Today the MMR is a major navigation transportation corridor. The MMR is located centrally within the larger Mississippi River drainage system and it is used for shipping of agricultural, industrial, and commercial commodities. Figure 3 provides a series of aerial photographs of the Project Area from 1890 to 2015, which shows the formation and changes of Crains Island over time. Figures 4-8 document the land cover changes for Crains Island and Figure 9 documents the topographic elevation for Crains Island.

The Mississippi River near Crains Island has been dramatically altered over the years as a result of the construction of river training structures. The structures were constructed as part of the U.S. Army Corps of Engineers authority to obtain and maintain a safe and dependable navigation channel. Additionally, the floodplain has been disconnected as a result of the construction of the Bois Brule levee originally completed in 1937 and completed to its current state in 1968. This levee also ultimately closed the Missouri Chute, an old channel located inland of Crains Island that shared the same entrance and exit. The levee is currently operated and maintained by the Bois Brule Drainage and Levee District.

Crains Island was created by the river, the use of timber piles expanded the island and connected it largely to the mainland right-descending bank, causing loss of "true" island and side channel habitat. Historical documentation shows that seven structures built between 1928 and 1968 were primarily responsible for expanding Crains Island. Prior to the 1960s it is presumed almost all of the structures placed in MMR, including ones located in the vicinity of Crains Island were of the wooden pile type. During the same period, river training structures also led to the loss of numerous islands in the MMR.

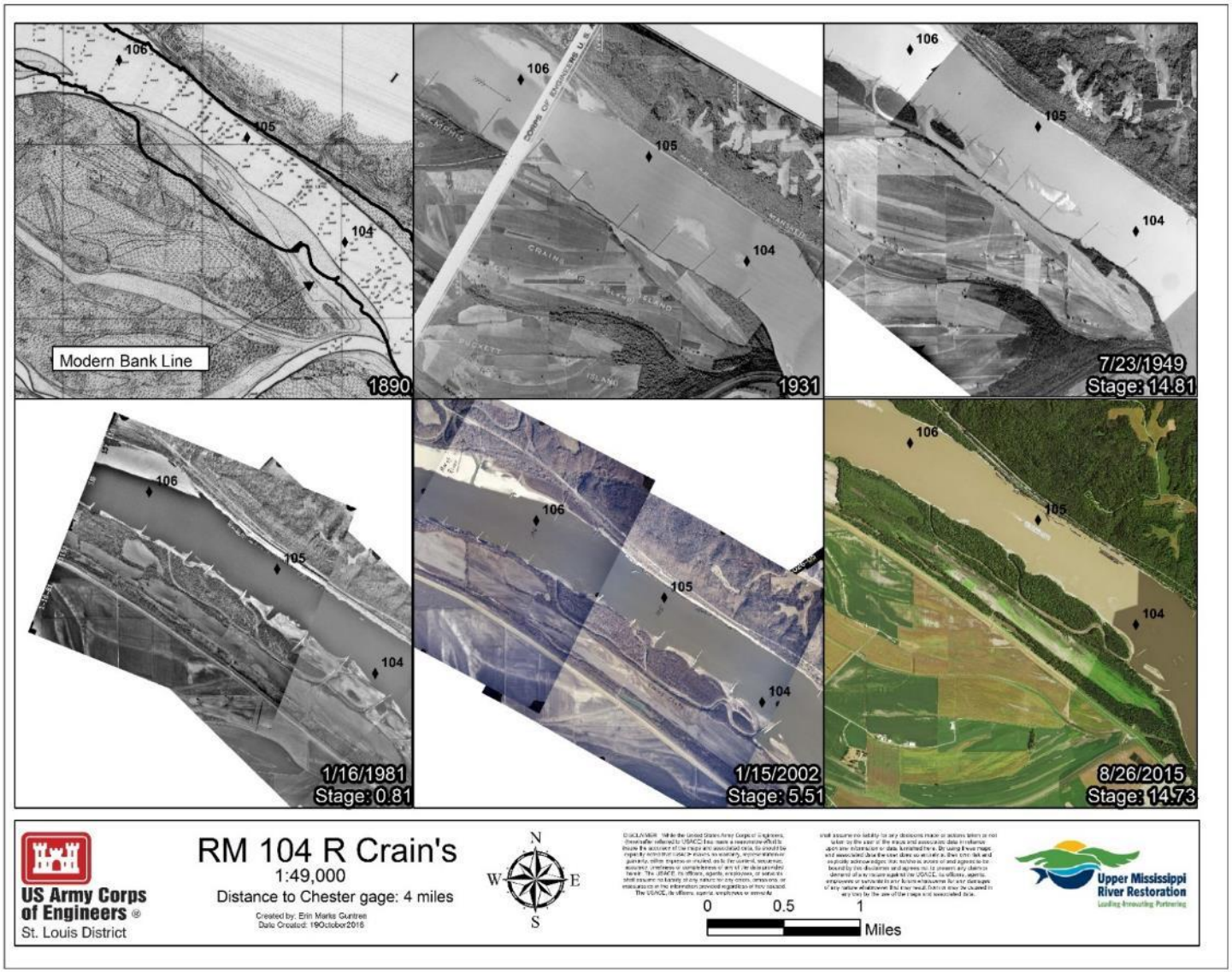

Figure 3. Crains Island historical imagery for 1890, 1949, 1981, 2002, and 2011 with stages at Chester, IL gage.

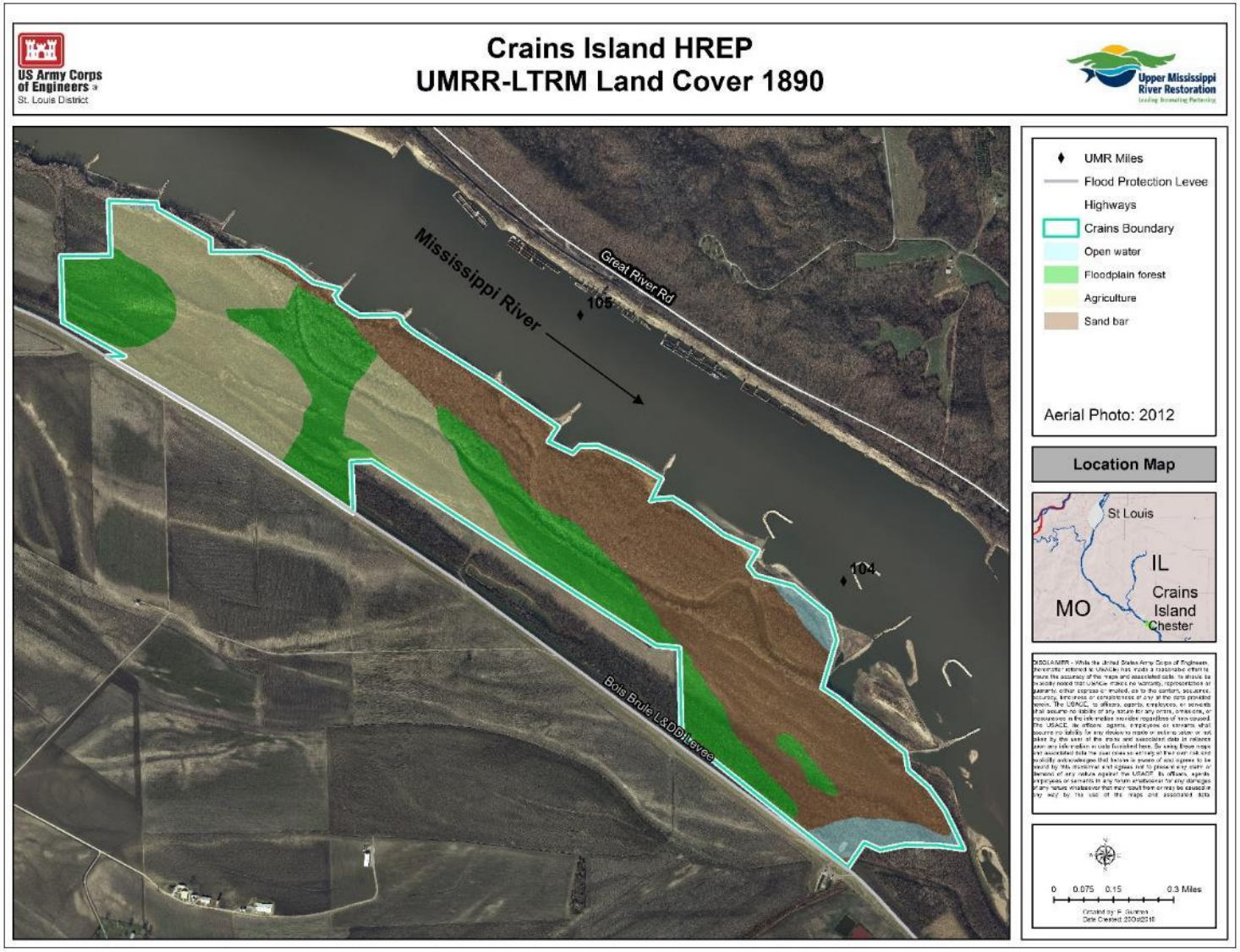

Figure 4. Crains Island 1890 land cover classification.

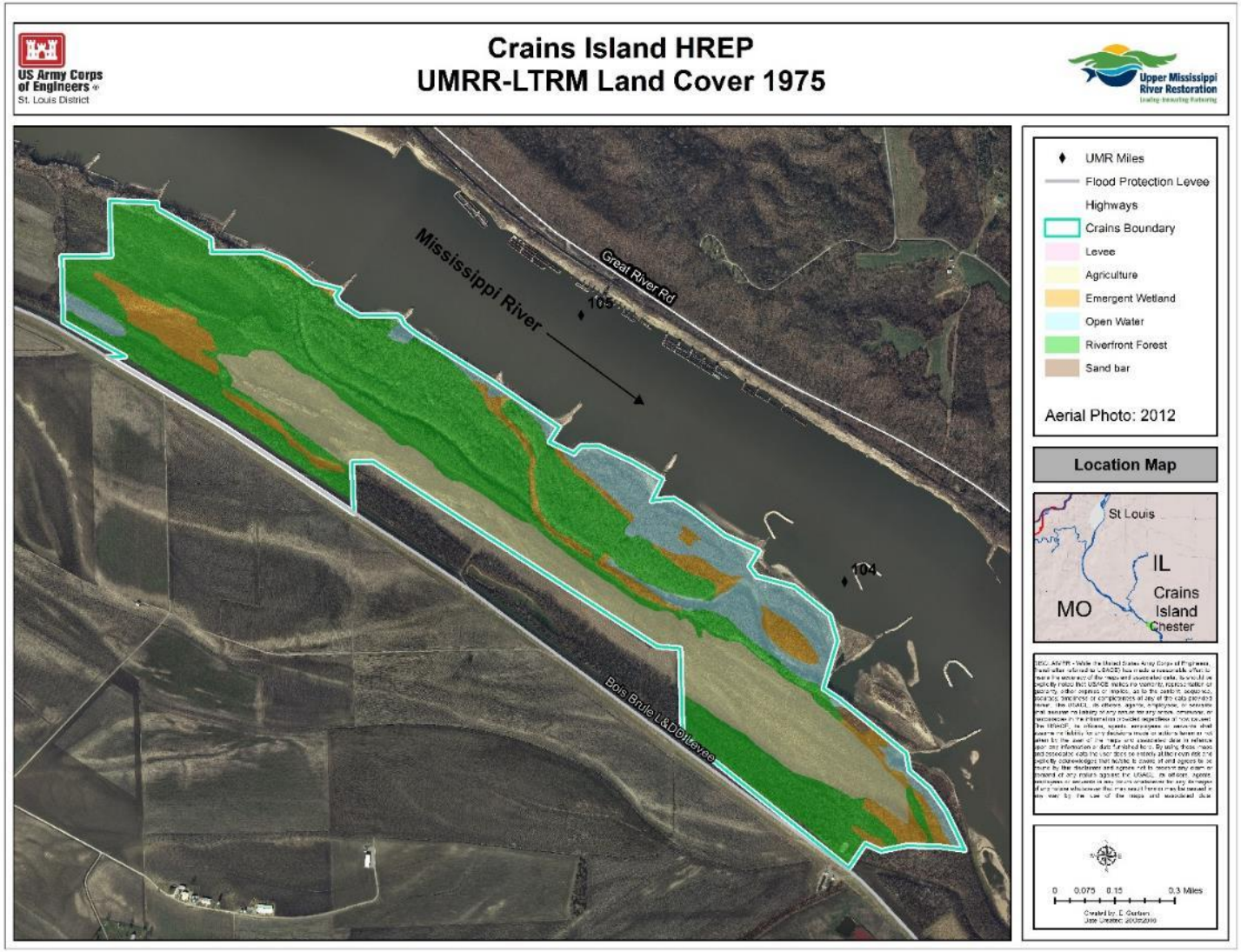

Figure 5. Crains Island 1975 land cover classification.

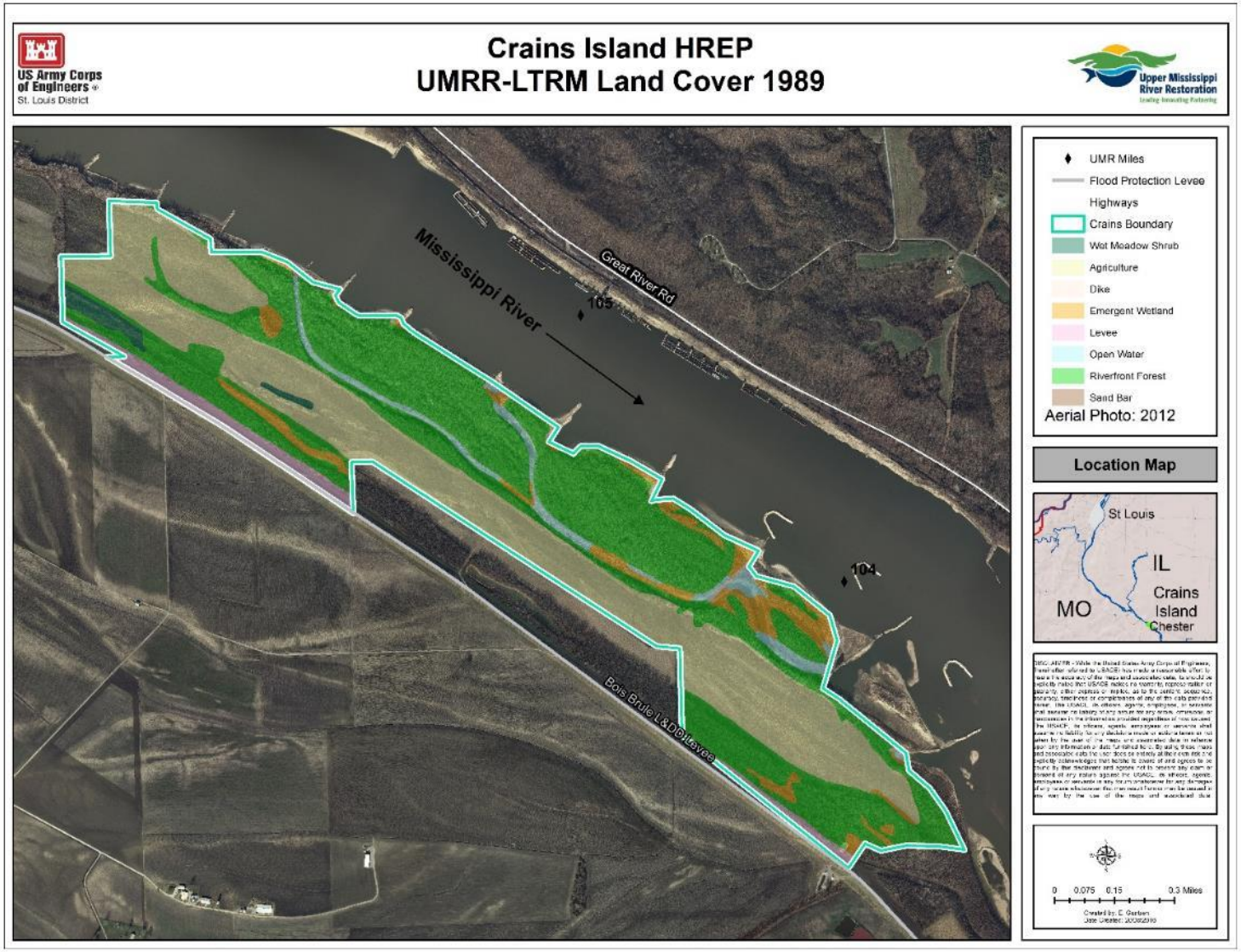

Figure 6. Crains Island 1989 land cover classification.

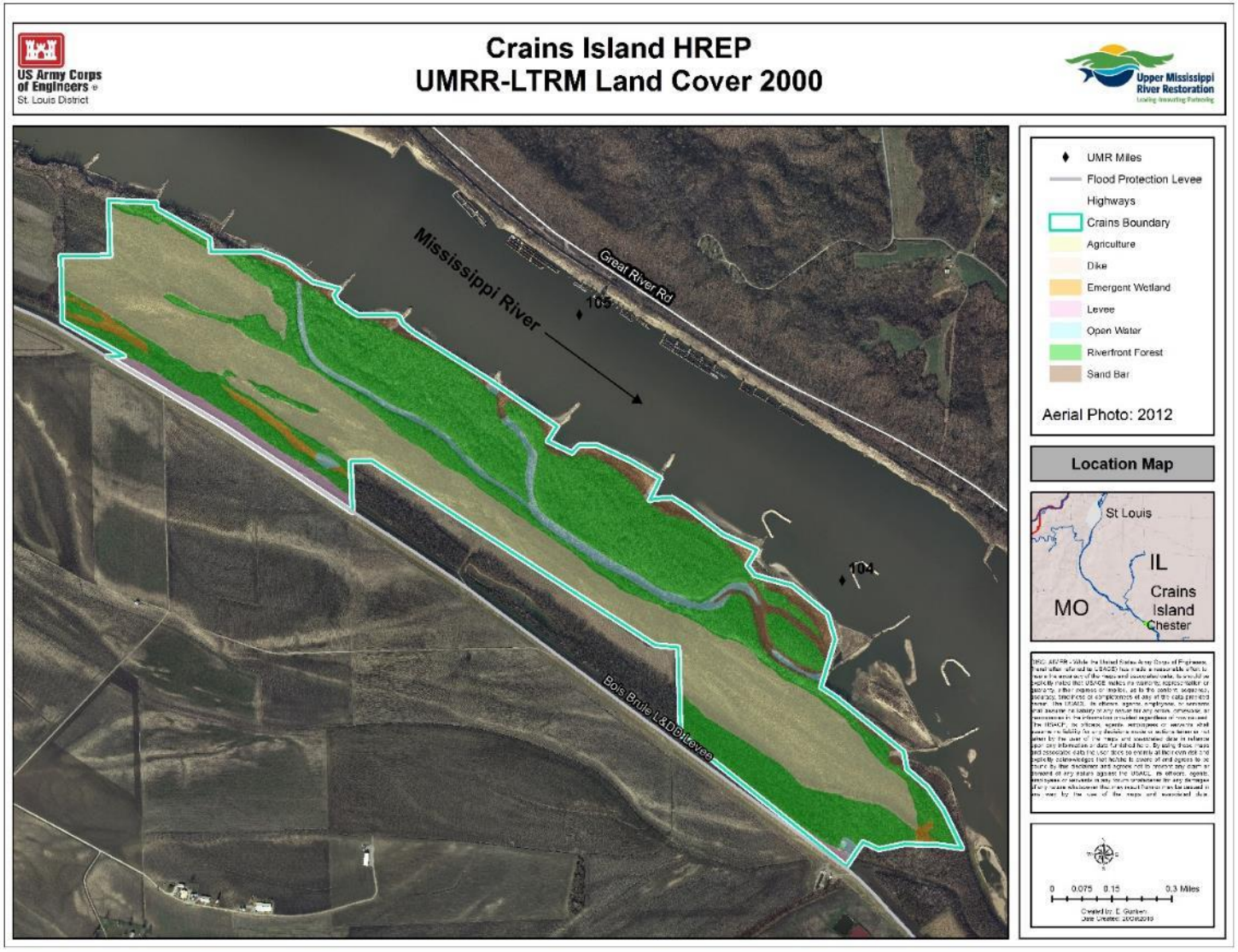

Figure 7. Crains Island 2000 land cover classification.

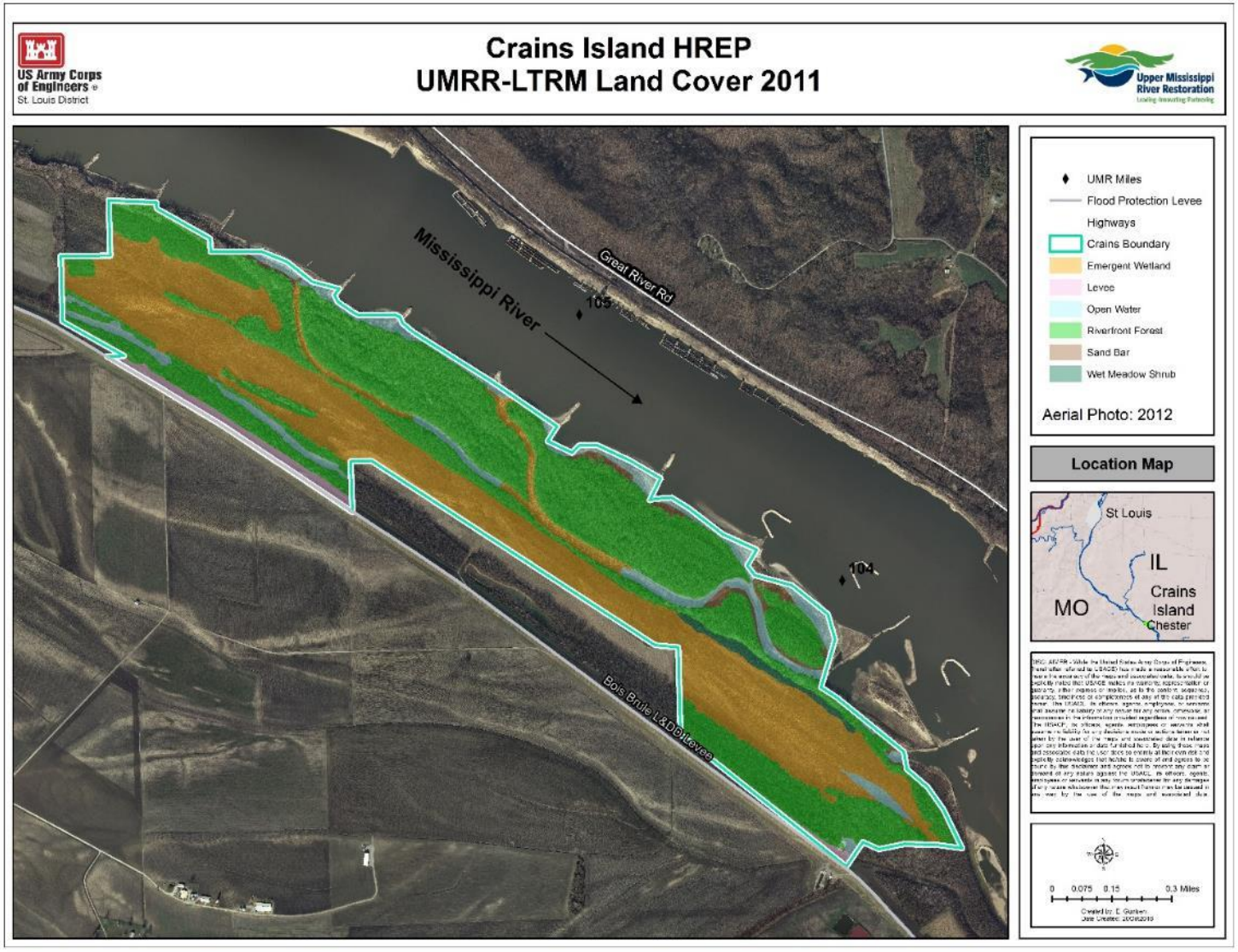

Figure 8. Crains Island 2011 land cover classification.

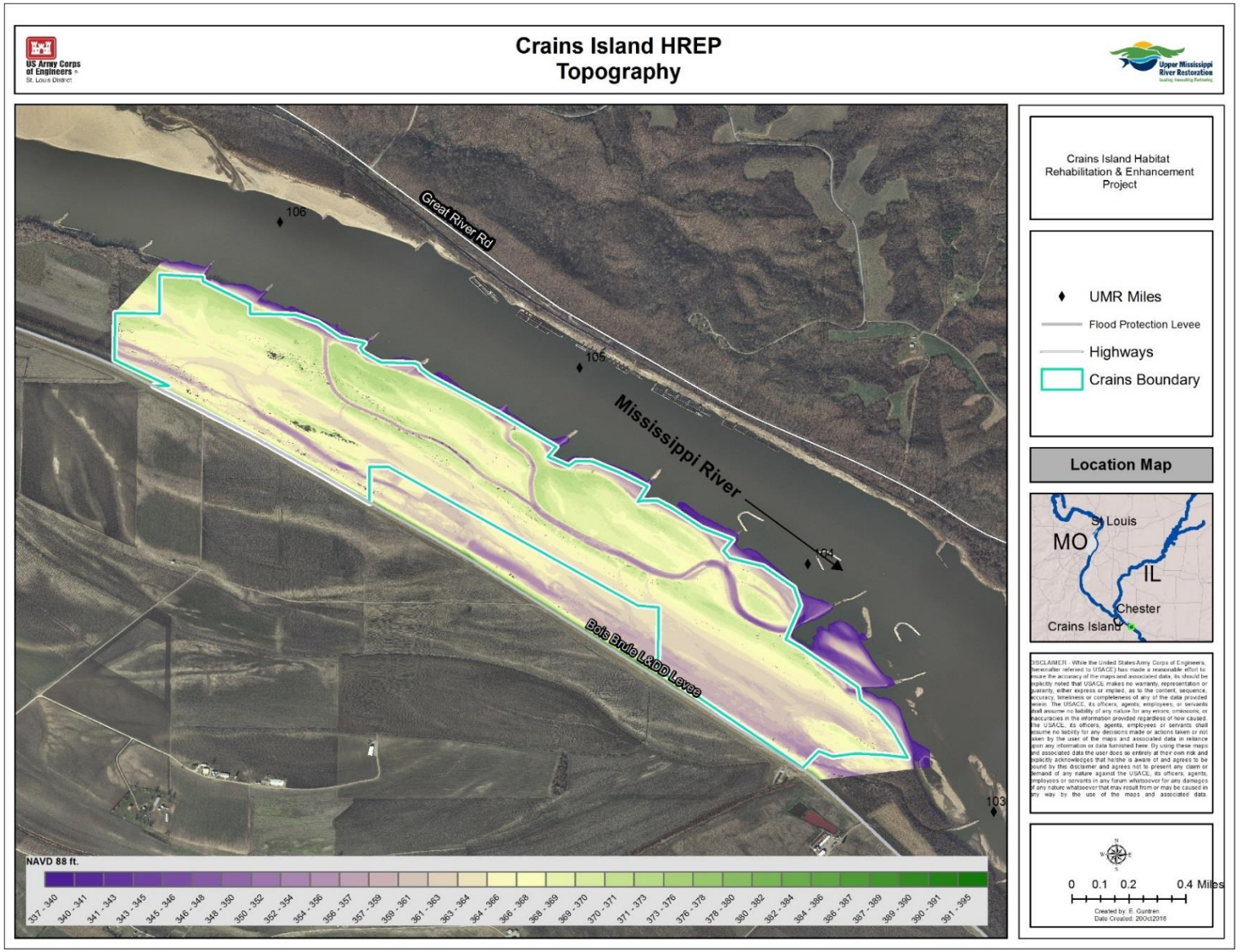

Figure 9. Topographic elevation map of Crains Island.

2.2 Description of Current Management

The project encompasses 553 acres of aquatic side channel, floodplain forest, and wetland habitat. Lands of the Project are owned and managed by the USFWS, as part of the MMRNWR. The Project Area is primarily passively managed for floodplain forest habitat. Active management includes invasive species management, mowing of access trails, and maintenance of access locations.

2.3 Floodplain Habitat

The MMR has meandered across the floodplain many times over geologic time. During the last 200 years, it has maintained its position along the eastern edge of the valley for most of its length (Theiling 2000). The MMR region contains about 673,000 acres of floodplain. Five floodplain reaches were established for the MMR based on land use, river segments, and resource issues and opportunities. The Project falls within the Crains Island Floodplain reach (RM 80-117).

This reach is within the Mississippi Flyway and has the greatest concentration of bird species in Illinois (USACE 2009). Much of the original forest and prairie vegetation has been converted primarily to agricultural use (54% of the present day land use). Prior to settlement (early 1800s), the vegetation (116,000 acres) within this floodplain reach was dominated by forest (76%). In addition, this floodplain reach historically had the highest acreage of bottomland prairie ridge (appx 4,000-acres), floodplain forest ridge (appx 19,000-acres), and floodplain forest swale (appx 40,000-acres) of the entire MMR; however, today approximately 66-acres, 3,400-acres, and 3,100-acres of these vegetation types remain, respectively (USACE 2009). In 2000, the dominant land use in this floodplain reach was agriculture.

Specifically at Crains Island Division (RM 104-107; 553-acre tract), presettlement vegetation was primarily floodplain forest (84%) (USACE 2009). A large portion of the presettlement forest and wetland habitats were cleared, filled, and/or drained and converted to agricultural use. Approximately 82% of the floodplain in the MMR was leveed for agricultural use, which causes habitat fragmentation (Theiling 2003). Habitat fragmentation, which is the process in which large continuous habitat types are broken apart into smaller dissimilar habitat types, severely degrades overall floodplain ecosystem structure and function. Habitat fragmentation is currently caused by the deposition of coarse sediment material (i.e., sand) throughout the Project Area. The deposition of coarse sediments during high water events results in large sandy areas that provide limited habitat and also are a physical obstruction for wetlands species. The large sandy areas do not provide soil conditions suitable for hard mast tree establishment, which lead to fragmented forest blocks within the Project Area. Several wetland species require large contiguous blocks of bottomland forest habitat to thrive.

Floodplain Forest

The structure (e.g., age, canopy gaps, species) of floodplain forest is a vital component of sustaining a healthy and resilient floodplain river ecosystem. Historically, floodplain forests were a transition between early succession riverfront forests, occurring on coarse sediment, to bottomland hardwood forests occurring on silt-clay type soils. In the MMR, the bottomland hardwood forest was widely dispersed and interconnected. The forest community of the MMR first became altered during the steamboat era in the 1800s, where large portions of the bankline were logged for fuel (Norris 1997) and early snagging operations that removed trees hundreds of feet back from the river to prevent future snags (Theiling 1998). The bottomland hardwood forest component continued to disappear in the 1900s, when large expanses were cleared for agriculture (Theiling 1999). Prior to European settlement, forest communities had a higher proportion of hard mast, i.e., nut producing tree species such as oaks (*Quercus* spp.) and

hickories (*Carya* spp.) (Nelson et al 1994). Due to the altered hydrology as well as several large flood events, including the flood of 1993, the proportion of hard mast species has greatly declined. Unfortunately, several ecological challenges are occurring for floodplain forest within the MMR in response to the catastrophic flooding during 1993 (Knutson et al. 2005). This flood in particular induced considerable physical and biological changes throughout the entire Mississippi River floodplain forest (Yin 2009) in which the forest community has shifted to a more flood tolerant and even aged, early succession forest community consisting of silver maple (*Acer saccharinum*), willow (*Salix* spp.), and eastern cottonwood (*Populus deltoides*) (Cosgriff 1999). In addition coarse sedimentation has been seen throughout the Mississippi River floodplain and within the Project Area. Coarse sediment (i.e. sand) limits forest community composition to early succession species such as willow, cottonwood, and sycamore that can sustain large soil compositions of sand. Soils with high composition of silt are limited throughout the Project Area. Hard mast species now make up a smaller proportion of the forest community composition throughout the Mississippi River. Today, hard mast species like pecans (*Carya illinoinensis*) exist on higher elevation ridges and point bars (Heitmeyer 2008). In addition, forest habitat primarily exists in a relatively narrow band of riverfront forest (e.g., early successional and water tolerant species) between the main channel and the levee system (Theiling 2000). The result is a highly fragmented forest community reaching maturity at relatively the same time period and providing little structural, age, and species diversity. Fragmentation of forest habitat has large consequences on neotropical and other migratory birds. Tree roosting bat species including the federally endangered Indiana bat (*Myotis sodalis*) and federally threatened northern long-eared bat (*Myotis septentrionalis*), and other floodplain species which rely on the forest resources within the Project Area. Within the Project Area, dense, early-aged willow stands exists throughout with blocks of riverfront forest consisting of maples, cottonwoods, and sycamores.

2.4 Hydrology & Hydraulics

Modification of the Mississippi River for navigation purposes began in the early 1800s. The Corps of Engineers maintains a minimum 9-foot deep navigation channel, maintained by 29 lock-and-dam structures, thousands of river training structures, and hydraulic dredging. The Middle Mississippi River is located below the lock-and-dam system but is influenced by variables from upstream. In general, the Middle Mississippi River experiences a spring flood, a late summer low, and minor fall flood pulse. Average flow for the Mississippi River at Chester, IL (RM109.9) in 15 year increments from 1951 to 2016 is shown in Figure 11. Increments include: 1961 to 1976, 1971 to 1986, 1981 to 1996, 1991 to 2006, and 2001 to 2016. The year 1951 was chosen as the beginning point of historical record due to the completion of all of the major reservoir projects on the Missouri river by that year (Hesse and Mestl 1993). The more recent period of record shows an increase in flows during the spring as well as a later peak during the summer months. In addition, lower water elevations during the fall and early winter months can be attributed to timing of flows. The existing side channel at Crains Island lacks depth and is often blocked by woody debris. The current channel bottom at Crains Island is exceeded only 33% of the time (250,000 cfs). The average flows though the months of August through February are well below the values needed to inundate the current channel.

Above St. Louis, MO at the confluence of the Missouri and Mississippi Rivers, the amount of suspended sediment dramatically increases in the Middle Mississippi River (Figure 10**Error! Reference source not found.**). The main source of sediment into the MMR is the Missouri River. Although the Missouri River contributes only fifty percent of the flow, it contributes approximately seventy percent of the sediment. This includes both suspended sediment and bedload. Between 1968 and 2011 the average suspended sediment load (SSL) on the Mississippi River at St. Louis, MO was 102,770,634 Tons/Yr. During the same time period, the average SSL

on the Missouri River at Herman, Mo and the Mississippi River at Grafton, IL were 71,164,988 Tons/yr and 24,027,165 Tons/yr respectively. Approximately 1,280,829 Tons/yr were lost between Herman, MO and St. Louis, MO due to commercial dredging on the Missouri River. The approximated bedload on the Missouri River at Herman, MO was 526,654 Tons/day. In large, low-gradient river bedload has been estimated to range from less than 5 percent to 8 percent of total sediment load (USGS 2016). Additional hydrology and hydraulics information can be found in Appendix C – *Hydrology and Hydraulics*.

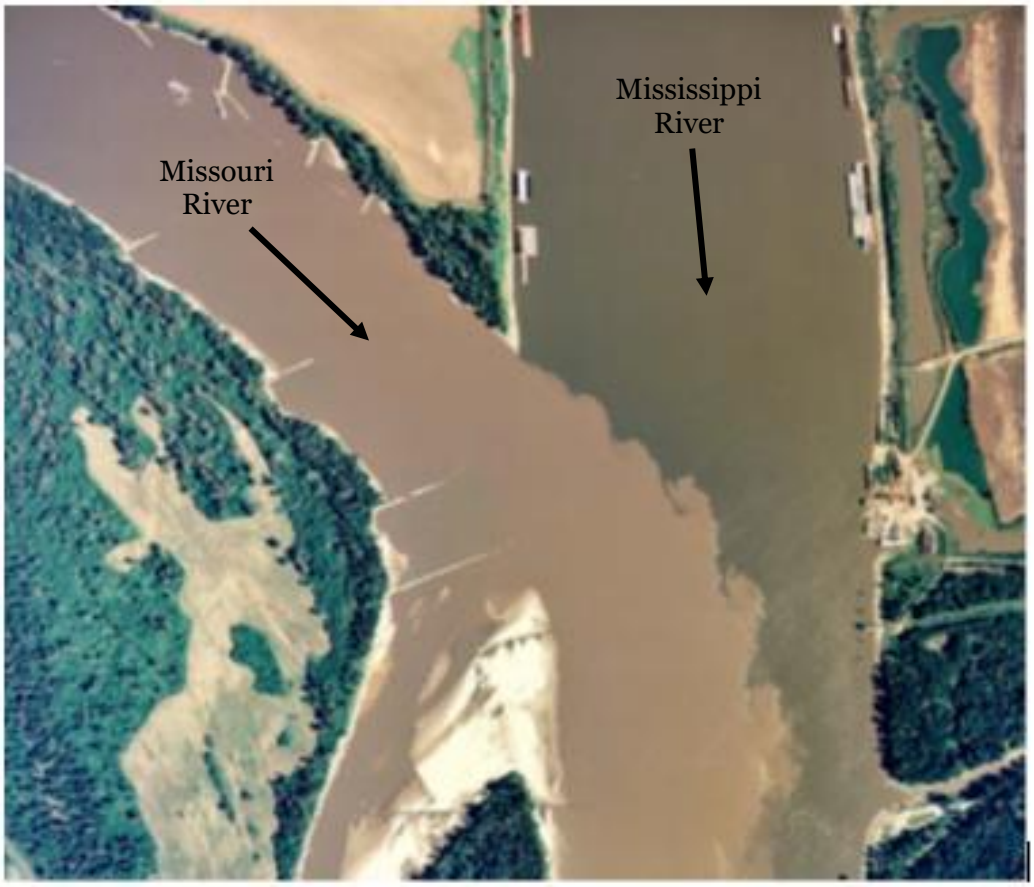

Figure 10. Aerial photo from USACE, St. Louis District aerial photo archives showing the heavy sediment load from the Missouri River at the confluence of the Mississippi River.

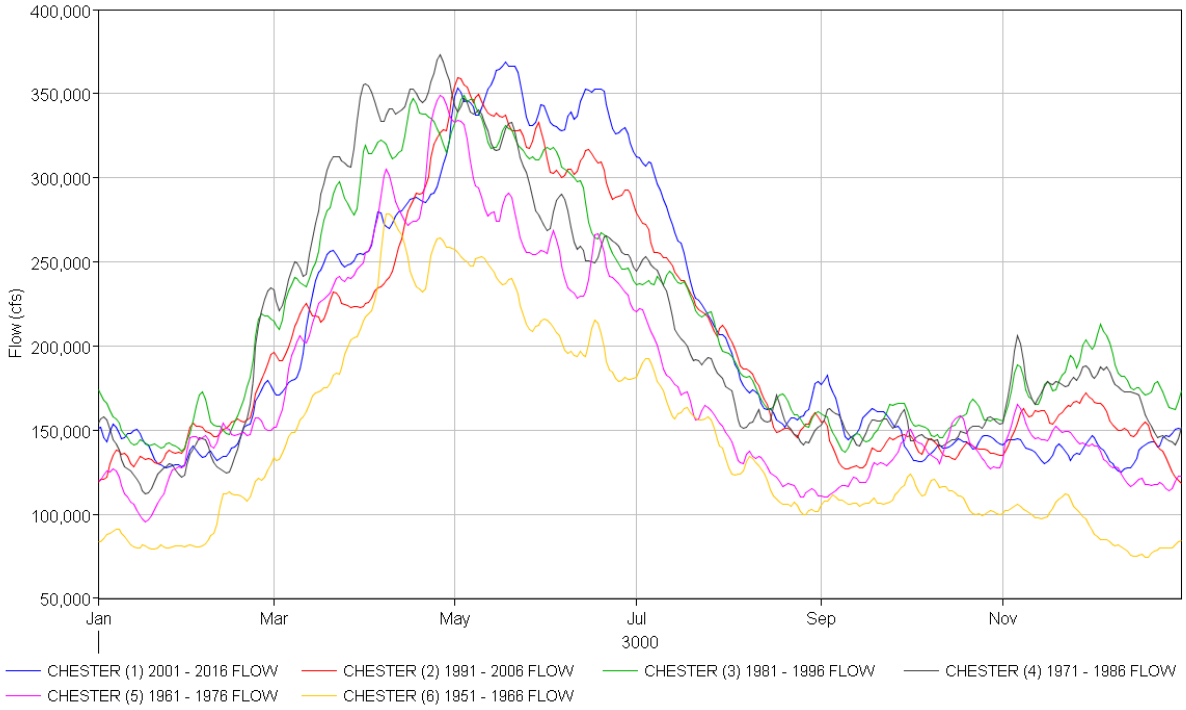

Figure 11. Daily Average Flow for the Mississippi River at Chester, IL (RM109.9) in 15 year increments from 1951 to 2016. Increments include: 1961 to 1976, 1971 to 1986, 1981 to 1996, 1991 to 2006, and 2001 to 2016.

2.5 Aquatic & Wetland Resources

Side channels provide extremely important habitat in the MMR for fish and invertebrates. They provide refuge for fish escaping navigation disturbances, as well as important feeding, spawning, nursery, and overwintering fish habitat (Scheaffer and Nickum 1986). Past land and river changes have reduced this type of habitat. Side channels represent the major source of off-channel water bodies in the MMR. They provide a well-defined gradient between flowing to non-flowing water depending on the level of connectivity to the main channel. The St. Louis District has undertaken several recent analyses in the MMR to document the historic and current conditions of side channels to help quantify their current state and past trends (USACE 2017). Of the 32 side channels in the MMR, connectivity varies greatly by river stage, choke point elevations, and bottom elevations. In general, there is a lack of flowing side channels with connectivity and flow throughout the year, specifically during normal and low flow conditions. In addition, log jams/excessive woody debris limit connectivity to the river. Of the 32 side channels identified in the MMR, 25 are unrestored or considered inadequate habitat (USACE 2017). Flow through side channels improve water quality conditions, which has been associated with higher diversity fish communities (Crites et al 2012). At Crains Island, the two entrances and the exit to the side channel are currently blocked by excessive woody debris thereby restricting flow and connectivity to the main channel.

Recent analyses of the geomorphology of the MMR have documented many physical changes in the region from 1817 to present, demonstrating that side channels generally went through a period of narrowing from the mid-1800s through the mid-1900s, followed by relative stability since the 1950s (Figure 12). This reduction occurred prior to the 1960's. However, since then, the MMR has remained in a state of dynamic equilibrium, where the average side channel

length, average river width, and acres of island habitat have varied from year to year (Brauer et al 2013).

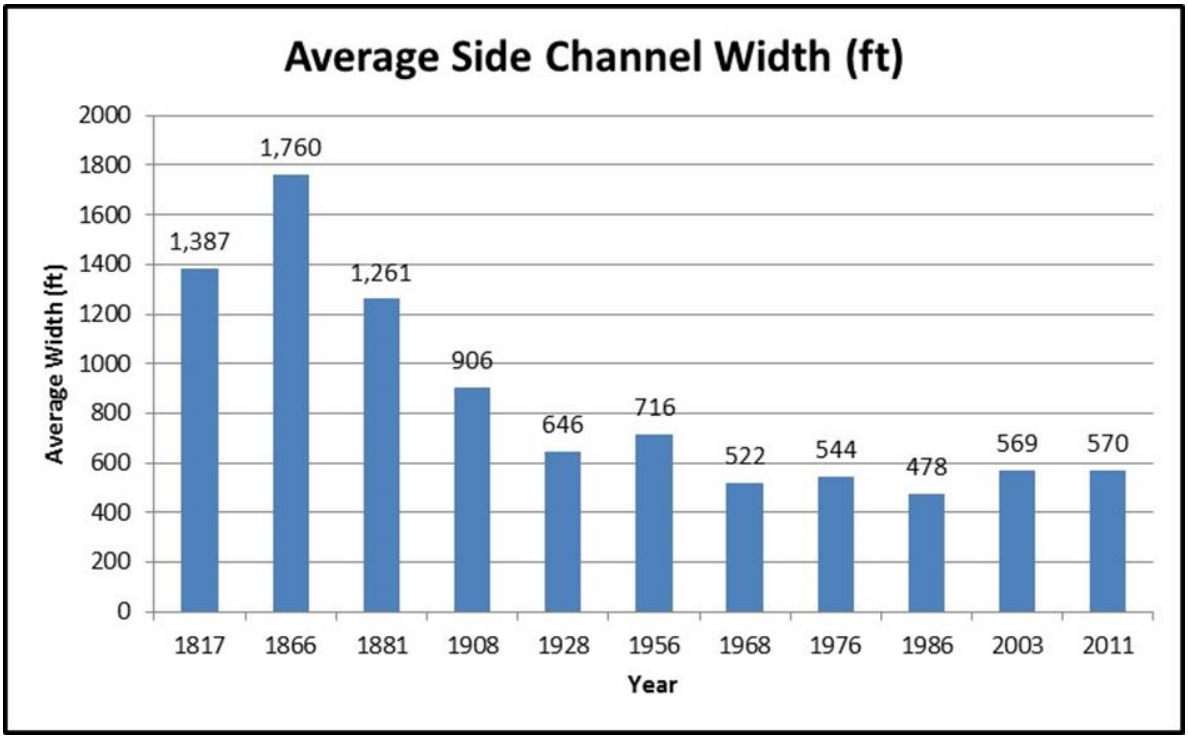

Figure 12. Average planform width of MMR side channels from 1817 to 2011 (from Brauer et al. 2013).

Currently the side channel at Crains Island has two upstream entrances and one downstream exit, as shown in Figure 14. Both of the upstream entrances have been disconnected from the main channel during normal water levels since approximately 2005. In addition, large deposits of woody debris have accumulated in the entrances since 2006, further increasing the rate in which the entrances receive sediment deposition. The woody debris has also begun to spread downstream within the side channel, further degrading the already shallow aquatic area (**Error! Reference source not found.**). Overall, the side channel has seen a decrease in areas with water by 29% from 1976 to 2011 and an increase in areas with sedimentation from 0% to 43% (Figure 13). It should be noted that the river stage in the 2011 image was at least 3.15 feet higher than any other images used in the analysis (Figure 12). So it is likely that the area with water present is lower than what is portrayed in Figure 12. In addition, the lower portion of the side channel only receives water 33% of the time, during high flow events (above 250,000 cfs). After high flow events, water is trapped in several small pockets, where dissolved oxygen concentrations and high temperature conditions lead to anoxic conditions in which no fish species can survive. This habitat does not have the ability to serve as valuable spawning habitat nor is it able to provide refugia for young of the year fish species that typically use this type of habitat. In addition, connectivity between the side channel and the main channel is limited to above average flow events, limiting the fisheries communities which can exist within the side channel for long period of disconnectivity. These deteriorated habitat conditions not only limit fish assemblages but also reduce the amount of area in which invertebrates, birds, mammals, reptiles and amphibians can utilize the aquatic habitat thereby limiting the overall ecosystem function of the entire Project Area and MMR region as a whole.

Wetlands are arguably the most important ecosystems on Earth and are valuable resources for fish and wildlife, of which most species depend on in one way or another throughout their

lifecycle. Wetlands serve as sources and sinks for multiple biological, chemical, and physical processes locally as well as on a landscape scale. Wetlands are often defined as having the presence of water, either at the surface or within the root zone; possessing unique soil conditions that differ from adjacent uplands; and support biota, especially vegetation adapted to we conditions (Mitsch and Gosselink 2000). In the United States, over a period of 200 years, between the 1780s and the 1980s, the lower 48 states have lost an estimated 53% of the 221 million acres of original wetlands. On average, this equates to the loss of over 60 acres of wetlands lost every hour between the 1790s and 1980s (Dahl 1990). In Illinois, wetlands once covered more than 8 million acres, or 23% of the land. Through land use changes, approximately 90% of presettlement wetlands were lost by the 1980's (Suloway and Hubbell 1994). In Illinois, the primary loss of wetlands has been due to the conversion of the land to agricultural uses, and to a lesser extent, urban development (Suloway and Hubbell 1994). The wetlands that remain are degraded by fragmentation, siltation, altered hydrology, and the introduction of aggressive species (Havera et al. 1997, CTAP 2001). Within the MMR, wetlands existed in an area that is now approximately 80% leveed for agricultural use (Theiling 2000). Each of these stresses has reduced the ability of remaining wetlands to perform their ecosystem functions, including the provision of sustainable, diverse, and abundant wildlife populations.

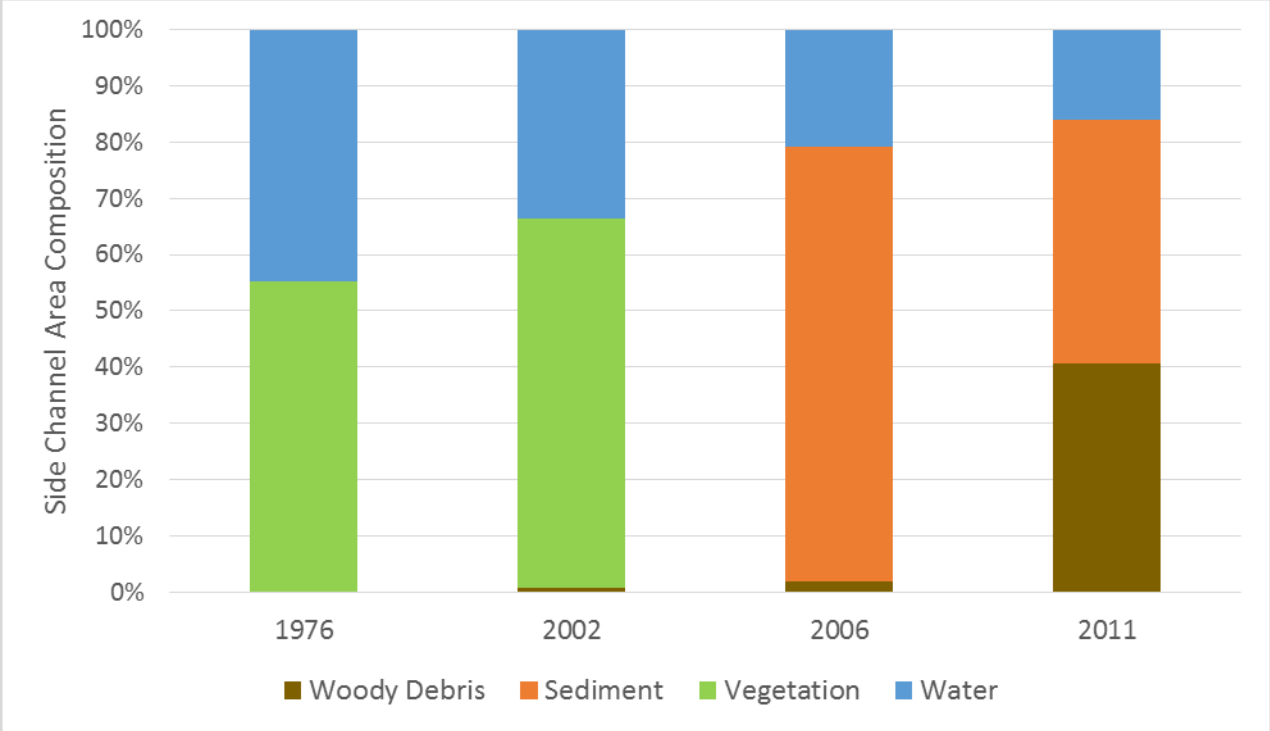

Figure 13. Data from Figure 10 aerials showing the total area composition within the side channel as categorized by woody debris, sediment, vegetation, and water from 1976, 2002, 2006, and 2011.

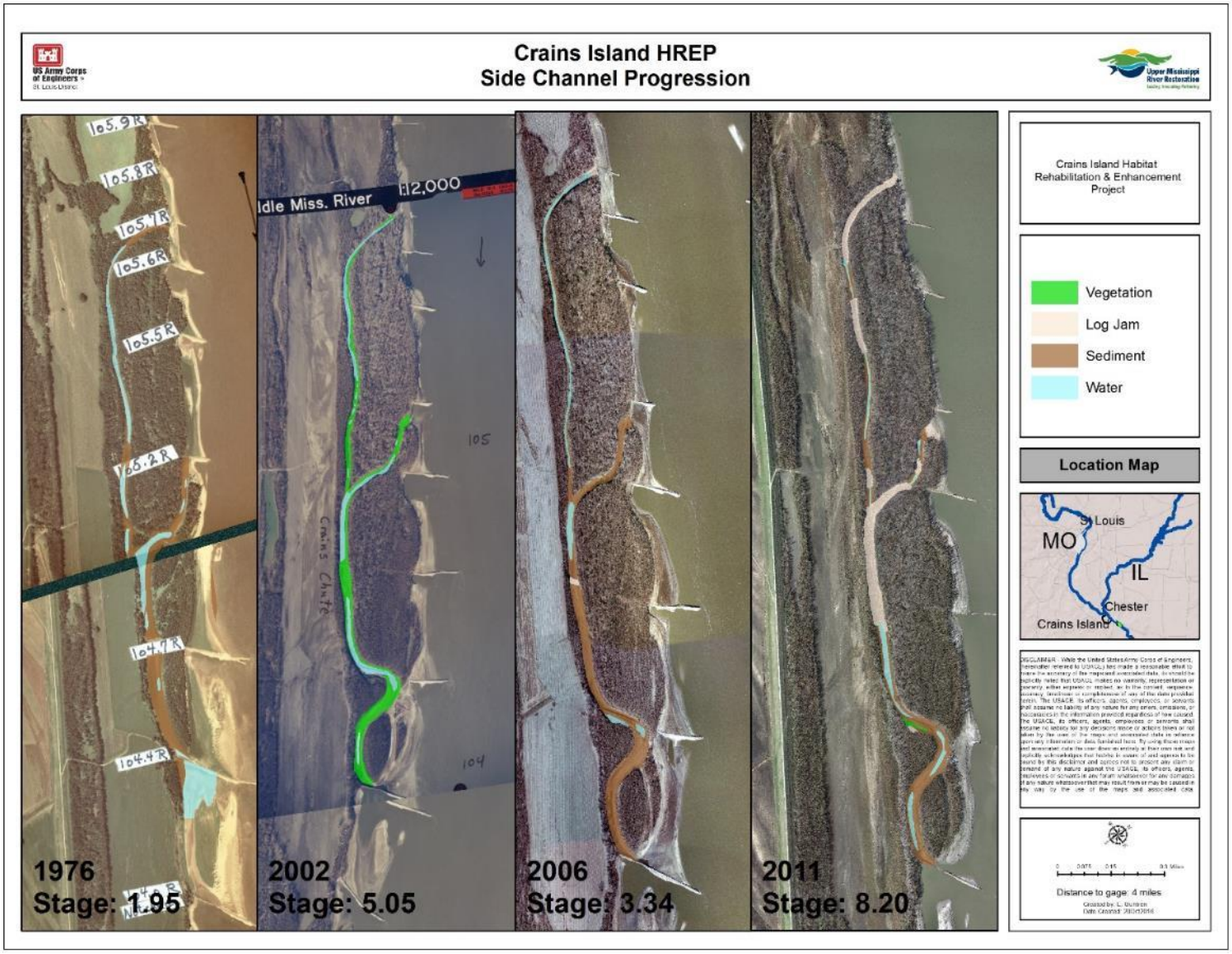

Figure 14. Aerial imagery of Crains Side Channel from 1976, 2002, 2006, and 2011 showing the reduction of total area with water and increase in sedimentation and woody debris.

2.6 Geology and Soils

Geology. The Mississippi River has been the primary drainage system for central North America since the Late Mesozoic period (the last 150 million years). The oldest floodplain deposits are from the Pleistocene glacial outwash which contains sand, gravel, and silty sands (Heitmeyer 2008). The current Mississippi River floodplain, including the Project Area, has formed and reshaped through repeated cycles of deposition, erosion, and lateral migration of the Mississippi River. Much of the sedimentation occurring in the MMR is closely correlative with the contributions of suspended sediment from the Missouri River Basin (USGS 2011).

Soils. A variety of soil types are present across the Project Area formed through river processes of sediment erosion and deposition (Figure 15). Repeated flooding through time has greatly influenced their development and properties. The soil in the Project Area has been characterized by the Illinois Natural Resource Conservation Service as Darwin silty clay, Blake silty clay loam, Haynie silt loam, and Fluvaquents-Orthents complex, frequently flooded, long duration soils. The soil typically very deep, with moderately well drained to poorly drained permeability. During site visits, the USFWS and USACE observed high composition of coarse sediment in the upper 10 inches of the soil while using a soil core to sample the area. The coarse sediment consisted primarily of sand and occurs mostly within the upstream two thirds of the island. Hydric soil characteristics were observed within the top 10 inches in various areas. The majority of the Project Area contains hydric soils, which are soils that are sufficiently wet and develop anaerobic conditions during the growing season. Hydric soils are a major component of wetland habitat. For more detailed information on soil resources within the Project Area, see Appendix B – *Geotechnical Considerations*.

Prime Farmland (Farmland Protection Policy Act, 7 CFR Part 658). Prime farmland is land considered to have the best combination of physical and chemical characteristics for producing food and feed. According to Natural Resources Conservation Service, the Project Area does contain prime farmland (Appendix B -*Soil Resources*). The areas classified as prime farmland are not currently in agricultural production. **Error! Reference source not found.** documents the acres of prime farmland and Figure 16 shows the prime farmland within the Project Area.

Table 2. Acres of prime farmland within Project Area.

	Crains
Not Prime Farmland	138.0 acres
Prime farmland if protected from flooding or not frequently flooded during the growing season	415.0 acres

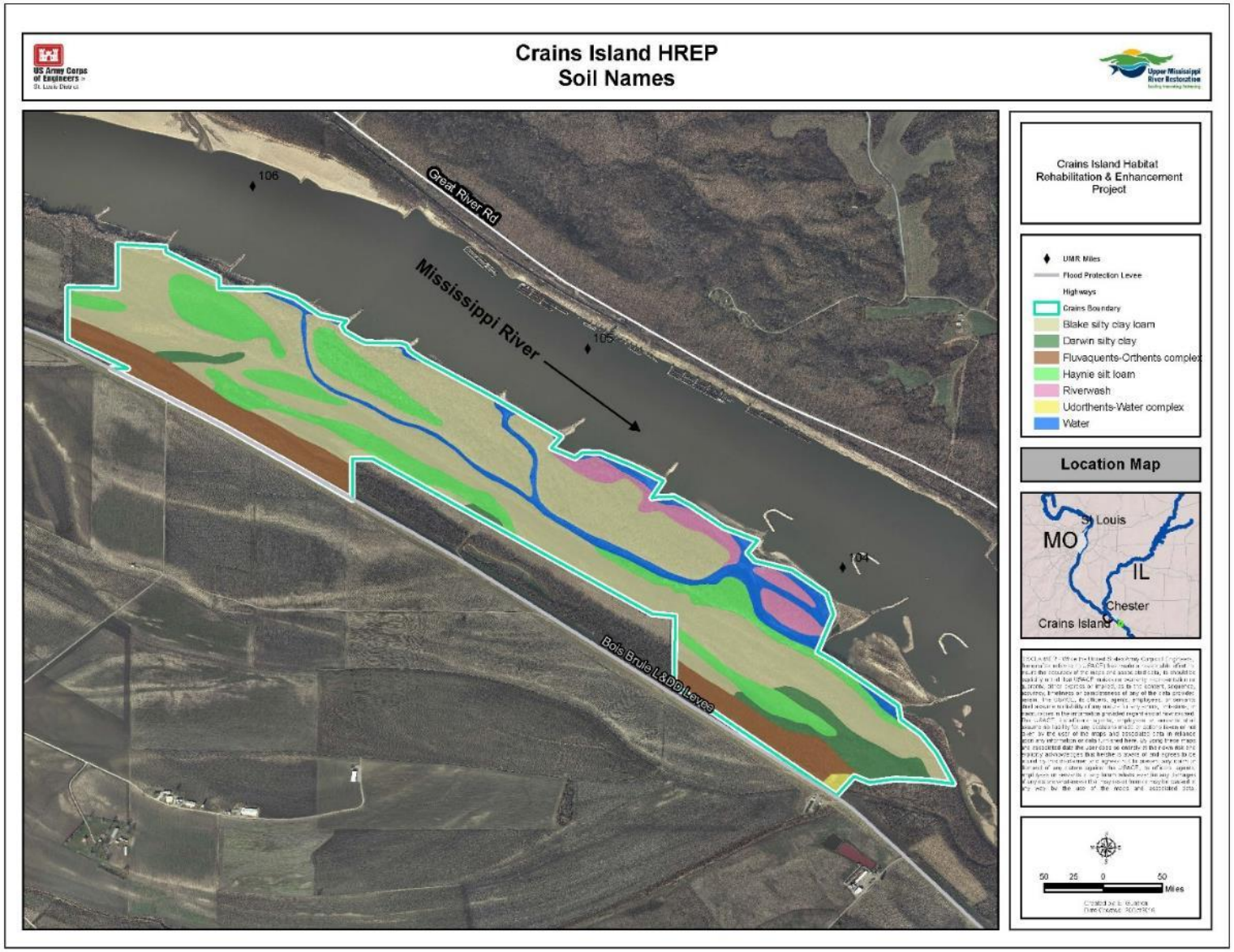

Figure 15. Crains Island soil classification.

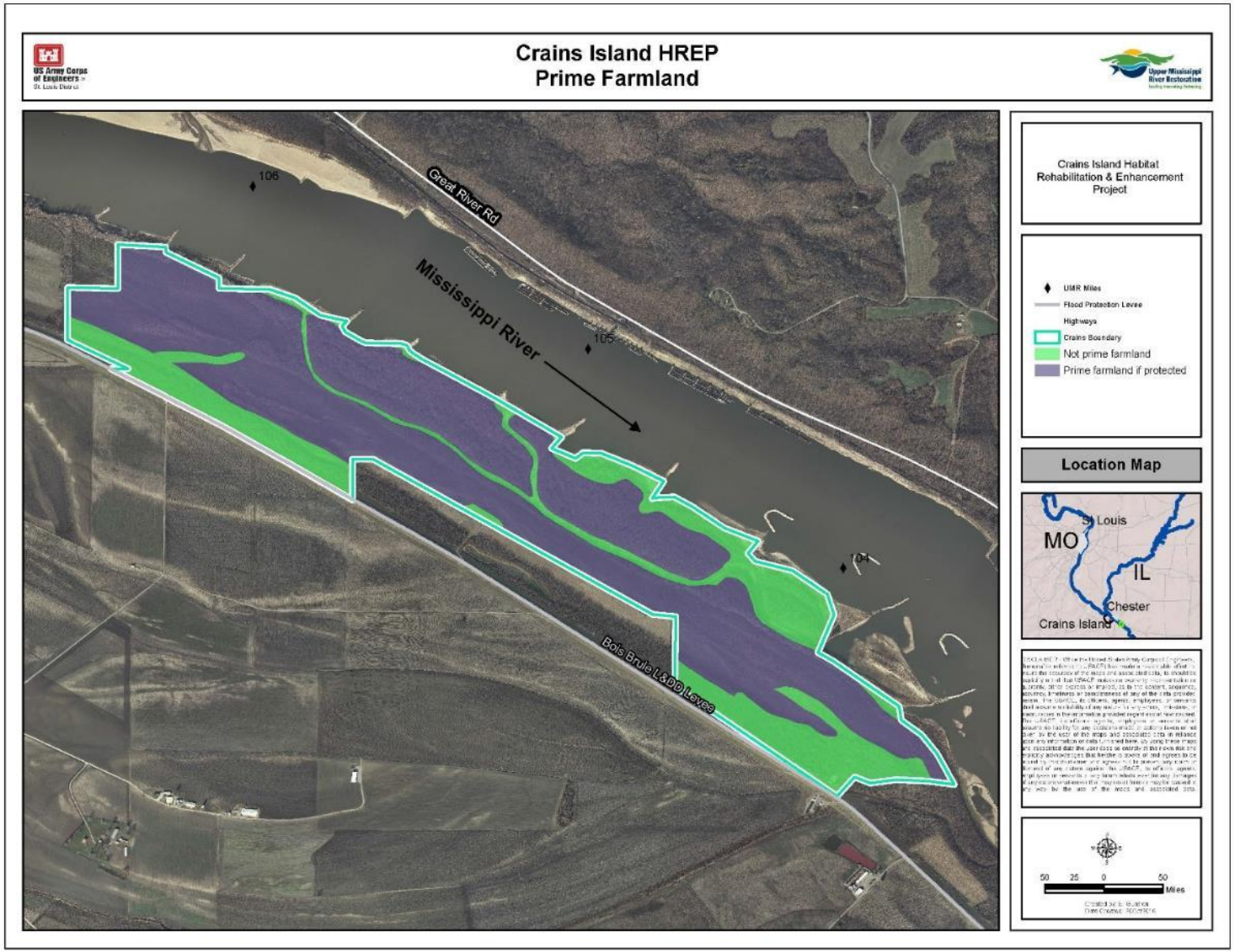

Figure 16. Prime farmland occurring within the Project Area.

2.7 Fish and Wildlife

Since the early 1900s, native fish populations in the Mississippi River have declined (Heitmeyer 2008; Duyvejonck 1996). A major change in fish fauna of the MMR occurred when common carp (*Cyprinus carpio*) were introduced in the 1880s and by the mid-1900s common carp made up of 2/3 of all commercial harvest from the Mississippi and Illinois Rivers (Heitmeyer 2008). More recently, common carp have declined, but there has been an increase in aggressively invasive populations of bighead (*Hypophthalmichthys nobilis*), silver (*Hypophthalmichthys molitrix*), and grass carp (*Ctenopharyngodon idella) (*Heitmeyer 2008; Koel et al. 2002). Pallid sturgeon (*Scaphirhynchus albus*), a federally endangered species, historically occurred from the Gulf of Mexico in the Mississippi River through the Yellowstone River tributary of the Upper Missouri River. A naturally reproducing population exists within the Middle Mississippi River, but it is limited by the lack of braided sandbar habitat and connectivity to which it evolved (Koch et al. 2009). As backwater and side channel areas decrease in depth and connectivity, native fish community assemblage diversity dramatically decreases (Miranda, 2005).

Waterfowl and waterbird populations in the MMR region historically were large and diverse (Bellrose 1968, 1980), with markets for ducks and geese being common in the late 1800s. Loss of wetlands and land use changes led to market declines. Although most waterfowl species in North America have had an overall increase in populations since the 1950s, species like the northern pintail (*Anas acuta*), lesser scaup (*A. affins*), and greater scaup (*A. marila*) have seen a population decline (USFWS 2014). Species like these utilize valuable overwintering and migration habitats present in the MMR. Wetland habitat utilized by waterfowl have been in decline in the MMR. Specifically, bottomland hardwood forests along the Mississippi River in this region are famous for their ability to support large winter populations of waterfowl (Tiner 1984). Today, waterfowl numbers are highly concentrated in remnant wetland complexes (Heitmeyer 2008). After agricultural use, Crains Island lacks these significant habitat types.

Migratory Birds

The Migratory Bird Treaty Act (MBTA) of 1918 regulates and protects most aspects of the taking, possession, transportation, sale, purchase, barter, exportation, and importation of migratory birds. As of March 31, 2010, the MBTA regulates and protects 1,007 species.

Neotropical migrants are bird species that breed in North America but migrate to wintering grounds in Mexico, Central and South America, and the Caribbean Islands. Populations of neotropical migrants have continued to decline over much of the last century. Much of this decline is due to habitat loss in areas used for wintering, breeding, and migration. Floodplain forests serve as some of the most densely populated and diverse avian habitat in North America with high species richness and high abundances (Best 1996, Knutson 1995, Twedt and Portwood 1997). In particular, the Upper Mississippi River serves as a major corridor for neotropical migrants within the Mississippi Flyway (Grettenberger 1991). It has also been documented that neotropical species prefer foraging on insectivorous guilds associated with hard mast tree species occurring in the Upper Mississippi River (Gabbe 2002). Habitat fragmentation has contributed to declines in abundance of neotropical migrants within the Upper Mississippi River (Knutson 1995). Specifically, bird abundance and species richness declines associated with forest community species shifts from a higher composition of hard mast trees to a higher composition of flood tolerant tree species after the 1993 flood have been documented in the Upper Mississippi River (Knutson 1997).

USFWS provided species lists for migratory birds of concern that may be affected by the Project (dated 18 April 2017 and IPAC Report dated 18 April 2017; Appendix A - *Coordination*; Table 3).

Table 3. Migratory birds of concern.

Species Name	Seasonal Occurrence
Bald Eagle (*Haliaeetus leucocephalus*)	Year-round
Bell's Vireo (*Vireo bellii*)	Breeding
Cerulean Warbler (*Dendroica cerulea*)	Breeding
Dickcissel (*Spiza americana*)	Breeding
Fox Sparrow (*Passerella iliaca*)	Wintering
Henslow's Sparrow (*Ammonodramus henslowii*)	Breeding
Kentucky Warbler (*Oporornis formosus*)	Breeding
Least Bittern (*Ixobrychus exilis*)	Breeding
Loggerhead Shrike (*Lanius ludovicianus*)	Year-round
Mississippi Kite (*Ictinia mississippiensis*)	Breeding
Peregrine Falcon (*Falco peregrinus*)	Breeding
Pied-billed Grebe (*Podilymbus podiceps*)	Year-round
Prairie Warbler (*Dendroica discolor*)	Breeding
Prothonotary Warbler (*Protonotaria citrea*)	Breeding
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	Year-round
Rusty Blackbird (*Euphagus carolinus*)	Wintering
Sedge Wren (*Cistothorus platensis*)	Migrating
Short-eared Owl (*Asio flammeus*)	Wintering
Willow Flycatcher (*Empidonax traillii*)	Breeding
Wood Thrush (*Hylocichla mustelina*)	Breeding
Worm Eating Warbler (*Helmitheros vermivorum*)	Breeding

Focal and Surrogate Species for the MMRNWR

Through the development of the Habitat Management Plan for the MMRNWR, a list of focal species (which represent other species or guilds) was developed through consultation from many biologists, USFWS personnel, and leading fish and wildlife experts. The list of species is used to guide and inform management decisions, and these species may be affected by the proposed project actions (Table 4). In addition to focal species, surrogate species are also used for the conservation planning. Surrogate species are used as an indicator of landscape habitat or system conditions, and also represent other species or aspects of the species' environment. The Project Area is within the Eastern Tallgrass Prairie Big Rivers Landscape Conservation Cooperative, and the USFWS has identified 22 surrogate species for this geographic region (USFWS 2014). Table 5 lists the surrogate species that are applicable for the Project Area, and may be affected by the proposed actions.

Table 4. Focal species for the Middle Mississippi River NWR and the guild or group they represent (modified from the HMP for MMR NWR 2012).

Focal Species	Guild/Group
Wood Duck	Wooded Wetland Species
Bald Eagle, Red-shouldered Hawk, Prothonotary Warbler, Indiana Bat	Forest Species (Mid to Late successional floodplain and riverfront forest)
Yellow-billed Cuckoo	Open Forest, Woodland, and Edge Species (riverfront and floodplain forests, shrub swamps, shrub/scurb complex)
Bell's Vireo	Shrub swamp and shrub/scrub complex Species
Mallard	Shallow Wetland Species (emergent vegetation/open water)
Solitary Sandpiper	Shorebirds (mudflats)
Black-necked Stilt	Shorebirds (flooded agricultural fields outside of Refuge)
Interior Least Tern	Terns and Gulls (sandbar nesters and open water)
Swamp Rabbit	Forest Species (understory of wet bottomland forest)
Pecan	Wet Bottomland Forest Tree Species
Channel Catfish, Sturgeon Chub, and Pallid Sturgeon	Large River Fish
Mussel Species	Main River Channel Mussels
Mussel Species	Backwater Mussels
Wet Bottomland Prairie	Ecosystem

Table 5. Surrogate species representing the habitats found within the Project Area (modified from USFWS 2014).

Surrogate Species	Indicator of	Project Area Habitat
River Redhorse	Good water quality	Interconnected riverine habitat; moderate to swift current, riffle-run habitat, clean coarse substrate
Shoal Chub	Other minnow species and Pallid Sturgeon (due to direct link in food web)	Large rivers; sand and gravel substrates, slower velocity
Pallid Sturgeon	Other obligate large river species	Large, free-flowing, warm-water, and turbid rivers with diverse physical complexity
Shovelnose Sturgeon	Other riverine species	Large rivers and mid-size tributaries
Paddlefish	Other riverine and aquatic species	Medium- to large-size rivers; low velocity side channel and off channel habitats; lotic backwaters
Green-winged Teal	Other palustrine emergent wetland species	Palustrine emergent wetlands during migration
Mallard	Other palustrine emergent wetland species	Palustrine emergent wetland breeding habitat
Pectoral sandpiper	Other late migrants	Mudflats; shallow water habitats; wet meadow; flooded agricultural fields
Marsh Wren	Other emergent wetland species	Emergent wetlands
Smallmouth Bass	Water quality	Range of habitats from small order streams to large order rivers

2.8 Illinois Resources of Concern

The Illinois Department of Natural Resources EcoCAT Natural Heritage Database was accessed on 30 May 2017. This database provides information on protected natural resources in the vicinity of the proposed action. For Crains Island (located in Randolph County, Illinois), 3 protected resources were identified in the vicinity of the project including (1) the Chester South Geological Area Illinois Natural Areas Inventory (INAI) Site, (2) the Mississippi River – Mudds

Landing INAI Site, and (3) the American eel (*Anguilla rostrate*). Table 6 displays the state listed species in Randolph County, Illinois.

The Chester South Geological Area is a 3.45 acre site and classified as an INAI Category IV, which means it contains "outstanding geological features". This Natural area is located on the east side of the Mississippi River.

The Mississippi River-Mudds Landing is a 4,089-acre INAI Category II site, which means it contains "specific suitable habitat for state-listed species or state-listed species relocations". This Natural Area is located on the east side of the Mississippi River.

American eel has a wide distribution within the U.S. Adults migrate to an area in the Atlantic Ocean to reproduce and die. The larva that hatches from the fertilized egg makes a one-year trip to the shores of North America. After maturing, males remain along the coast, and females move upstream where they may remain for 15 years. The American eel is the only species of freshwater eel found in North America. In Illinois, the species primarily occurs along major rivers. This species has been found adjacent to the Project Area.

Table 6. State listed species in Randolph County, Illinois.

Species	State T&E Status
Lake Sturgeon	Endangered
Western Sand Darter	Endangered
American Eel	Threatened
Short-eared Owl	Endangered
Bradley's Spleenwort	Endangered
Bellows Beak Sedge	Endangered
Common Striped Scorpion	Endangered
Northern Harrier	Endangered
Timber Rattlesnake	Threatened
Whitlow Grass	Endangered
Common Gallinule	Endangered
Eastern Narrowmouth Toad	Threatened
Crested Coralroot Orchid	Endangered
Mississippi Kite	Threatened
Small Whorled Pogonia	Endangered
Loggerhead Shrike	Endangered
Yellow Honeysuckle	Endangered
Coachwhip	Endangered
Northern Long-eared Myotis	Threatened
Indiana Bat	Endangered
Bigeye Shiner	Endangered
Great Plains Ratsnake	Endangered
Shortleaf Pine	Endangered
Mock Bishop's Weed	Endangered
Missouri Orange Coneflower	Threatened
Pallid Sturgeon	Endangered
Carolina Whipgrass	Endangered
Least Tern	Endangered
Fameflower	Endangered
Flathead Snake	Threatened
Ornate Box Turtle	Threatened
Barn Owl	Endangered

2.9 Federally Threatened and Endangered Species

In compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, the USFWS provided the official species lists (dated 18 APR 2017; Appendix A - *Coordination*) identifying any federally threatened, endangered, proposed, and candidate species that may occur within the vicinity of the Project Area or may be affected by the proposed actions. Table 7 lists the species that may occur in the vicinity of Crains Island. No critical habitats within the Project Area have been identified. Some of the listed species are only found in specific habitats, which are not found in close proximity to the Project Area like the small whorled pogonia (*Isotria medeoloides)*, which is found in dry woodlands. Even though these species are known to occur within the counties of the Project Area, they are not known to occur near the Project Area, and therefore are not discussed further. Additional up-to-date information will be provided in the USFWS draft Fish and Wildlife Coordination Act Report (FWCAR), which will be received prior to approval (Appendix A -*Coordination*). This section and section 8.7 of this report will be used to satisfy the requirement of completing a Biological Assessment.

Table 7. Federally listed species for the Project Area.

Name	Status	Habitat
Mammals		
Indiana Bat (*Myotis sodalis)*	FE	Hibernacula = caves and mines; Maternity and foraging habitat = small stream corridors with well-developed riparian woods; upland forest
Northern Long-Eared Bat (*Myotis septentrionalis*)	FT	Hibernacula = caves and mines; swarming in surrounding wooded areas in autumn; roots and forages in upland forests during spring and summer
Gray Bat (*Myotis grisescens*)	FE	Hibernacula = caves and mines; summer foraging habitat along rivers or lakes; roosts in caves scattered along rivers during the summer
Birds		
Least Tern (*Sterna antillarum*)	FE	Large rivers – nest on sandbars
Fishes		
Grotto Sculpin (*Cottus specus*)	FE	Caves in Missouri
Pallid Sturgeon (Scaphirhynchus albus)	FE	Mississippi and Missouri Rivers
Flowering Plants		
Small whorled pogonia (*Isotria medeoloides*)	FT	Dry woodlands

FE = Federally Endangered; FT = Federally Threatened; PE = Proposed as Endangered

Indiana bat. Indiana bats (*Myotis sodalis*) hibernate in caves or mines from late-fall to early-spring. The rest of the year during the day, females roost under sloughing bark of larger trees with high amounts of solar exposure, while males are less specific, using smaller trees that may not be suitable for females. During the night, individuals forage above tree canopies of floodplain, riparian, upland forests, and surrounding fields. No suitable winter hibernation habitat is present within the Project Area. However, known winter hibernacula exists within 50 miles of the Project Area. Additionally, many habitats suitable for summer roosting and foraging likely exist within the Project Area.[1] The hard mast forest restoration portion of the Project as would improve habitat for the Indiana bat.

[1] http://www.fws.gov/midwest/Endangered/mammals/inba/inbafctsht.html;
http://www.fws.gov/midwest/endangered/mammals/nlba/nlbaFactSheet.html; accessed online 25 Feb 2015

Northern long-eared bat. Northern long-eared bats (*Myotis septentrionalis*) hibernate in caves or mines from late-fall to early-spring. The rest of the year they roost under sloughing tree bark, tree crevices, or cavities during the day and forage under tree canopies but above the shrub layer of floodplain, riparian, and upland forests at night. No suitable winter hibernation habitat is present within the Project Area; however, many habitats suitable for summer roosting and foraging may exist within the Project Area.[2] The hard mast forest restoration portion of the Project would improve habitat for the northern long-eared bat.

Gray bat. Gray bats (*Myotis grisescens*) live in caves year-round. During the winter they hibernate in deep, vertical caves. In the summer, they roost in caves which are scattered along rivers. Gray bats forage on a variety of aquatic and terrestrial insects present along rivers or lakes. No suitable winter hibernation habitat is present within the Project Area; however, suitable foraging habitat may exist within the Project Area. The hard mast forest restoration portion of the Project would improve habitat for the Gray bat.

Least tern. The least tern (*Sterna antillarum*) is common on bare alluvial and dredged spoil islands. Historically, terns nested on sparsely-vegetated sandbars along major rivers in the Central United States; however, much of their natural habitat has been lost because of broad-scale changes to natural river systems.[3] Although the least tern is not known to nest on sandbars within the proximity of Crains, it has been documented nesting at several locations within the MMR.

Grotto sculpin. The grotto sculpin (*Cottus specus*) are found in an area of Missouri characterized by thousands of sinkholes and over 700 caves. Grotto sculpin live in cave streams, springs, and surface streams. Individuals migrate between underground and aboveground habitats, with adults found more often in the cave portions and juveniles in surface springs and streams. Grotto sculpin use stream pools as well as areas under rocks that offer more protection. Both pool and riffle areas with a variety of substrates are used, including silt, gravel, cobble, and bedrock. No caves exists within the Project Area and drainage from within the Project Area does not flow into caves. Therefore, suitable habitat for the grotto sculpin does not exist within the Project Area.

Pallid sturgeon. The pallid sturgeon (*Scaphirhynchus albus*) has experienced a dramatic decline throughout its range since the mid to late 1960s. Nearly its entire habitat has been modified through river channelization, construction of impoundments, and related changes in water flow. This species inhabits close to the bottom of large, silty rivers and prefers a diversity of depths and velocities formed by braided channels, sand bars, sand flats, and gravel bars.[4] Documentation of catches of the pallid sturgeon exist immediately adjacent to Crains Island near the tips of several wing dikes. The increased depth, flow, and connectivity to the main channel of the MMR would improve pallid sturgeon access to this important off-channel habitat, which is currently limited.

Small whorled pogonia. The small whorled pogonia (*Isotria medeoloides)* is a member of the orchid family. This orchid grows in older hardwood stands of beech, birch, maple, oak, and hickory that have an open understory. It prefers acidic soils with a thick layer of dead leaves, often on slopes near small streams.[5] Small whorled pogonia habitat is not known to exist within the Project Area.

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[2] http://www.fws.gov/midwest/Endangered/mammals/inba/inbafctsht.html;
http://www.fws.gov/midwest/endangered/mammals/nlba/nlbaFactSheet.html; accessed online 25 Feb 2015
[3] http://www.fws.gov/midwest/Endangered/birds/leasttern/IntLeastTernFactSheet.html; accessed online 25 Feb 2015
[4] http://www.fws.gov/midwest/endangered/fishes/palld_fc.html;accessed online 25 Feb 2015
[5] https://www.fws.gov/midwest/endangered/plants/smallwhorledpogoniafs.html, accessed online 3 Oct 2016

2.10 Invasive Species (Executive Order 13112)

Several invasive plant and wildlife species are present within the Middle Mississippi River region. Table 8 lists the plant and wildlife species known to occur within the Project Area. Of the invasive plant species, Johnson grass (*Sorghum halepense*) and white field aster (*Symphyotrichum lanceolatum var. lanceolatum*) are the most common throughout the Project Area. Johnson grass and white field aster form dense stands of vegetation preventing establishment of other plants (including tree regeneration). However, the other non-native invasive plant species such as Japanese honeysuckle (*Lonicera japonica*), Japanese hops (*Humulus japonicas*), and Garlic mustard (*Alliaria petiolata*) compete with native vegetation and limit species diversity as well. Asian carp (both bighead and silver carp) are present in large numbers throughout the MMR and likely use the Project Area currently. Zebra mussels (*Dreissena morpha*) and Quagga mussels (*D. bugensis*) have been recorded and are known to compete with native mussel species. Emerald ash borer has been observed throughout the region and continues to spread rapidly. Emerald ash borer, which is non-selective upon any ash (*Fraxinus* spp.) trees has the potential to decimate the entire ash tree population within the United States.

Table 8. Invasive plant and wildlife species known to occur within Project Area.

	Common Name	Scientific Name
Plants		
	Japanese honeysuckle	*Lonicera japonica*
	Japanese hop	*Humulus japonicus*
	Johnsongrass	*Sorghum halepense*
	Garlic mustard	*Alliaria petiolata*
	White field aster	*Symphyotrichum lanceolatum* var. *lanceolatum*
Wildlife		
	Bighead Carp	*Hypophthalmichthys nobilis*
	Silver Carp	*H. molitrix*
	Zebra mussel	*Dreissena polymorpha*
	Quagga mussel	*D. bugensis*
	Emerald Ash borer	*Agrilus planipennis*
	Feral dogs	Not applicable
Scientific names follow nomenclature from USDA Plants Database (http://plants.usda.gov; accessed on 9 April 2015)		

2.11 Water Quality

Flooding and sedimentation have had the greatest impact within the Project Area. The existing sloughs, wetlands, and backwaters have lost much of their depth. The existing side channel at Crains Island is disconnected from the Mississippi River for most of the year. In general, the longer a side channel is isolated from the main channel the more likely the water quality will not support aquatic life due to high water temperatures and anoxic conditions, especially during summer (Crites et al. 2012). At Crains Island, massive log jams at the upper entrances coupled with a dike at the lower end of the side channel have reduced connectivity of this side channel (Photo 1). The log jams have further limited connectivity of the side channel to the main channel and have likely increased sedimentation within the side channel. Disconnected waterbodies with limited depth lose dissolved oxygen levels that are needed to sustain large fish species diversities. Fish assemblages in isolated backwaters such as this only include species that thrive in turbid shallow areas with few predators and low oxygen content (Miranda, 2011).

Photo 1. Excessive woody debris buildup at the upper entrance of Crains Island side channel (April 2015).

Section 303(d) of the Clean Water Act requires that each state identify waters not meeting water quality standards related to beneficial uses of water including whole body contact (e.g., swimming), support aquatic life, and provide drinking water for people, livestock, and wildlife.

In Illinois, the entire length of the MMR is listed as impaired on the 2016 EPA Approved Section 303(d) Listed Waters related to elevated levels of mercury, Polychlorinated Biphenyls (PCBs), fecal coliform, and atrazine.[6]

2.12 Air Quality

The U.S. Environmental Protection Agency (USEPA) has identified standards for seven pollutants: lead, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter less than 10 microns in diameter, and particulate matter less than 2.5 microns. Currently, the Project Area meets all USEPA air quality standards.[7]

2.13 Greenhouse Gas Emissions and Climate Change

Climate change is a fundamental environmental issue, and is a particularly complex challenge given its global nature and inherent interrelationships among its sources, causation, mechanisms of action, and impacts. Analyzing a proposed action's greenhouse gas emissions and how climate change may change an action's environmental effects can provide useful information to decision makers and the public. Climate change science is evolving, and is only briefly summarized here. In 1970 the Council of Environmental Quality estimated the level of atmospheric carbon dioxide to be 325 parts per million (ppm)[8]. Since 1970, the concentration

[6] http://www.epa.illinois.gov/Assets/iepa/water-quality/watershed-management/tmdls/2016/303-d-list/appendix-a1.pdf; accessed 12 April 2017
[7] http://www.epa.gov/airquality/greenbk/ancl3.html; accessed 13 May 2015
[8] Available online at: http://www.slideshare.net/whitehouse/august-1970-environmental-quality-the-first-annual-report-of Accessed 16 November 2016

of atmospheric carbon dioxide has increased at a rate of about 1.6 ppm per year (1970-2012) to approximately 400 ppm as of September 2016 (current globally averaged value)[9]. Based on the United States Global Change Research Program as well as other scientific records, it is now well established that rising global atmospheric greenhouse gas emission concentrations are significantly affecting the Earth's climate[10]. A large body of scientific evidence indicates that increases in greenhouse gases (GHG) in the Earth's atmosphere are contributing to changes in national and global and climatic conditions (Melillo, Richmond, & Yohe, 2014). These changes include such things as average temperature, changes in precipitation patterns, and increases in the frequency and intensity of severe weather events. These changes have the potential to impact a wide sector of the human environment including water resources, agriculture, transportation, human health, energy, and aquatic and terrestrial ecosystems. Therefore, it is important to understand the potential impacts of federal actions on GHG emissions and climate change as well as the potential changes that may occur to the human environment that could affect the assumptions made with respect to determining the impacts and efficacy of the federal action in question.

Upper Mississippi River Region Climate Trends

In terms of climate change, changes in the annual and long-term hydrologic cycles of the Mississippi River influence the Project Area. The two primary factors influencing hydrology in the vicinity of the Project Area include (1) snowmelt and precipitation events throughout the Upper Midwest, which includes the portions of the Mississippi River above St. Louis, Missouri, and the entire Missouri River watershed; and (2) local and regional precipitation. In general, there is a seasonal pattern to the river's hydrology with peak flows typically occurring in the spring and early summer associated with rain and snowmelt followed by declining flows from early summer through early fall. In addition to the annual seasonal pattern of the river's hydrology, historical data shows an 11 to 15 year cycle of increasing discharge and flooding followed by declining flows and drought (Knox 1984; Franklin et al. 2003). Changes in hydrology (e.g., wet vs. dry periods) ultimately influence what floodplain habitats establish and are able to persist.

USACE is undertaking climate change preparedness and resilience planning and implementation in consultation with internal and external experts using the best available climate science and climate change information. USACE is preparing concise and broadly-accessible summary reports of the current climate change science with specific attention to USACE missions and operations for the continental United States, Alaska, Hawaii, and Puerto Rico. Each regional report summarizes observed and projected climate and hydrological patterns cited in reputable peer-reviewed literature and authoritative national and regional reports. The following information on climate trends and future climate projections comes from the climate change and hydrology literature synthesis report for the Upper Mississippi River region (USACE, 2015).

Summary of Observed Climate Findings:

The general consensus in the recent literature points toward moderate increases in temperature and precipitation, and streamflow in the Upper Mississippi Region over the past century. In some studies, and some locations, statistically significant trends have been

[9] U.S. Department of Commerce, National Oceanic and Atmospheric Administration Earth Systems Research Laboratory, available at http://www.esrl.noaa.gov/gmd/ccgg/trends/global.html Accessed on 16 Nov 2016

[10] Intergovernmental Panel on Climate Change, 2014, available at www.ipcc.ch/report/ar5/index.shtml Accessed on 6 January 2015

quantified. In other studies and locales within the Upper Mississippi Region, apparent trends are merely observed graphically but not statistically quantified. There has also been some evidence presented of increased frequency in the occurrence of extreme storm events (Villarini et al., 2013). Lastly, a transition point in climate data trends, where rates of increase changed significantly, at approximately 1970 was identified by multiple authors.

Summary of Future Climate Projection Findings:

There is strong consensus in the literature that air temperatures will increase in the study region, and throughout the country, over the next century. The studies reviewed here generally agree on an increase in mean annual air temperature of approximately 2 to 6 ºC (3.6 to 10.8 ºF) by the latter half of the 21st century in the Upper Mississippi Region. Reasonable consensus is also seen in the literature with respect to projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves in the long term future compared to the recent past.

Projections of precipitation found in a majority of the studies forecast an increase in annual precipitation and in the frequency of large storm events. However, there is some evidence presented that the northern portion of the Upper Mississippi Region will experience a slight decrease in annual precipitation. Additionally, seasonal deviations from the general projection pattern have been presented, with some studies indicating a potential for drier summers. Lastly, despite projected precipitation increases, droughts are also projected to increase in the basin as a result of increased temperature and [evapotranspiration] *rates.*

A clear consensus is lacking in the hydrologic projection literature. Projections generated by coupling [Global Climate Models] *with macro scale hydrologic models in some cases indicate a reduction in future streamflow but in other cases indicate a potential increase in streamflow. Of the limited number of studies reviewed here, more results point toward the latter than the former, particularly during the critical summer months.*

Given the high degree of variability and uncertainty in weather patterns in general and in predictions of future weather patterns in particular, quantifying future Project impacts is inexact. As summarized above, there is no consensus with respect to forecasts for future streamflow in the basin.

Project Area Climate Trends & Greenhouse Gas Emissions

In terms of the Project Area, existing greenhouse gas emissions are related to the site access and trail maintenance. Approximately 70 gallons of fuel are used across the entire Project Area per year, or approximately 0.622 metric tons of carbon dioxide, which is equivalent to the annual greenhouse gas emissions from 0.131 of a passenger vehicle.[11]

2.14 Hazardous, Toxic and Radioactive Waste

A Phase I Environmental Site Assessment was prepared on 30 July 2015. The following is a brief synopsis of the report. Additional narrative is provided in Appendix D – *Hazardous, Toxic, and Radioactive Waste*.

Standard agricultural chemicals were probably used throughout the site at some time. However, farming practices have been halted for at least 8 years and in some cases for more than 20 years, and flood events have probably leached most of the chemicals from the soil. Interviews with the manager indicated that no spills have occurred on any of these properties in the recent past.

[11] http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results; accessed 4 Jan 2017

USEPA's Enforcement and Compliance History Online (ECHO) did not indicate any violations on the site. Generally, the Project Area contains no sites of interest, which pose significant environmental concerns. Potential recognized environmental conditions (RECs) on adjoining or nearby properties are either considered deminimus or only potential RECs that are not expected to impact the site due to the distance or topographic features. Currently the only real potential of RECs is from dumping of solid waste by local residents or debris drifting down the river from either a spill or flood event. A listing of incidences is contained in Appendix D – *Hazardous, Toxic, and Radioactive Waste*.

2.15 Historical and Cultural Resources

The below is a brief description of the historical and cultural resources for the Project Area. Additional narrative is provided in Appendix F - *Historical and Cultural Resources*.

Documentation of the Mississippi River Valley prehistoric and historical sequence is extensive and potentially the entire prehistoric cultural sequence may be present: Paleo-Indian (10,000–8,000B.C.), Dalton (8,000–7,000 B.C.), Early Archaic (7,000–5,000 B.C.), Middle Archaic (5,000–3,000 B.C.), Late Archaic (3,000–1,000 B.C.), Early Woodland (1,000–200 B.C.), Middle Woodland (200B.C. –A.D. 400), Late Woodland (A.D. 400–900), Mississippian (A.D. 900–1350). The most numerous archaeological sites were occupied during the Hopewell-influenced Middle Woodland, Late Woodland, and Mississippian period (Rusch et al. 1999).

The historical period begins with European exploration of the Middle Mississippi River and the voyage of Jacques Marquette and Louis Joliet in 1673. Several trading posts were established and much of the river commerce during the 18th and 19th centuries was driven by the fur trade.

Crains Island formed relatively recently with the earliest detailed map available being the 1815 plat map (Figure 17). Through the shifting nature of the Mississippi River, erosion and accretion of the island, construction of dikes in the 1920s and 1930s, the current Crains Island boundary really did not develop until the 1960s (Figure 18) (See Appendix F - *Historical and Cultural Resources* for more information).

There are no known prehistoric occupation of Crains Island. Most of the island has formed recently (post-1930) through accretion. Early aerial photography shows the entire island under cultivation. The island was farmed until 2007 when the property was acquired by the USFWS and taken out of agricultural use.

Tribal & SHPO Coordination

On 25 August 2015 a tribal consultation letter outlining the project was sent to the twenty eight federally recognized tribes notifying them of the project, five tribes responded with no objections. Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), was initiated with the Illinois State Historic Preservation Officer (SHPO) via a letter. They requested that a Phase I survey be conducted. The Phase 1 survey was completed in 2016. SHPO concurred that no historic properties are affected and therefore they have no objections to the proposed project. (See Appendix A – *Coordination* and Appendix F - *Historical and Cultural Resources* for more information).

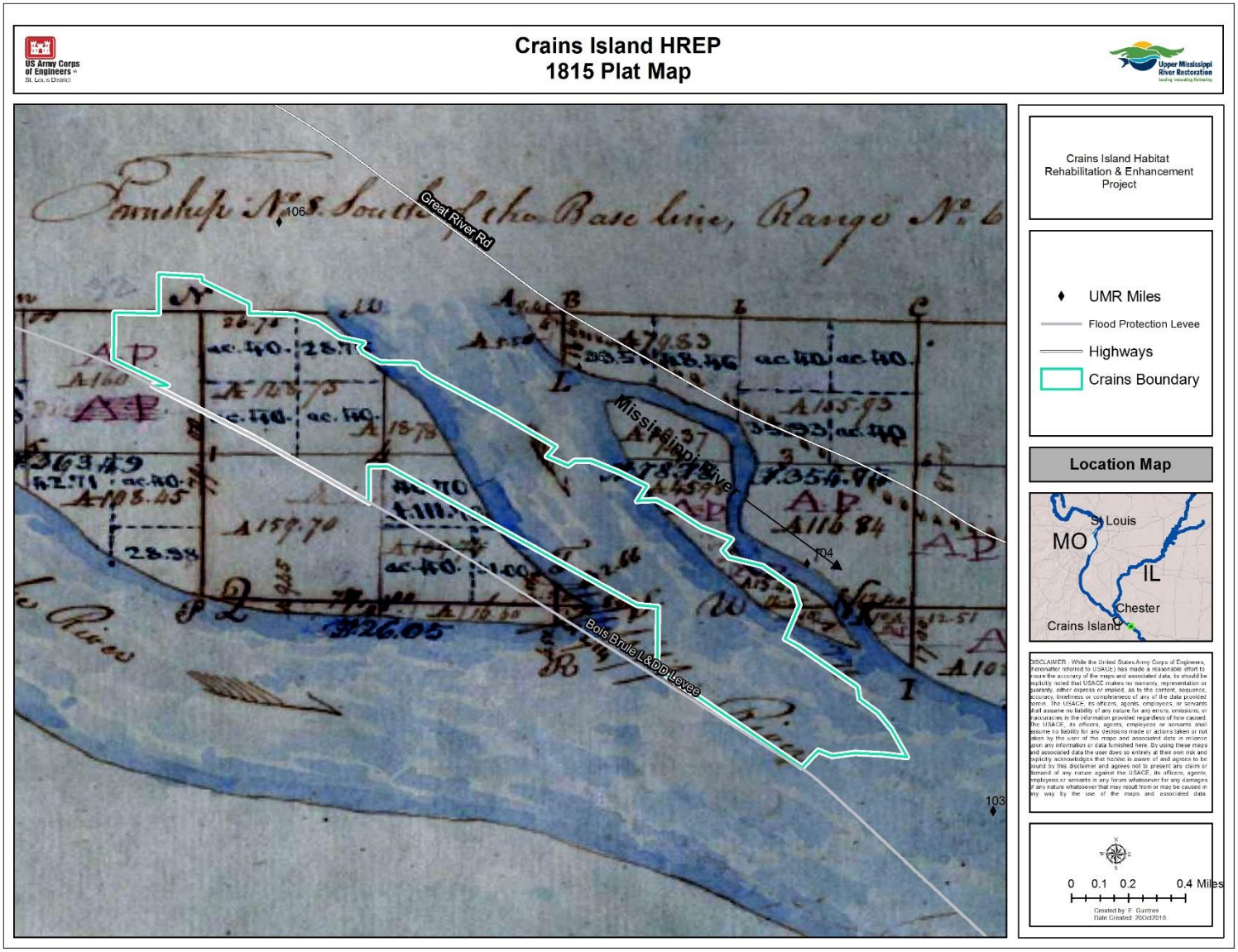

Figure 17. 1815 Plat map of Crains Island overlaid with current project boundary.

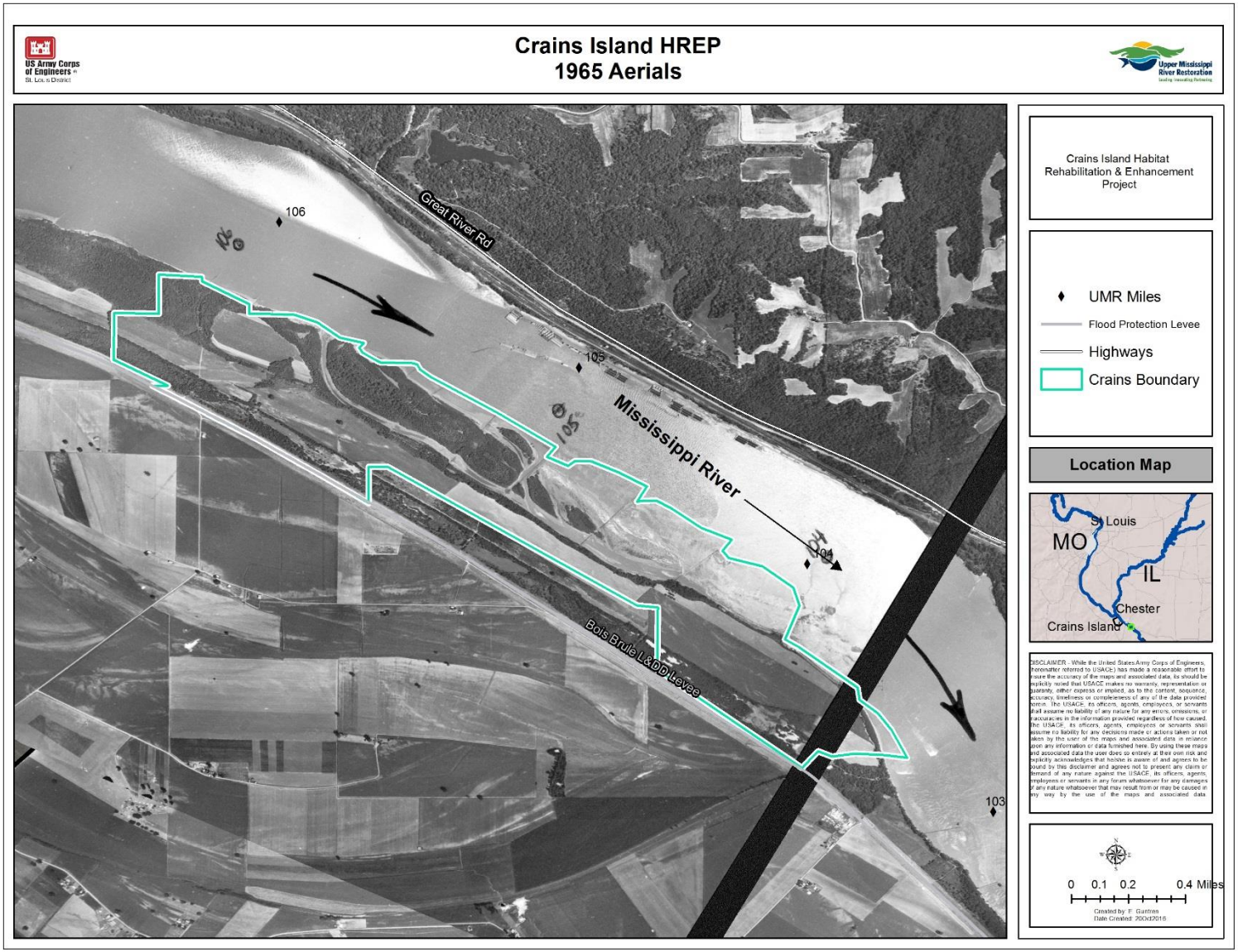

Figure 18. 1965 aerial image of Crains Island overlaid with current project boundary.

Shipwreck Inventory

As part of the 2003 USACE study, archival research documented 687 ships abandoned or reported lost prior to 1940 between Saverton, Missouri and the confluence of the Mississippi and Ohio Rivers (Norris 2003). Two vessels were recorded as being wrecked in the vicinity of Crains Islands (specific locations have been omitted from this public document). The nearest known modern wreck is over 3.5 miles away (See Appendix F - *Historical and Cultural Resources* for more information). The side channel only developed during the middle of the 20th century, so it is very unlikely to be the location of any known watercraft.

2.16 Socioeconomic Resources

Wildlife viewing, hunting, and hiking as well as water-based activities such as boating and boat fishing are the most popular activities within the Project Area. The majority of the recreating public is drawn from the immediate bordering counties, and most visits are day trips.

The Project Area is located in Randolph County, Illinois. Table 9 summarizes the census information obtained from the 2010 U.S. Census Bureau.[12] As of August 2016, the unemployment rate for Randolph County, Illinois was 4.8%.[13]

Table 9. 2010 U.S. Census information for the Project Area.

County	Pop.	% Male	Race	% below poverty level	Median household income ($)	Average household size	Main industry
ILLINOIS							
Randolph	33,476	54.9	87.6% white	8.0	47,427	2.37	Education and health care services; manufacturing

2.17 Aesthetic Resources

Aesthetic resources of the Project Area consist primarily of natural habitats. This includes forest, wetlands, sloughs, side channels, and river habitats that serve as scenery for visitors. Navigation traffic along the Mississippi River may also detract from the natural views within the Project Area.

2.18 Noise Levels

Noise levels surrounding the Project Area are varied depending on the time of day and season. The current human activities causing elevated noise levels in the vicinity of the Project Area include cars, trucks, recreational boats, navigation traffic, and rail road traffic. The sound of firearms during hunting season is also prevalent.

A typical vehicle can produce 60-90 decibels (dB) at a distance of 50 feet (USEPA 1974). A public boat ramp exists in close proximity to the Project introducing noise from recreational boat traffic. A pleasure boat's noise range can typically be between 65-115 dB (USEPA 1974). Barge traffic is frequent in the main channel bordering the Project Area. While the engine noise from the barge would be similar to the vehicle noise heard along a highway, infrequent horn blasts may be in excess of 120 dB at one foot. Although part of the USFWS Refuge system, the Project Area is open for hunting. The National Wildlife Refuge System Administration Act of 1966, other laws, and the USFWS's policy permit hunting on a national wildlife refuge when it is

[12] http://factfinder2.census.gov; accessed on 12 October 2016
[13] Data from the U.S. Bureau Labor Statistics; accessed online on 12 October 2016

compatible with the purposes for which the refuge was established and acquired. The noise from a typical 12 gauge shotgun is 130 dB. All of these may contribute to noise levels within the Project Area.

2.19 Environmental Justice (Executive Order 12898)

Under this Executive Order, a Federal agency "shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States." The standard unit of analysis for environmental justice is the census-designated block. Census blocks and census block groups are geographical areas that are normally smaller than a size of city and provide city block or community level census information.

Due to the rural nature of the Project Area, the census block analysis was expanded to look at the Census Block Group (Table 10)[14]. Based on the 2008-2014 median averages, for Crains Island, the median household income is below the Illinois statewide median average.

Table 10. Census Block Group Analysis.

Location	County	Census Block Group	Total Area (sq. mi)	Population	Census Block Group Median Household Income*	Statewide Median Household Income*
Crains Island	Randolph Co, IL	951300-4	4.10	642	$49,167	$57,166
* based on 2008-2014 averages; data courtesy of www.usa.com						

[14] http://www.usa.com; accessed on 16 November 2016

3 PROBLEMS AND OPPORTUNITIES*

Chapter 3 identifies the Crains Island Project resource problems and opportunities and objectives and constraints. Problem statements are concise characterizations of the broad issue that will be addressed with the project. Opportunities can be directly related to solving the problem at hand but can also be ancillary to the identified problem. From the list of problems and opportunities, objectives for the project are drafted, and study specific constraints are identified. The success of the project planning is determined by the fulfillment of the objectives through identified alternative measures.

As part of the problem identification, the future without project condition scenario (FWOP) is described. The FWOP forecasts what the Project would be like if no federal action is taken and includes inventory and forecast of critical resources (physical, demographic, economic, social, etc.) relevant to the problems and opportunities under consideration in the planning area. Following the discussion of resources problems, the goals and objectives for addressing these problems are described.

3.1 Future Without Project Conditions

Forecasting the future is an essential part of the USACE planning process with most important recurring forecasts being the future without project condition (FWOP) and future with project condition (FWP). The purpose of the FWOP is "to identify the uncertainty that is most relevant for solving problems" and can be defined as a story told about the future if the planning partnership takes no action (Yoe 2012). The FWOP, considered the No Action Alternative, would not include any USACE project measures, and no additional costs to USACE would be generated.

A 50-year period of analysis was used to forecast the FWOP and FWP conditions. The period of analysis was limited to 50 years in accordance with USACE Regulations (ER 1105-2-100), even though project measures are anticipated to continue having beneficial effects beyond 50 years. The base year of 2024 and period of analysis continued until 2074.

Assumptions are one of the most common ways to address uncertainty in a planning study. Several assumptions have been made in forecasting the FWOP scenario:

1) Past land use of the site has detrimentally impacted the native plant communities, and these communities would not naturally recover.
2) USFWS would continue to maintain access areas and field roads throughout the Project Area.
3) No substantial increases to USFWS Project Area's current operation and maintenance budget for the site would occur.
4) Side channel aquatic habitat would continue to degrade with sedimentation and lack of connectivity to the river.
5) Heavy coarse bed load deposition would continue to occur on the upstream portion of the island, limiting forest community diversity and natural succession to hard mast species.
6) The navigation channel would be maintained in its current location.
7) Bois Brule Levee District underseepage deficiency will be corrected and no anticipated change in maintenance or performance of the levee.

Side Channel Habitat

Total cumulative length of side channels in the MMR has decreased from 121 to 83 miles between 1817 and 1968 (Brauer et al. 2005). After 1968, side channels in the MMR remained in a state of equilibrium, where cumulative side channel length and width vary year to year.

However, at Crains Island the side channel has become disconnected from the main channel, and it is anticipated that this lack of connectivity would continue into the future, leading to loss of total side channel length, depth, and aquatic habitat. From 1999 to 2014, the average depth of the Crains Island side channel was reduced from 9 feet to 7.5 feet. Using these data, the estimated sediment deposition rate is 1.2 inches per year. Using this rate for Crains Island side channel would suggest that the remaining portion of the side channel would fill in completely in approximately 75 years. However, based on aerial imagery analysis comparing 1976 to 2011, the side channel has seen a decrease surface water area by 29% and an increase in areas with sediment from 0% to 43%. In addition the area with excessive woody debris has increased by 41% from 1976 to 2011. Further, it is known that sediment loads increase with flood events. So if a series of more severe flood events were to occur, the life expectancy could be much less than projected. This is due to sedimentation as well as excessive woody debris buildup from high flow events in several locations throughout the side channel, which has added to disconnectivity and reduced flow at the entrances. The side channel habitat is expected to continue to degrade with shallow depths, zero to no flow, low dissolved oxygen, hot water temperatures, and little thermal cover, i.e. tree cover. Further, projections of increased air temperatures, particularly in the summer months, would result in increased water temperatures and may lead to decreased dissolved oxygen levels (USACE 2015). Ultimately, the Project Area would not likely support native fish assemblages at any time (other than flood events) approximately 70 years from now.

Floodplain Forest

It is anticipated that USFWS would continue to manage Crains Island, under the 2004 Mark Twain National Wildlife Refuge Complex Comprehensive Conservation Plan and Environmental Assessment. Without the Project, it is assumed that the forest community composition would continue to persist as an early succession state. As discussed in Yin 1999, the forest seedling community throughout the region resembles overstory forest composition, which suggests that the early succession silver maple, cottonwood, and willow species would be maintained for the next 70 years. Coarse bed-load deposition during flood events would continue on the upstream portion of the island, limiting hard mast species (i.e., nut-producing trees) establishment. Even-aged low species and structural diversity riverfront forest communities (e.g., silver maple and green ash) would persist throughout the island, also limiting the establishment of hard mast species. Even-aged forests would continue to provide little habitat diversity and value over time. The lack of hard mast species would continue to provide little habitat benefits for wildlife. Without the Project, it is anticipated that formerly cultivated fields would continue to support dense willow stands, which provide little benefits to ecosystem structure and function.

Hydrology and Hydraulics

As illustrated in Figure 11 flow in the Project vicinity has increased. In addition, *Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions: Upper Mississippi Region* 07 found that projections show an annual increase in precipitation and in the frequency of large storm events in the future of the Upper Mississippi Region (USACE 2015). Studies of trends in streamflow collected over the past century have been performed and there appears to be a consensus among these studies that show a general increase in river flow for the Upper Mississippi Region (USACE 2015). However past trends may no longer be a good predictor of the future. To predict future streamflow some studies used Global Climate Models (GSM's), which are widely recognized as the best available source. Clear consensus in the data is lacking, with some studies predicting an increase in future streamflow in the study region, while others project a decrease in flows (USACE 2015). It is also expected that sediment delivery from outside the Project Area would continue. Overall, the side channel has seen a decrease in areas with water by 29% from 1976 to 2011 and an increase in areas with sedimentation from 0% to 43%. In addition, the lower portion of the side channel only receives

water 33% of the time, during high flow events (above 250,000 cfs).

3.2 Problem Identification & Opportunities

Human-induced physical modifications over the past two centuries within the Middle Mississippi River floodplain has altered hydrology, topography, and biotic communities historically present within the Project Area. These alterations have degraded aquatic resources (i.e., side channel, fisheries, and wetland habitat), reduced forest community diversity (i.e., age, structure, and species composition), impaired ecosystem functions, and threatened the future sustainability of the river-floodplain ecosystem.

The following problems and opportunities have been identified:

Problem 1: Degraded side channel structure and connectivity resulting in loss of side channel habitat. Side channel habitat is an important component of the Mississippi River ecosystem. This type of habitat has declined in most of the UMRS due to the leveling effects of sedimentation in some off-channel areas and reduced connectivity to the main channel during low river stages (Simons et al. 1975; Theiling 1998; USACE 2001) causing a loss of aquatic habitat for fishes and other aquatic assemblages. Within the proposed Project Area, the side channel habitat has decreased in depth resulting in loss of connectivity within the main channel for most of the year, thereby limiting fish movement between the main channel and side channel. The two entrances of the side channel within the Project Area are impeded due to sediment deposition and/or expansive woody pile deposition/log jam. The lower end of the side channel has silted in limiting year-round fish movement between the off channel habitat and main channel river.

Problem 2: Limited wetland diversity due to changes in hydrologic processes. Topographic diversity on the floodplain is an important component of the Mississippi River ecosystem providing a diversity of wetland habitat types. Topographic diversity has declined due to sedimentation and lack of natural hydrologic processes within the Project Area, resulting in the loss of historic ephemeral wetland habitat in the Project Area. As topographic diversity has declined, the quality and quantity of wetland habitat available for migratory and resident fish and wildlife species has diminished.

Problem 3: Habitat fragmentation of the floodplain ecosystem. Habitat fragmentation, which is the process in which large continuous habitat types are broken apart into smaller dissimilar habitat types, severely degrades overall floodplain ecosystem structure and function. Habitat fragmentation is currently caused by the deposition of coarse sediment material (i.e., sand) throughout the Project Area. The deposition of coarse sediments during high water events results in large sandy areas that provide limited habitat and also are a physical obstruction for wetlands species. The large sandy areas do not provide soil conditions suitable for hard mast tree establishment, which lead to fragmented forest blocks within the Project Area. Several wetland species such as neotropical nesting birds and amphibians require large contiguous blocks of bottomland forest habitat to thrive.

Problem 4: Loss of/lack of forest community diversity in the MMR. Land use practices within the past 100 years have limited the ability of the Project Area to produce and sustain the diverse native floodplain forest community. Historically this community provided habitat for the diverse native wildlife species. Changes in land cover and land use within the MMR region have resulted in no or limited hard mast producing tree species and smaller proportion of forest community of soft mast producing tree species, which provide food resources for migratory and resident wildlife.

Opportunities: There are opportunities in the Project Area to:

1) Increase area protected from coarse sediment deposition while simultaneously increasing area of fine sediment deposition to increase soil composition, to support hard mast tree species;

2) Provide increased recreational opportunities in the project area, including wildlife observation, wildlife photography, interpretation, and environmental education opportunities;

3) Protect and restore the floodplain forest; and

4) Provide habitat benefits for the pallid sturgeon and interior least tern, both federally listed species.

3.3 Goals and Objectives

UMRR Program Mission and Vision

The UMRR program vision and mission statements were integral components of the strategic planning efforts of an interagency UMRR Coordinating Committee's efforts. The strategic plan sets a clear direction for the program in federal fiscal years 2015 to 2025. The overarching program mission is *to work within a partnership among federal agencies, state agencies, and other organizations; to construct high-performing habitat restoration projects; to produce state-of-the-art knowledge through monitoring, research, and assessment; and to engage other organizations to accomplish the Upper Mississippi River Restoration Program's vision.*

The overarching program vision is as follows:

A healthier and more resilient Upper Mississippi River ecosystem that sustains the river's multiple uses.

3.3.1.1 Upper Mississippi River System (UMRS) Ecosystem Goals

The goal and vision statement imply conserving the UMRS's remaining structure and function while restoring the degraded components to realize a sustainable UMRS. Five system-wide objectives have been identified (Galat, et al. 2007) to:

- Manage for a more natural hydrologic regime;
- Manage for processes that shape a physically diverse and dynamic river-floodplain system;
- Manage for processes that input, transport, assimilate, and output material within the UMR basin river-floodplains;
- Manage for a diverse and dynamic pattern of habitats to support native biota; and
- Manage for viable populations of native species within diverse plant and animal communities.

3.3.1.2 UMRR Reach Objectives

Reach planning for the UMRS was undertaken to support an anticipated $100 million per year ecosystem restoration program authorized in WRDA 2007, but was subsequently expanded to apply to all UMRS ecosystem restoration programs, including the UMRR. Reach planning relied on state and federal partners to refine ecosystem restoration objectives based on the longitudinal differences that exist over the 1,100 river miles of the UMRS. The UMRS was divided into four floodplain reaches (USACE 2009) to identify reach specific objectives in order to maximize the benefits of individual projects within a given reach.

The Project Area is located within the unimpounded (Middle Mississippi) reach. The Project Area is within the Crains Island priority floodplain reach. The following reach objectives were identified for this reach: floodplain, side channel, and backwater. The following documents the objectives for the unimpounded floodplain reach that apply to the Crains Island HREP. The UMRR objectives are:

- Hydrology and hydraulics: Restore hydraulic connectivity (surface and ground water) between rivers and their floodplains, especially backwater flows into lakes, wetlands, sloughs, swales, abandoned channels, and backswamp depressions.
- Biogeochemistry: Enhance water quality parameters (e.g. nutrients, dissolved oxygen) sufficient to support native aquatic biota and designated uses.
- Geomorphology: Restore hydrogeomorphic processes that create, maintain, and improve connectivity, bathymetric diversity, and flow variability of channel borders, side channels, islands, sand bars, shoals, and associated habitats.
- Habitat: Restore, expand, and maintain the amount and diversity of floodplain terrestrial habitats emphasizing contiguous patches of plant communities to provide a corridor along the UMR and riparian buffers. Restore habitat types most reduced from their pre-settlement extent.
- Biota: Diverse and abundant native fish community; viable populations of native species throughout their range in the UMRS at levels of abundance in keeping with their biotic potential; reduced adverse effects of invasive species.

Project Goal

The goal of the project is to restore the quality and diversity of aquatic, floodplain forest, and wetland ecosystems within the Project Area. The overarching UMRR program goal and reach objectives, as well as input from state and federal agency natural resource managers and interested stakeholders, were used to guide the development of the Crains Island Project goal and objectives. A conceptual model was developed to illustrate the interactions amongst drivers (i.e., climate, geology, ecological disturbance, and land use), essential ecosystem characteristics, and potential management actions (Figure 19). Essential ecosystem characteristics (EEC) are broadly defined categories of environmental features, are critical for sustaining ecological systems, and are valued by stakeholder interests (Nestler et al. 2010). Five EECs have been identified for the UMRS: Geomorphology, Hydrology and Hydraulics, Biogeochemistry, Habitat, and Biota (Lubinski and Barko 2003). The primary stressors for the Project are past and present land use and levee system as well as coarse sediment throughout the Project Area. These stressors directly impact the Habitat EEC and Hydrology and Hydraulics EEC. The changes in habitat and hydrology and hydraulics then impact geomorphology (i.e., sediment, bathymetry, and topography), biogeochemistry (i.e., dissolved oxygen and turbidity), habitat (i.e., cover, diversity, and connectivity), and biota (e.g., fish, wildlife, floodplain forest, emergent wetland) within the Project. The potential project features were then identified to show how they interact with the various EECs. The conceptual model aided the identification of resource problems, opportunities and constraints, development of project objectives, and potential project features. The Project goal, objectives, and potential features are also summarized in Table 11.

Table 11. Problems, Stressors, Goal, Objectives, and Potential Measures Considered

PROBLEMS	STRESSORS	GOAL	OBJECTIVES	POTENTIAL MEASURES
Degraded side channel structure and connectivity	- Sedimentation in side channels - Excessive woody debris deposition/ log jam - Loss of hydraulic connectivity	To restore and improve the quality and diversity of aquatic and wetland ecosystem resources within the Project Area	Increase connected aquatic side channel habitat with depth diversity for enhance fisheries habitat benefits	- Dredge - Terraced side channel side slopes - Remove woody debris/ log jam - Modify side primary and secondary channel entrance/exit
Limited floodplain topographic diversity	- Sedimentation - Hydrologic flow conditions - Loss of ridge & swale		Restore wetland ecosystem resources as measured in acres	- Excavation of swales - Construct ridges - Excavation of ephemeral wetlands
Habitat fragmentation	- Coarse sediment deposition		Increase acreage protected from coarse sediment deposition and promote favorable fine sediment deposition in the Project Area as measured in acres	- Sediment deflection berm
Loss of/lack of forest community diversity	- Land use practices - Land cover		Restore floodplain forest communities as measured in acres	- Reforestation of hard mast tree species - Reforestation of soft mast tree species

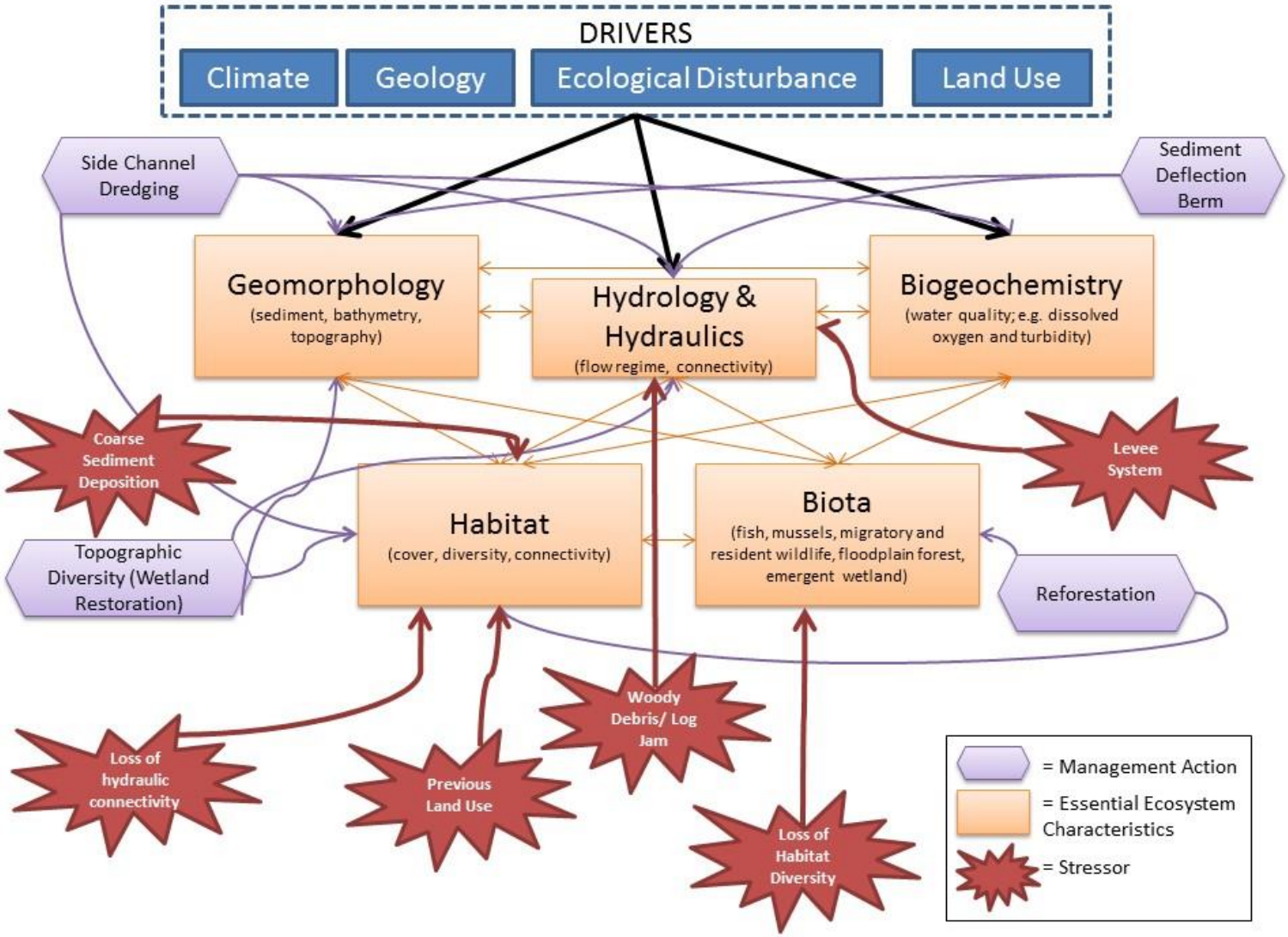

Figure 19. Conceptual model for Crains Island HREP.

Objectives

Based on the project goal, specific objectives were established according to USACE planning guidance ER 1105-2-100 and the objectives are listed below. Many of these objectives are interrelated and will assist in meeting the overall goal. For the purpose of the Feasibility Report, the location for all objectives is generally defined as the Project Area. The timing or duration of the objectives is assumed to be the 50-year period of analysis. The objectives for the Crains Island HREP are listed below:

1. Increase connected aquatic side channel habitat with depth diversity for enhanced fisheries habitat benefits.
2. Restore wetland ecosystem resources as measured in acres.
3. Increase acreage protected from coarse sediment deposition and promote favorable fine sediment deposition in the Project Area as measured in acres.
4. Restore floodplain forest communities as measured in acres.

Table 11 provides an overview of the project problems, stressors, potential restoration measures, and relation to resource significance.

Table 11. Problems, Stressors, Goal, Objectives, and Potential Measures Considered

PROBLEMS	STRESSORS	GOAL	OBJECTIVES	POTENTIAL MEASURES
Degraded side channel structure and connectivity	- Sedimentation in side channels - Excessive woody debris deposition/ log jam - Loss of hydraulic connectivity	To restore and improve the quality and diversity of aquatic and wetland ecosystem resources within the Project Area	Increase connected aquatic side channel habitat with depth diversity for enhance fisheries habitat benefits	- Dredge - Terraced side channel side slopes - Remove woody debris/ log jam - Modify side primary and secondary channel entrance/exit
Limited floodplain topographic diversity	- Sedimentation - Hydrologic flow conditions - Loss of ridge & swale		Restore wetland ecosystem resources as measured in acres	- Excavation of swales - Construct ridges - Excavation of ephemeral wetlands
Habitat fragmentation	- Coarse sediment deposition		Increase acreage protected from coarse sediment deposition and promote favorable fine sediment deposition in the Project Area as measured in acres	- Sediment deflection berm
Loss of/lack of forest community diversity	- Land use practices - Land cover		Restore floodplain forest communities as measured in acres	- Reforestation of hard mast tree species - Reforestation of soft mast tree species

The relationship between objectives and the criteria to determine achievement of that objective is summarized in Table 12. It should be noted that not all criteria must be met in order to achieve the objective; the criteria are indicators of ideal conditions.

Table 12. Crains Island Objectives and Perfomance Criteria.

Objective	Performance Criteria	Rationale
Restore side channel connectivity, depth, and structural diversity	• An increase by more than 20% of native species • At least 1 ft/sec velocity and connectivity to the main channel. • Side Channel bottom depth of at least 5 feet at LWRP[1] +5 • Limit woody debris buildup	The performance criteria described are meant to provide high quality side channel habitat that supports water flow throughout and depth throughout the year
Restore wetland ecosystem resources measured in acres	• Increase wetland topographic diversity • Difference of 3 feet from the top of slope to bottom of wetland area	The performance criteria described are meant to provide wetland habitat diversity
Increase acreage protected from coarse sediment as measured in acres	• Increase percent soil composition of silt/loam by 5% every 10 years	The performance criteria described are meant to improve soil composition over time in order to support natural regeneration of hard mast species
Restore floodplain forest communities as measured in acres	Increase quantity and quality of floodplain forest on Crains Island and survivability of planted trees.	The performance criteria described are meant to provide high quality, sustainable floodplain forest including a natural diversity of tree species, ages, canopy heights, and understory vegetation. Forests meeting these criteria would support a number of ecosystem functions and provide sustainable habitat for wildlife.

3.4 Planning Constraints and Considerations

The following constraints were considered in plan formulation:

1. *Laws and Regulations* – Measures would be designed and constructed to be consistent with Federal, state, and local laws.
2. *Impacts to Cultural Resources* – Measures would not detrimentally affect historical and archaeological sites located within the Project.
3. *Impacts to Federal Projects* – Ensure measures do not negatively impact existing federal projects.
4. *Flood Heights* – Restoration measures should not detrimentally increase flood heights or adversely affect private property or infrastructure.
5. *Aesthetics* – Measures should be designed to minimize negative impacts to aesthetics.
6. *Invasive Species* – Measures should be designed to minimize the spread and introduction of invasive species to and transfer from the Project.

4 FORMULATION & EVALUATION OF ALTERNATIVE PLANS

4.1 Management Measures Considered and Criteria for Screening*

The National Environmental Policy Act (NEPA) requires Federal agencies to evaluate a range of reasonable alternatives to a proposed Federal action. For this environmental assessment, the proposed Federal action is to improve or restore ecosystem structure and function within the Crains Island Project Area. 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. Management measures were developed to address Project Area problems and to capitalize upon Project Area opportunities. The following features and combination of features were formulated during scoping and discussion between the USACE and USFWS.

This chapter presents the potential features that were considered for implementation of the Crains Island HREP. The No Action Alternative, as required by NEPA, is also analyzed.

Several features were discussed during meetings with state and federal resources agencies, meetings with nongovernmental organizations, meetings with the project partner, and the USACE Project Delivery Team (PDT). Not all features were carried forward, and some were eliminated from further consideration based on the screening criteria developed by the PDT. The following screening criteria was used to determine which features were retained for further consideration:

- Meets at least one project objective
- Acceptability
- Sustainability over the 50-year period of analysis
-

The following table (Table 13) summarizes the restoration features considered and the screening process. Additional descriptions and justification for screening of each management feature is provided in the following sections.

Table 13. Features Considered and Screening Criteria. Scoring Criteria based on Low (One criterion met), Medium (Two criteria met), and High (Three or more criteria met). *Continuity of function over the 50-year period of analysis

Management Feature	Screening Criteria						Scoring Criteria	Carried Forward?
	Objective 1	Objective 2	Objective 3	Objective 4	Acceptability	Sustainability*		
Side Channel Excavation	X				X	X	High	Yes
Excavated Swale Wetland		X					Low	No
Constructed Ridges				X			Low	No
Depressional Wetland		X			X	X	High	Yes
Moist Soil Unit		X					Low	No
Reforestation - Hard Mast				X	X	X	High	Yes
Reforestation - Soft Mast				X	X	X	High	Yes
Sediment Deflection Berm			X	X	X	X	High	Yes
Island Restoration		X			X		Medium	No
Removal of River Structures	X					X	Medium	Yes
Best Management Practices					X	X	Medium	No
Education and Outreach					X	X	Medium	No
Buy Land						X	Low	No

4.2 Side Channel Excavation

Excavation is proposed as a potential feature to provide suitable year-round habitat for fish. Excavation would also provide material needed to construct the sediment deflection berm. This feature consists of hydraulically and/or mechanical excavating material on the side channel banks in order to restore depth diversity, overwintering fish habitat, and connectivity to the Mississippi River during normal/low water conditions. Several potential excavation configurations (i.e., side channel cross sections, depth, and length) within the Project Area were evaluated. Any remaining material not utilized for the construction of the sediment deflection berm would be placed on an existing dredge disposal site located adjacent to Crains Island at RM 103.3 (494,000 CY) and behind 4 existing chevron dikes at RM 103.4 (65,000 CY), RM 103.7 (76,000 CY), RM 104.0 (174,000 CY), and RM 104.4 (162,000). Additionally a new disposal site would be constructed at RM 105.5 (521,000 CY).

The following documents several construction methods that could be used to accomplish the side channel excavation. The exact method of excavation would be determined during detailed design.

4.2.1.1 Hydraulic Dredging

Bathymetric diversity could be accomplished using a hydraulic dredge. A hydraulic dredge floats on the water while it excavates and pumps the material through a temporary pipeline to

another location. This dredge acts like a floating vacuum cleaner that can remove sediment and debris very precisely and deposit it at a different location.

With a hydraulic dredge, the dredge discharge line and return line are the only obstructions in the environment. The lines are usually floating or laid on the ground surface. Hydraulic dredging provides the least obtrusive method for sediment removal. Two types of hydraulic dredging placement are commonly used within the St. Louis District and were considered for the Project:

Rigid Dredge Pipe: Traditionally, rigid metal pipe attached to pontoons to float (Photo 2) has been used to move the unwanted sediment slurry to a different location out of the side channel. The rigid metal pipe only allows for a side-cast of dredge disposal parallel to the dredge cut in the main channel or shallow bar area. The end result is a long, narrow disposal bar that is limited in size, elevation, location, and diversity to both aquatic and waterfowl species. Disposal sites have been identified adjacent to Crains Island and would be finalized during Plans and Specs.

Photo 2. Example of rigid dredge pipe attached to pontoons.

Flexible Dredge Pipe: Another method of moving the sediment slurry is through a rubberized flexible pipeline (Photo 3). The pipeline itself floats without any aid (i.e., pontoons). The final piece of pipe is tied into a spill barge that can change the point of discharge by raising or lowering the pipe. This allows the dredge disposal to be placed over and behind river training structures. Because outlet pressures at the discharge end of the pipe are very large, significant scouring could occur, thus reducing the height of the disposal bar. The scouring potential is therefore reduced by adding attachments that help diffuse and disperse the sediment slurry. A properly designed flexible floating dredge pipe operation, with or without the use of river training structures and/or plantings, has the potential to construct sandbars and islands in various shapes, sizes, and elevations. Disposal sites have been identified adjacent to Crains Island and would be finalized during Plans and Specs.

Photo 3. Example of flexible pipe.

This feature was retained for further consideration.

4.2.1.2 Mechanical Dredging:

Bathymetric diversity could be accomplished using a mechanical dredge. Mechanical dredging would necessitate adjacent placement by way of a crane loaded barge or floating excavator. Mechanical dredging involves the use of heavy equipment at the shoreline or working off a barge. The area is surrounded by mature trees, so tree clearing would be required prior to side casting the material. This material would be used to construct the sediment deflection berm (4.5)

Based on analysis of existing elevation and gage data, the side channel has limited connectivity during normal/low water conditions. This measure includes excavation to variable depths and cross-sections to increase depth and bathymetric diversity of aquatic habitats. This feature was retained for further consideration.

4.3 Wetland Diversity

Wetland diversity would be accomplished by using land based excavation equipment. Excavation equipment can be used to remove (Photo 4) soil from the surface of an area and transports it to other locations to be deposited. Bulldozers can then shape the deposition area to restore ridges with higher elevations for hard mast tree planting areas and restore swales with lower elevation areas for wetlands.

Several construction methods that could be used to accomplish different features on the landscape throughout the Project Area are described below.

Photo 4. Example of a scraper moving material.

4.3.1.1 Excavated Swales (Wetlands)

This measure would increase the topographic diversity of the Project Area by restoring additional wetland acres with varying depths and structural complexity (Photo 5). The locations of the wetlands would be determined by soil type and utilize existing low elevation areas. This type of feature was not considered suitable for this site because the site's narrow geography. This feature would meet one planning objective and was not retained for further consideration.

4.3.1.2 Constructed Ridges

This measure would increase topographic diversity of the Project Area by restoring areas with higher elevation and proper soil type for hard mast and soft mast tree plantings (Photo 5). The locations of the ridges would be determined by the location of the adjacent excavated wetlands. This type of feature was not considered suitable for this site because the site's narrow geography. This feature would meet one planning objective and was not retained for further consideration.

Photo 5. Example of an excavated swale with adjacent constructed ridges in West Alton, MO.

4.3.1.3 Depressional Wetland

Depressional wetlands could be constructed in areas with soil composition 30% or more composition of clay. These wetlands would be ephemeral in nature, receiving water from river level fluctuations and rainwater input at various times throughout the year. These wetlands would provide valuable habitat for reptiles, amphibians, migratory bird species, and other wildlife. This feature would meet the planning objective and was retained for further consideration.

4.3.1.4 Moist Soil Management Unit (MSMU)

MSMUs could be constructed to provide emergent aquatic vegetation. This measure would be accomplished with diesel powered water pumps to flood and dewater MSMUs for migratory waterfowl. Maintenance and staff availability make it difficult to maintain proper water elevations. This feature is not efficient as a planning objective, therefore this feature was screened from further consideration.

4.4 Reforestation

Reforestation is proposed as a potential measure to diversify forest age, structure, and species composition in Crains Island through planting hard mast and soft mast species. This feature would restore bottomland forest community dynamics, thereby improving habitat for a variety of native wildlife species.

There are two types of restoration, hard mast and soft mast. Additional information on each is described below.

Hard Mast Reforestation

This measure would increase hard mast tree species composition. The target species for this measure include: bur oak (*Quercus macrocarpa*), pin oak (*Q. palustris*), overcup oak (*Q. lyrata*), swamp white oak (*Q. bicolor*), willow oak (*Q. phellos*), willow oak (*Q. nuttalli*), shumard oak (*Q. shumardii*), swamp chestnut oak (*Q. michauxii*), cherrybark oak (*Q. pagoda*), shellbark hickory (*C. lciniosa*), and pecan (*Carya illinoinensis*). This forest community type is missing/critical/ to Crains Island and within the Middle Mississippi River. The material from the depressional wetlands and/or side channel excavation would be used on the sediment deflection berm to create areas with appropriate soils to plant hard mast tree species. The side slopes of the sediment deflection berm could be planted with hard mast species appropriate for the soil type (i.e., high composition of silt and/or loam). This feature would meet the planning objective and was retained for further consideration.

Soft Mast Tree Plantings

This measure would provide floodplain forest diversity. The top and side slopes of the sediment deflection berm would be planted with soft mast species appropriate soil type (i.e., high composition of silt, sand, and/or clay). The side slopes of the excavated wetlands would be planted with soft mast species. The targeted species are hackberry (*Celtis occidentalis*), persimmon (*Diospyros virginiana*), hawthorn (*Crataegus* spp.), and cypress (*taxodium distichum*). Other light-seeded species such as willow (*Salix spp.*), cottonwood, (*Populus* deltoides), and sycamore (*Platanus occidentalis*) could be included as well. These species provide valuable habitat for many migratory and resident bird species. This feature would meet the planning objective and was retained for further consideration.

4.5 Sediment Deflection Berm

This measure would improve aquatic and floodplain forest habitat by deflecting coarse sediment material (i.e., sand) and reducing high flows in the Project Area. Currently, high sand

deposition limits forest diversity by preventing hard mast tree species establishment. The sediment deflection berm would also improve backing of water from the lower end of the island during high flow events, which would increase the amount of fine sediment deposition (i.e., silt/clay), thereby improving the soils overtime for hard mast tree establishment. The sediment deflection berm measure is dependent on side channel excavation because a portion of the material dredged from the side channel will be utilized to construct a portion of the berm. The berm would have a 1:4 slope on the upstream side with a gradual slope on the interior side to minimize scouring from overtopping during high water events. The crown of the sediment deflection berm and the interior side slope would provide area to plant hard and/or soft mast tree species. Several elevations were considered for the height of the sediment deflection berm including 20% chance of annual exceedance elevation, 10% chance of annual exceedance elevation, and 8% chance of annual exceedance elevation. However, based on hydrologic modeling, only 20% chance of annual exceedance would be under the acceptable threshold for the State of Illinois 100 year flood height impacts. Refer to Appendix C, *Hydrology and Hydraulics* for more details. This feature would tie into the Bois Brule levee at the upper end of the island. This feature would meet the planning objective and was retained for further consideration.

4.6 Island Restoration

This feature would restore natural riverine processes as well as provide essential aquatic and isolated sand bar habitat. Potential features in the larger group of island restoration considered include: sand gravel islands, dike notches, and chevrons. The PDT believes that these features would not be sustainable over the 50-year period of analysis. Past island building operations one mile directly downstream were washed away during high flow events less than two years after construction. The team evaluated island restoration but screened it out from further consideration as the design proved challenging and it did not meet the objectives of the project.

4.7 Removal or Modification of Existing Structures

Removal or modification of existing structures within the side channel as well as modifying river training structures along the bank have been proposed to improve the hydrodynamics to a more natural state in the Project Area. However, removal of sediment and woody debris from the side channel could not be accomplished by altering remnant wood pile structures or installing new rock structures within the side channel alone. Removal of wood pile structures was retained for further consideration throughout the Project Area and a component of the side channel excavation and construction.

4.8 Non-Structural Methods

Non-structural methods have been considered and proposed to help meet the objectives of the Project Area.

Best Management Practice (BMPs)

BMPs are defined by the U.S. Environmental Protection Agency (EPA) as non-regulatory guidance for agriculture issued to farmers to reduce non-point source pollution. By implementing these BMPs, the public has the capability to reduce sediment loads and increase the water quality of the Mississippi River significantly. The eight basic types of BMPs are Conservation Tillage; Crop Nutrient Management; Pest Management; Conservation Buffers; Irrigation Water Management; Grazing Management; Animal Feeding Operation Management; and Erosion and Sediment Control. Since this measure is outside of USACE authority, it would be evaluated further by the responsible persons rather than in this report. This feature does not meet the planning objectives and was screened from further consideration.

Education and Outreach

Education motivates people to think about the world, their relationship to it, and their ability to influence it. Without education the public may not be well-informed about public measures available to aid in the restoration of the environment. Education measures related to Crains Island include, but is not limited to, information on non-point source pollution, point source pollution, agriculture practices, invasive species, threatened and endangered species, floodplain, and wetlands. Education and Outreach programs are established through local, state and Federal agencies as well other public forums. Several education programs have been implemented by the USDA and EPA regarding BMPs and other agriculture practices. USACE' education programs are available to schools, civic groups, and local organizations to include sponsoring Living Lands and Waters' new classroom barge. These outreach programs are dedicated to educating people of all ages about the natural environment, promoting safety, and encouraging good stewardship. USACE realized that there are several education vehicles in place and that the continuation of these programs is essential to the continued improvement of the UMR, but these features were not be evaluated further for the purposes of this study. This feature does not meet the planning objectives and was screened from further consideration.

Land Acquisition

USACE realizes that there are several advantages to buying and placing land into the USFWS refuge and believe it is an endeavor the USFWS should pursue. However, for this project the feature would not be acceptable to the public and landowners and would also be cost prohibitive, and therefore, it was screened from further consideration.

4.9 Restoration Measures Retained for Further Evaluation

Based on the discussion above, a limited number of restoration features were retained for further evaluation. The remaining features were then further refined and iterations of the measures were developed which are documented below as "functional groups". Additional screening was then done within the "functional groups". Screening was based on how each feature best met the planning objectives, results of the hydraulic numerical models, and professional judgment. The functional groups include sediment deflection berm, reforestation, side channel, and wetland.

Sediment Deflection Berm

This feature would increase fine bed load deposition throughout the Project Area. Material for the berm would come from excavation of the side channel. There were three iterations of this feature, which are described below. Several elevations for each iteration were considered for the height of the sediment deflection berm including 20% chance of annual exceedance elevation, 10% chance of annual exceedance elevation, and 8% chance of annual exceedance elevation. However, based on hydrologic modeling, only 20% chance of annual exceedance would be under the acceptable threshold for the State of Illinois 100-year flood height impacts.

A1 – The berm would start from the existing Bois Brule Levee and tie into the existing bank of the side channel. This measure would meet the project objective of deflecting coarse sediment from the upper end, but the high bank side channel is not sufficient to provide coarse sediment deflection. This iteration of the sediment deflection berm would also not protect the side channel from wandering inland towards the in-holding. This feature was screened from further evaluation.

A2 - The berm would start from the existing Bois Brule levee and curve towards the side channel, running parallel to the side channel. The proposed measure would have a 1:4 slope on the exterior with a 1:8 slope on the interior to minimize scouring when overtopped by flood

events. The top of the berm would be constructed to a 20% chance of annual exceedance elevation of 374.48 NAVD 88 at a length of 13,500 feet long. The cross-sectional width of the sediment deflection berm would be approximately 150 feet wide at the base. This measure is preferred over A1 because it increases the area with protection from coarse sediment material deposition and increase fine sediment deposition. This feature was retained for further evaluation.

A2* - This berm would be the same alignment as A2 with an additional kicker berm on the inside. This measure is a larger increment of A2 and would increase the amount of acreage for reforestation when compared to A2. This feature was retained for further evaluation.

Reforestation

This measure would improve the habitat quality and reduce the fragmentation of forest throughout the Project Area. The sediment deflection berm would also be reforested. There were two iterations of reforestation considered and described below.

F1 – This measure would involve reforestation throughout the area. This feature was retained for further evaluation.

F2 – This measure would involve reforestation throughout the study, but it is exclusive with the A2* measure and would include more acres of reforestation than F1. This feature was retained for further evaluation.

Side Channel

This feature involves excavation of the side channel and several iterations of the side channel were considered and described below. The side channel would restore depth and connectivity and increase aquatic habitat diversity and quality. Recommendations on channel bottom width, side slopes, and sinuosity from the USACE, Kansas City District were incorporated into the design of all side channel features. Refer to Appendix C, Hydrology and Hydraulics for more information on designs and drawings. Potential areas with enough holding capacity to dispose of excess material from side channel excavation were identified adjacent to the Project area for in-stream disposal. These areas would be further refined during Plans and Specs.

S1 – This feature involves excavation of the side channel at the lower entrance approximately 20 ft. deeper with an elevation of 337 ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. The bottom width would be approximately 80 ft. with a trapezoidal cross section with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. This feature was screened from further evaluation for several reasons: 1) the trapezoidal cross section did not provide enough depth diversity for fisheries resources, 2) only excavating the lower portion of the side channel does not effectively restore year-round connectivity and flow to the side channel, and 3) sediment in the lower potion would fill back into the river if existing river training structures were not altered to change the flow.

S2 – This feature involves excavation of the neck of the side channel approximately 20 ft. deeper with an elevation of 337 ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. The bottom width would be approximately 80 ft. with a trapezoidal cross section with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. The wider side channel has a higher probability of maintaining flow through along with reduces opportunity for side channel lose connection due to debris. With a wider footprint a “crane’s

neck" design would be difficult to construct. The trapezoidal cross section did not provide enough depth diversity for fisheries resources. In addition, the "crane's neck" design would likely not support higher velocities needed to sustain depth and reduce sedimentation over time. The design would also be difficult to construct. This feature was screened from further evaluation.

S3 – This project feature would have an excavated depth of the bottom of the side channel approximately 20 ft. deeper with an elevation of 337 ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. The bottom width would be approximately 80 ft. with a trapezoidal cross section with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. Excavated material would be used for construction of the sediment deflection berm and dredge material would be placed adjacent to Crains Island. This feature was retained for further evaluation.

S4 – This project feature would have an excavated depth of the bottom of the side channel approximately 20 ft. deeper with an elevation of 337 ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. The bottom width would be approximately 80 ft. with a trapezoidal cross section with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. This measure involves excavation of the side channel with benching of the banks on the river side the entire length. Benching involves one or more terraces of approximately 20 feet in width placed roughly midway through the bank. The benches allow for more vegetation growth on a less steep slope. This allows the vegetation to become inundated at different times and allows fish and wildlife to utilize this habitat. Excavated material would be used for construction of the sediment deflection berm and dredge material would be placed adjacent to Crains Island. This feature was screened from further evaluation because benching the length of the side channel only on the river side does not effectively maximize the fisheries benefits for the entire side channel.

S5 – This project feature would have an excavated depth of the bottom of the side channel approximately 20 ft. deeper with an elevation of 337 ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. The bottom width would be approximately 80 ft. with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. This feature involves excavation of the side channel with benching on the land side the entire length. Benching involves one or more terraces of approximately 20 feet in width placed roughly midway through the bank. Excavated material would be used for construction of the sediment deflection berm and dredge material would be placed adjacent to Crains Island. This feature was screened from further evaluation because benching the entire length of the land side would likely not be sustainable on the outside bends of the two entrances where velocities are the highest. Benches constructed in these areas would likely revert to 1 ft. vertical on 3 ft. horizontal, in which case, adding the benches would not add habitat value for the entire 50 year evaluation period. In addition, benching only on one side does not effectively maximize the fisheries benefits for the entire side channel.

S6 – This project feature would have an excavated depth of the bottom of the side channel approximately 20 ft. deeper with an elevation of 337 ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water

approximately 98% of the time. The bottom width would be approximately 80 ft. with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. This feature involves excavation of the side channel with benching on the river and land side the entire length. Benching involves one or more terraces of approximately 20 feet in width placed roughly midway through the bank. Excavated material would be used for construction of the sediment deflection berm and dredge material would be placed adjacent to Crains Island. This feature was screened from further evaluation because benching the entire length of the land side would likely not be sustainable on the outside bends of the two entrances where velocities are the highest. Benches constructed in these areas would likely revert to 1 ft. vertical on 3 ft. horizontal, in which case, adding the benches would not add habitat value for the entire 50 year evaluation period.

S7 – This project feature would have an excavated depth of the bottom of the side channel approximately 20 ft. deeper with an elevation of 337ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. The bottom width would be approximately 80 ft. with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. This feature involves excavation of the side channel with benching where hydraulic conditions are most suitable. Benching involves one or more terraces of approximately 20 feet in width placed roughly midway through the bank. Benches would be placed where they are sustainable for the 50 year evaluation period and not on the outside bends where flows are higher. This feature is most effective by maximizing the fisheries habitat benefits throughout the entire side channel. Excavated material would be used for construction of the sediment deflection berm and dredge material would be placed adjacent to Crains Island. This feature was retained for further evaluation.

Depressional Wetlands

This feature would improve and increase the acreage of wetland habitat throughout the Project Area. One iteration of the feature was evaluated and is documented below.

W1 – Depressional wetlands would increase the topographic diversity of the Project Area by restoring additional wetland acres with varying depths and structural complexity. This feature was retained for further evaluation.

4.10 Final Array of Restoration Features

The final array of restoration features is documented below in

Table 14.

Table 14. Final Array of Restoration Features.

Code	Description	Benefit	Carried Forward?
Sediment Deflection Berm			
A0	No Action	Increase fine bed load deposition	Yes – All measures compared against no action.
A2	Starting from Bois Brule levee that curves back toward side channel and runs downstream along bank of side channel		Yes – Meets project objective
A2*	Starting from Bois Brule levee that curves back toward side channel and runs downstream along bank of side channel, with an additional kicker berm		Yes – Meets project objective
Reforestation			
F0	No Action	Improve habitat quality and reduces fragmentation	Yes – All measures compared against no action.
F1	Reforestation throughout study area		Yes – Meets project objective.
F2	Reforestation throughout the study area – dependent on A2* feature		Yes – Meets project objective.
Side Channel			
S0	No Action	Restore connectivity; increase aquatic habitat diversity and quality	Yes – All measures compared against no action.
S3	Increase side channel depth and width, no benching		Yes – Meets project objective.
S7	Increase side channel depth and width, benching were opportunistic		Yes – Meets project objective.
Wetland			
W0	No Action	Improve and increase acreage of wetland habitat	Yes – All measures compared against no action.
W1	Depressional wetlands		Yes – Meets project objective.

4.11 Alternative Plan Formulation, Evaluation & Comparison

This section describes the feasible features that were retained and the formulation of the final array of alternatives. Due to the limited number of restoration features remaining, the team analyzed all possible combinations rather than identifying individual alternative formulation strategies. The final array of alternatives includes 9 action alternatives and the No Action Alterative. Each alternative was evaluated through an environmental benefits analysis to determine the magnitude of ecosystem benefits to be expected if the alternative was implemented. The benefits were then combined with cost estimates for each alternative and then an incremental cost analysis (ICA) was conducted to determine cost effectiveness. A full description of the environmental benefit analysis can be found in *Appendix G – Habitat Evaluation and Quantification.*

4.11.1 No Action Alternative

The No Action Alternative is defined as the alternative that the proposed federal action would not take place, and there would be no change from current management direction or level of management intensity. The resulting environmental effects from taking no action would be compared with the effects of implementing the proposed federal action. Chapter 8, *Environmental Effects*, and Chapter 9, *Cumulative Effects*, further define the effects of the no action alternative on the identified resources of concern.

4.11.2 Final Array of Alternatives

The final array of restoration features were combined into distinctly different alternatives based on feature dependencies and exclusivities. The following documents that rational for the formulation of alternatives.

The side channel excavation and sediment deflection berm are dependent on each other. The material excavated from the side channel would be used for the sediment deflection berm. Obtaining material for the berm off site would be cost prohibitive and was not considered.

Reforestation is dependent on the sediment deflection berm and is a cost effective feature and would meet the planning objective to restore floodplain forest communities. Further, reforestation is easily completed and provides benefits to areas where land disturbances occurred, such as the construction of the sediment deflection berm. The soil composition is critical to the success of the reforestation effort throughout the Project Area interior of the berm. The sediment deflection berm is a critical feature to ensuring forest community success is attainable by improving backing of water throughout the project area to improve soil composition. Without reforestation and the sediment deflection berm, forest community diversity and restoration would not be attainable.

The wetland feature is an independent feature of those described above and could be part of any alternative or as a standalone alternative. As a standalone feature it would meet one of the planning objectives.

In addition, past projects have shown that dredging is a significantly higher cost than the other features described above. Therefore, combinations of all features resulted in little additional cost compared to dredging and yielded greater ecological benefits than dredging alone. Dredging of the side channel, construction of the sediment deflection berm, and reforestation as each as stand-alone features would not provide enough ecological benefit for the Project Area.

The following (Table 15) documents the final array of alternatives, including the No Action alternative.

Table 15. Final Array of Alternative Plans.

		Restoration Feature						
		A2	A2*	F1	F2	S3	S7	W1
Alternative	**No Action**							
	1A	X		X		X		X
	1B		X		X	X		X
	2A	X		X			X	X
	2B		X		X		X	X
	3A	X		X		X		
	3B		X		X	X		
	4A	X		X			X	
	4B		X		X		X	
	9							X

A2 Sediment Deflection Berm	F1 Reforestation throughout study area	S3 Increase side channel depth and width, no benching	W1 Depressional wetlands
A2* Sediment Deflection Berm – with an additional kicker berm	F2 Reforestation– dependent on A2* feature	S7 Increase side channel depth and width, benching were opportunistic	

4.12 Habitat Benefit Evaluation

A habitat benefit evaluation was conducted to evaluate environmental benefits of alternative plans for aquatic and habitat improvements. The evaluation was conducted by a multi-agency team, which included representatives from the IDNR, USFWS, and USACE. Aquatic and terrestrial benefits were quantified through the use of the Habitat Evaluation Procedures (HEP; (USFWS, 1980)).

Habitat Evaluation Procedures

Habitat Evaluation Procedures (HEP) is a habitat-based evaluation methodology used in project planning. The procedure documents the quality and quantity of available habitat for selected fish and wildlife species. The HEP is based on the assumption that habitat for selected species can be described by a Habitat Suitability Index (HSI). This index value is an indication of habitat quality (rated from 0.0 to 1.0, with 1.0 being ideal habitat) and is multiplied by the area of applicable habitat to obtain Habitat Units (HUs).

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the period of analysis for the Project (50-years). Habitat Units are calculated for select target years and annualized over the period of analysis to derive the net Average Annual Habitat Units (AAHUs). Net AAHUs are used as the output measurement to compare the alternatives for the proposed Project.

The HEP was used to evaluate the effects of the proposed Project alternatives on island and aquatic habitat quantity and quality. The Smallmouth Buffalo was used to assess side channel aquatic habitat. The Bullfrog was used to assess the semi-permanently/permanently flooded wetland. The Fox Squirrel was used to assess the forested wetland habitat. Each of these models are Regionally Approved for Use per EC 1105-2-412, and each model spreadsheet calculator is approved for regional use (Appendix G, *Habitat Evaluation & Quantification*). The multi-agency team completed an assessment of existing Project Area conditions, projected future conditions without the Project, and estimated expected impacts of proposed Project measures. A detailed description of the habitat analysis is provided in Appendix G, *Habitat Evaluation & Quantification.*

4.13 Cost Effective & Incremental Cost Analysis of Alternatives

USACE guidance requires a cost effectiveness analysis and an incremental cost analysis (CE/ICA) for determining what project features and design alternatives should be built based on comparison of quantified habitat benefits (outputs) and estimated costs of alternative features designs. This process identifies alternative features or combinations of features that fully or partially meet the objectives of the project and at the same time are the most cost effective. A cost effective analysis is conducted to ensure that the least cost alternatives have been established, and subsequent incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

CE/ICA are two distinct analyses that must be conducted to evaluate the effects of alternative plans. First, it must be shown through cost effectiveness analysis that an alternative restoration plan's output cannot be produced more cost effectively by another alternative. "Cost effective" means that, for a given level of non-monetary output, no other plan costs less, and no other plan yields more output for less money. Subsequently, through incremental cost analysis, a variety of implementable alternatives and various-sized alternatives are evaluated to arrive at a "best" level of output within the limits of both the sponsor's and USACE' capabilities. The subset of cost effective plans are examined sequentially to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called "Best Buys". They provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of Best Buy plans. The results of the incremental analysis must be synthesized with other decision-making criteria (for example, significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the planning team select and recommend a particular plan.

Project first costs include the cost of construction, Operation, Maintenance, Rehabilitation, Replacement, and Repair (OMRR&R), and Adaptive Management and Monitoring (AM&M). Costs were annualized by applying a 2.875% interest rate (FY 2018) to the construction cost over the period of analysis of 50 years for planning purposes. The 50-year period of analysis was selected based on the expected time required to reach maximum environmental outputs from project features and the subsequent accrual of benefits leveling off past 50 years. The incremental analysis of alternatives was accomplished following guidance by USACE' Institute of Water Resources and using methodology described in Robinson *et al.* (1995). Refer to *Appendix H – Incremental Cost Analysis*, for the detailed results of the analysis.

Adaptive Management and Monitoring and relevant OMRR&R costs for features and subsequently for project alternatives were determined to be similar for each alternative and within the 30% contingency. Those costs were then annualized over the period of analysis, assuming a 50-year project period of analysis and a FY2017 project discount rate of 2.875%, to determine the average annualized costs. Table 16 documents the final array of alternatives, habitat features and benefits, costs and cost per average annual habitat unit.

Primary assumptions and constraints used in conducting CE/ICA for the Crains Island HREP are as follows:

1) AAHUs for all analyzed fish and wildlife species were assumed to have equal value in comparing alternative plans.
2) Alternatives analysis was limited to combinations that at least partially met the Project's objectives listed in section 3.3.3.
3) Feature dependencies were determined prior to alternatives being input to IWR-Plan and CE/ICA being run.

Table 16. Final array of alternatives, habitat types, habitat benefits, Construction Cost with Contingencies, Adaptive Management & Monitoring, Management Costs, Interest During Construction (2.875%), LEERDs, Project First Costs, Annualized Costs, and Cost per AAHU. (FY2016 Price Level – 50 year period of analysis using 2.875% discount rate and 4 phase construction)

Alternative	Restoration Feature	Habitat Type	Net Gain of AAHUs	Construction Cost w/ Contingency	Management	Interest During Construction	Adaptive Mgmt & Monitoring	LEERDs	Project First Cost	Annualized OMRR&R	Annualized Cost	$/AAHUs
No Action	None	None	0	0	0	0	0	0	$0		$0	$0
1A	A2	Floodplain Forest	150	$31,231,668	$7,807,917	$1,156,086	$397,000	$14,250	$39.5 M	$11,050	$1,552,005	$10,347
	S3	Side Channel										
	F1	Floodplain Forest										
	W1	Depressional Wetland										
1B	A2*	Floodplain Forest	166	$34,442,498	$8,610,624	$1,477,953	$397,000	$14,250	$43.5 M	$11,050	$1,716,525	$10,341
	S3	Side Channel										
	F2	Floodplain Forest										
	W1	Depressional Wetland										
2A	A2	Floodplain forest	151	$26,563,520	$6,640,880	$1,100,958	$397,000	$14,250	$33.6 M	$11,050	$1,328,479	$8,798
	S7	Side Channel										
	F1	Floodplain Forest										
	W1	Depressional Wetland										
2B	A2*	Floodplain Forest	166	$29,593,293	$7,398,323	$1,203,084	$397,000	$14,250	$37.4 M	$11,050	$1,476,072	$8,892
	S7	Side Channel										
	F2	Floodplain Forest										
	W1	Depressional Wetland										

Alternative	Restoration Feature	Habitat Type	Net Gain of AAHUs	Construction Cost w/ Contingency	Management	Interest During Construction	Adaptive Mgmt & Monitoring	LEERDs	Project First Cost	Annualized OMRR&R	Annualized Cost	$/AAHUs
3A	A2	Floodplain Forest	139	$30,483,670	$7,620,917	$1,113,671	$339,000	$14,250	$38.5 M	$11,050	$1,512,713	$10,883
	S3	Side Channel										
	F1	Floodplain Forest										
3B	A2*	Floodplain Forest	154	$33,693,639	$8,423,410	$1,428,505	$339,000	$14,250	$42.5 M	$11,050	$1,676,926	$10,889
	S3	Side Channel										
	F2	Floodplain Forest										
4A	A2	Floodplain Forest	139	$25,625,984	$6,406,496	$1,049,508	$339,000	$14,250	$32.4 M	$11,050	$1,279,853	$9,208
	S7	Side Channel										
	F1	Floodplain Forest										
4B	A2*	Floodplain Forest	155	$28,713,839	$7,178,460	$1,153,636	$339,000	$14,250	$36.3 M	$11,050	$1,430,277	$9,228
	S7	Side Channel										
	F2	Floodplain Forest										
9A	W1	Depressional Wetland	17	$848,656	$212,164	$9,838	$58,000	$14,250	$1.1 M	$550	$43,921	$2,583

A2 Sediment Deflection Berm	A2* Sediment Deflection Berm - with an additional kicker berm	F1 Reforestation throughout study area and on A2 feature	F2 Reforestation throughout study area and on A2* feature	S3 Increase side channel depth and width, no benching	S7 Increase side channel depth and width, benching were opportunistic	W1 Depressional wetlands

Ten plans were entered into IWR Plan to complete the CE/ICA analysis, and resulted in the identification of 6 cost effective plans of which 4 were "Best Buy" plans (including the No Action plan), and 4 plans that were not cost effective (Figure 20). A cost-effective alternative is defined as one where no other alternative can achieve the same level of output (net AAHU) at a lower cost, or a greater level of output at the same or less cost. A sub-set of cost-effective alternatives are identified as "best buy plans". Best buy plans are cost-effective alternatives that provide the greatest increase in environmental output for the least increase in cost per environmental output. The full array of alternatives and results of the CE/ICA analysis is displayed in Table 17. The Best Buy plans are displayed in Figure 21.

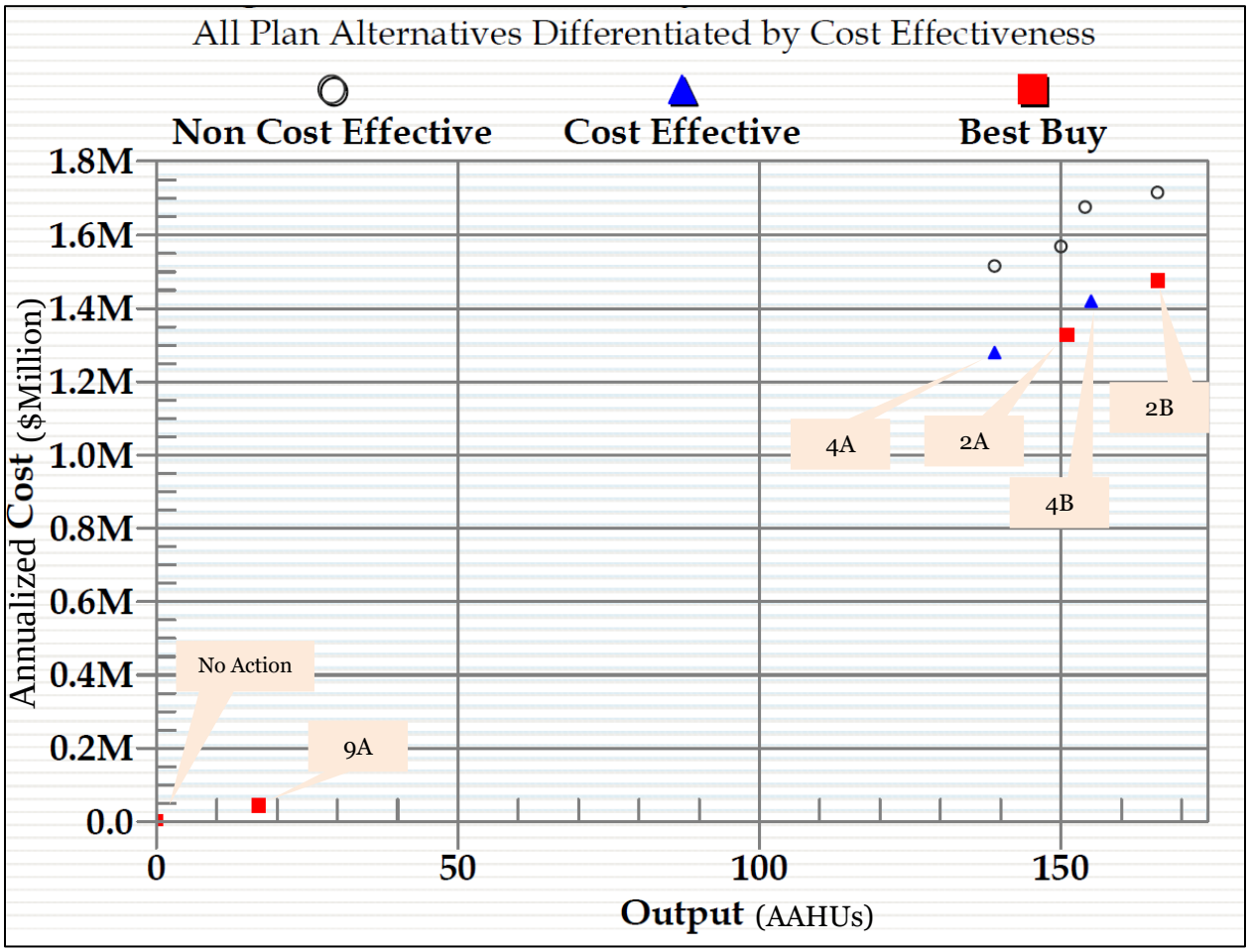

Figure 20. Cost effective analysis of all alternatives.

The best buy plans presented provide the information necessary to make well-informed decisions regarding desired project scale and features. Progressing through the increasing levels of output for the alternatives in Table 17 helps determine whether the increase in output is worth the additional cost. As long as decision makers consider a level of output to be "worth the additional cost", subsequent levels of output are considered. When a level of output is determined to be "not worth the additional cost", then subsequent levels of output will also likely be "not worth it", and the final decision regarding desired project scale and features for environmental restoration will be reached.

Typically in the evaluation of best buy plans, 'break points' are identified in either the last

column in Table 17, or in the stair-step progression from left to right in Figure 21. Break points are defined as significant increases or jumps in incremental cost per output, such that subsequent levels of output may not be considered "worth it". Identification of such break points can be subjective. For Crains Island HREP, break points were identified between Alternative 9 and 2A, and between Alternative 2A and 2B.

Table 17. Results of CE/ICA for Alterative Plans sorted in order of decreasing output. Rows in gray are Cost Effective.

Alternative	NET AAHU	$/AAHU	Project First Cost	Annualized Cost	Cost Effective	Incremental Output	Incremental Cost Per Unit of Output
No Action	0	$ -			Best Buy	0	$ -
Alternative 2A	151	$8,798	$33,630,000	$1,328,479	Best Buy	134	$9,587
Alternative 9A	17	$2,583	$1,113,000	$43,921	Best Buy	17	$2,579
Alternative 2B	166	$8,892	$37,380,000	$1,476,072	Best Buy	15	$9,840
Alternative 4B	154	$9,228	$36,250,000	$1,430,277	Yes		
Alternative 4A	139	$9,208	$32,380,000	$1,279,853	Yes		
Alternative 1B	166	$10,341	$43,500,000	$1,716,525	No		
Alternative 1A	150	$10,347	$39,500,000	$1,552,005	No		
Alternative 3B	154	$10,889	$42,500,000	$1,676,926	No		
Alternative 3A	139	$10,883	$38,500,000	$1,512,713	No		

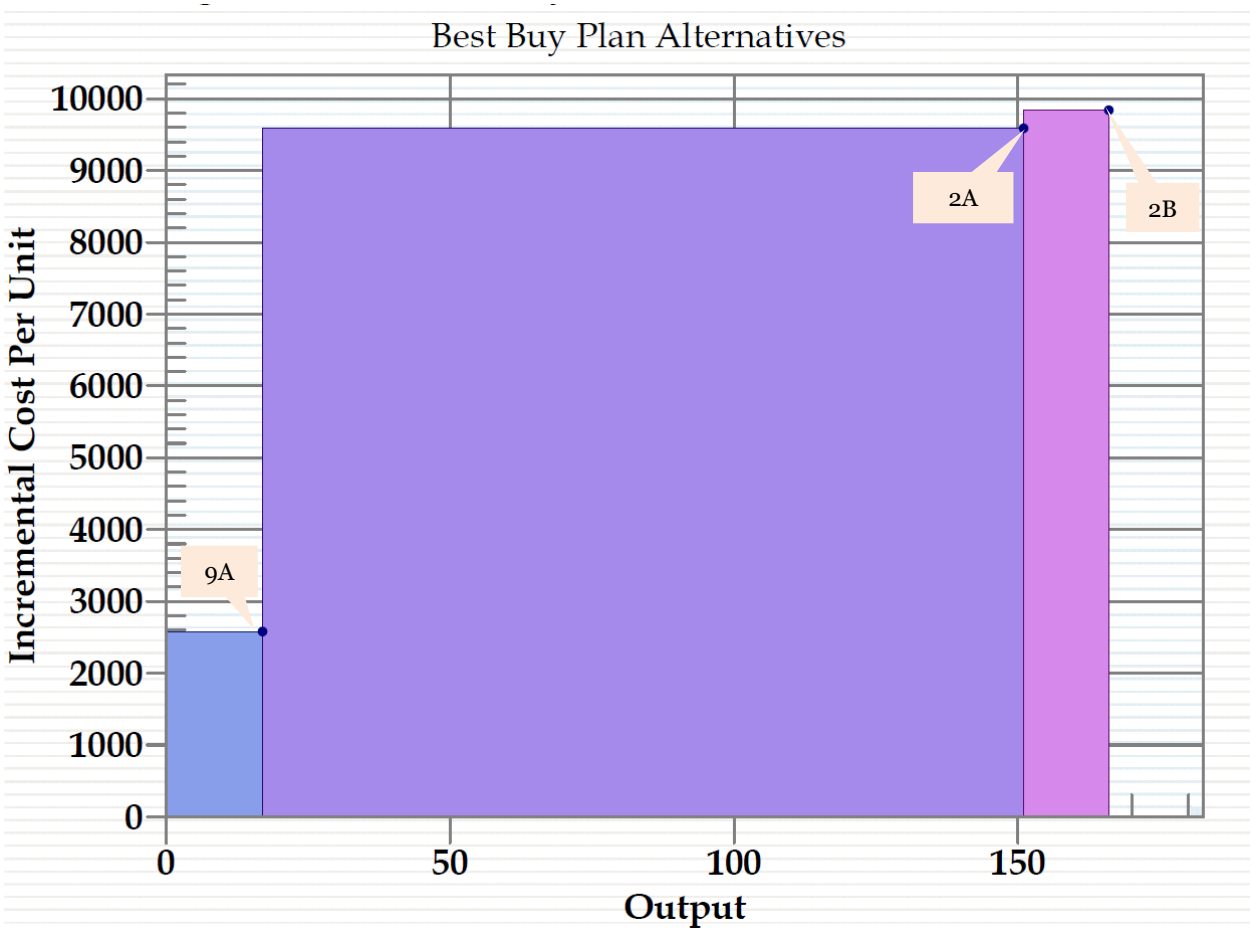

Figure 21. Incremental cost per unit of output (net AAHU) for the Crains Island HREP Best Buy plans.

4.14 Plan Selection

The CE/ICA Best Buy plans were assessed by the PDT and USFWS on their ability to meet the project objectives and achieve the four Planning and Guidance (P&G) evaluation criteria identified in ER 1105-2-100. The four evaluation criteria are acceptability, completeness, effectiveness, and efficiency. The descriptions of each is below.

Acceptability is the workability and viability of the alternative with respect to acceptance by federal and non-federal entities and the public and compatibility with existing laws, regulations, and public policies. Two primary dimensions to acceptability are ability to implement and satisfaction.

Completeness is the extent to which an alternative provides and accounts for all necessary investments or other actions that ensure the realization of the planning objectives.

Effectiveness is the extent an alternative alleviates the specified problems and achieves the specified objectives.

Efficiency is the extent to which an alternative is the most cost-effectives means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment (P&G Section VI.1.6.2(c) (3)).

A matrix (Table 18) was prepared to rank each "best buy' alternative according to how well the alternative met the evaluation criteria while considering the project objectives. The following is a discussion of the factors considered when ranking the alternatives.

No Action Alterative: The No Action Alternative does not meet any of the project objectives and does not improve the habitat at Crains Island. There is no cost associated with this alternative.

Alternative 9A: This alternative includes a wetland of 21.2 acres, resulting in 17 AAHUs at an average annual cost per habitat unit of $2,583. This alternative provides an additional 17 average annual habitat units at an incremental cost of $2,596. The cost for this alternative is approximately $1,113,000. This alternative only meets one of the planning objectives (to restore wetland ecosystem). This alternative doesn't sufficiently meet the project objectives and therefore was not selected.

Alternative 2A: This alternative includes wetlands of 21.2 acres, reforestation of approximately 61 acres, a sediment deflection berm that improves the forest resources for approximately 109 acres, and excavation of the side channel, resulting in a net gain of 151 AAHUs at an average annual cost of $8,798 per habitat unit. This alternative provides an additional 134 average annual habitat units at an incremental cost of $9,587. This alternative has direct reforestation but has less direct reforestation than Alternative 2B. Conversely, this alternative has more acres protected from the sediment deflection berm than Alternative 2B, which would indirectly restore the forest community. Indirect restoration is less expensive than direct reforestation. The habitat provided by indirect restoration would over time provide similar habitat to direct reforestation. The cost of this alternative is approximately $33,630,000. This alternatives meets all of the project objectives and reasonably maximizes habitat outputs compared to cost.

Alternative 2B: This alternative is similar to Alternative 2A with the addition of approximately 40 additional acres of reforestation on the sediment deflection berm. This alternative has a net gain of 166 AAHUs at a cost of $8,892 per habitat unit. This alternative provides an additional 15 average annual habitat units at an incremental cost of $9,840. The project first cost of this alternative is approximately $37,380,000. This alternative is very similar to Alternative 2A in terms of efficiency and ecosystem restoration outputs, but Alternative 2A adequately meets all project objectives and is less cost. This alternative is a more expensive method of accomplishing

reforestation when compared to Alternative 2A. The team found Alternative 2A more reasonably maximizes benefits and that Alternative 2B was not worth the additional cost of $3.8M for 15 habitat units.

National Ecosystem Restoration (NER) Plan

Engineering Regulation 1105-2-100 directs that the Corps of Engineers ecosystem restoration projects should contribute to national ecosystem restoration. The NER Plan reasonably maximizes ecosystem restoration benefits compared to costs. In addition to considering the system benefits and costs, it also considers information that cannot be quantified such as environmental significance and scarcity, socioeconomic impacts, and historic properties information. Alternative 2A has an overall output of 151 net AAHUs, and was identified as the TSP. While there were other "Best Buy" plans that meet or partially meet the objectives, Alternative 2A reasonably maximizes ecosystem restoration benefits compared to costs for the greatest diversity of habitat throughout the study area. Alternative 2A is identified as the NER Plan.

Table 18. Best Buy alternatives evaluated on their ability to achieve the four Planning and Guidance Evaluation criteria and project objectives. Scoring Criteria based on Low (Minimally meets criteria), Medium (Partially meets criteria), and High (Fully meets criteria).

Alternative	P&G Evaluation Criteria				Objectives			
	Acceptability	Completeness	Effectiveness	Efficiency	Increase connected aquatic side channel habitat with depth diversity for enhanced fisheries habitat benefits	Restore wetland ecosystem resources as measured in acres	Increase acreage protected from coarse sediment deposition and promote favorable fine sediment deposition in the Project Area as measured in acres	Restore floodplain forest communities as measured in acres
No Action	Low	Low	Low	Low	No	No	No	No
9A	Med	Med	Low	High	No	Yes	No	No
2A	High	High	High	High	Yes	Yes	Yes	Yes
2B	High	High	High	Med	Yes	Yes	Yes	Yes

Tentatively Selected Plan

The results of the NEPA analysis, incremental cost analysis, P&G criteria evaluation, and habitat evaluation in this chapter were considered with other factors, including physical features on the site, management objectives, critical needs of the region, and ecosystem needs of the UMRS were used in the decision making process. The Crains Island HREP team concluded that the alternative plan that best meets the goals and objectives is Alternative 2A. This alternative is cost-effective and justified as a "Best Buy" plan.

Implementation of the TSP would increase the quality and quantity of ecosystem resources and meet the needs for a large variety of native aquatic species. Restoring flow and connectivity of the side channel and the main channel of Mississippi River would contribute to overwintering fish habitat as well as feeding areas for migratory wildlife by approximately 66 acres; providing bathymetric diversity and flow within the side channel would provide important side channel habitat within the MMR; and restoring floodplain forest by approximately 61 acres with

reforestation and approximately 110 acres by improving soil conditions for flood plain forests; and approximately 21 acres wetland habitat; would allow the Project to realize the highest benefit to fish and wildlife. The Project outputs are also consistent with the goals and objectives of the Upper Mississippi River Restoration Program. For these reasons, Alternative 2A is identified as both the NER Plan as well as the project sponsor's preferred plan.

In cooperation with the USFWS, USACE has planned and designed a cost effective project. Alternative 2A has an overall output of 151 AAHUs for an estimated total construction cost of approximately $36,562,000 (FY 2018), the average annual cost per habitat unit is $9,539, and it includes the following restoration features (Figure 22):

- Side channel excavation
- Sediment deflection berm
- Reforestation
- Wetlands

Note: Costs increased from the preliminary FY2016 cost of $33,630,000 to Project First Cost of $36,562,000 (FY2018). This increase was due to the change in dollar value and more detailed design quantities. This type of increase would have impacted all the alternatives and did not affect project selection.

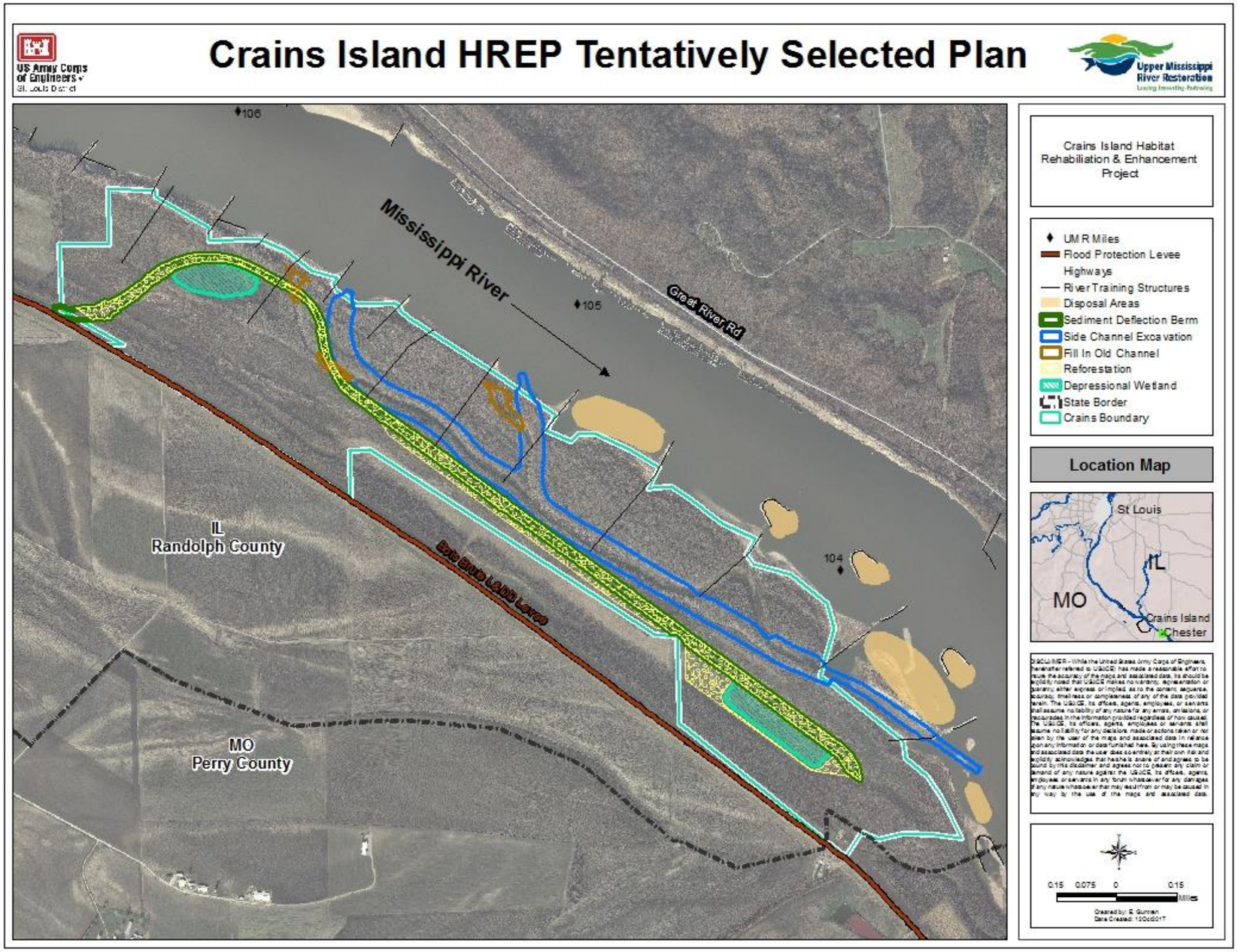

Figure 22. Crains Island HREP TSP.

In line with the principles of SMART Planning, a greater level of design was conducted on the TSP. Additional hydraulic modeling, geotechnical considerations, coordination with channel maintenance, and additional coordination with the Bois Brule Levee District has been ongoing.

Consistency with USACE Campaign Plan

USACE has developed a Campaign Plan[15]. This study is consistent with the USACE Campaign Plan by producing lasting benefits for the nation, by optimizing agency coordination, and by using innovative solutions in pursuit of a sustainable, environmentally beneficial, and cost-effective ecosystem restoration design.

Consistency with USACE Environmental Operating Principles

The U.S. Army Corps of Engineers has reaffirmed its commitment to the environment by formalizing a set of Environmental Operating Principles (EOP) applicable to all its decision-making and programs. The EOPs are: foster sustainability as a way of life throughout the organization; proactively consider environmental consequences of all USACE activities and act accordingly; create mutually supporting economic and environmentally sustainable solutions; continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments; consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs; leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner; and employ an open, transparent process that respects views of individuals and groups interested in USACE activities. The EOPs were considered during the plan formulation, and the TSP is consistent with the EOPs. The TSP promotes sustainability and economically sound measures by incorporating the most natural and least cost methods for restoring side channel, forest, and wetland habitat for fish and wildlife species.

4.15 Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made with some knowledge of the degree of reliability of the estimated benefits and costs of alternative plans. Risk is a measure of the probability and consequence of uncertain future events. The team worked to manage risk in developing measures. It developed measures by expanding on and referencing successful similar work completed by other UMRR HREPs, the *UMRR Design Handbook* (USACE, 2012), and applied lessons learned from USACE programs and activities as related to side channels designed for the Missouri River. The team used that lessons learned from previous projects and historical documentation to identify possible risks and decrease uncertainty in plan formulation. For example, a detailed compilation of the history and physical development of Crains Island identified seven wooden pile structures that would be removed prior to the actual side channel excavation. No measures in the TSP are believe to be burdened by significant risk or uncertainty regarding the eventual success of the proposed habitats. Significant risk would be avoided by proper design, appropriate selection, and correct seasonal timing or applications. The dynamic and complex nature of riverine environmental processes is a principal source of uncertainty. Post-construction monitoring and adaptive management plans would be used to address unplanned outcomes in all proposed measures.

[15] Available online at: http://www.usace.army.mil/About/Campaign-Plan/; accessed 20 January 2017

Based on modeling results, it is expected that the proposed measures would increase velocities and flow conditions within the side channel complex resulting in a reduced rate of deposition within Crains Island. Refer to Table 20 in Section 5.1.6.1 for more details. However, there is high uncertainty on the timing, frequency, and overall impacts of specific hydrologic events (large floods, for example) that could alter the expected performance of these measures. If monitoring demonstrates a need to address unexpectedly high rates of sediment deposition within Crains Island, adaptive management measures including the installation of rock structure(s) in order to direct flow through the side channel to scour sediment deposition. In addition, if woody debris accumulates to a point in which flow and connectivity are limited, removal of the woody debris would occur.

Sea level rise is not expected to impact the TSP since the Project is located several hundred feet above mean sea level.

The Bois Brule levee is currently undergoing construction for deficiency correction, dating back to underseepage during the 1993 flood. The deficiency correction project includes 297 seepage relief wells, 8,485 linear feet of seepage berms, a 7,000 foot long clay-filled seepage cutoff trench, three pump wells and restoration of 4.2 miles of levee to its design grade. Although none of these deficiencies were adjacent to Crains Island, there is concern that excavation in close proximity to the levee could cause further under seepage. Geotechnical engineers assigned to the project made several determinations about project features: any depressional wetlands could not be constructed within 600 feet of the toe of the levee to prevent under seepage, and tree plantings on top of the sediment deflection berm would not be planted within 50 feet of the toe of the existing levee to prevent root damage to the levee. Side channel excavation is outside of the 600 feet buffer and would not induce additional under seepage risk. As part of Plans and Specifications, a Section 408 permit will be required for modifications to the Bois Brule levee as part of the Crains Island HREP. Coordination has been made with the Bois Brule levee district and the USACE St. Louis District 408 Permit PDT. No concerns have been identified at this time. Additionally, successful project implementation is not contingent on Bois Brule access or tie-in, and design changes to the Sediment Deflection berm or Real Estate access would be possible, within project contingency costs, and with minimal decrease in function.

5 TENTATIVELY SELECTED PLAN – DESCRIPTION WITH DESIGN, CONSTRUCTION, OPERATIONS, MAINTENANCE, REPAIR, REHABILITATION, & REPLACEMENT CONSIDERATIONS

This chapter provides further information on the TSP. The TSP for ecosystem restoration at the Crains Island HREP includes construction of a sediment deflection berm, excavation of the side channel, wetland restoration, and reforestation.

The features of the TSP are designed to address study objectives (Table 19). A detailed description of the project features included in the TSP is provided in Chapter 4 and provided in Table 20.

Table 19. Goals, objectives, and the features of the TSP that address them. Some features of the TSP address multiple objectives.

Restoration Features	Objectives			
	Increase connected aquatic side channel habitat with depth diversity for enhanced fisheries habitat benefits	Restore wetland ecosystem resources as measured in acres	Increase acreage protected from coarse sediment deposition and promote favorable fine sediment deposition in the Project Area as measured in acres	Restore floodplain forest communities as measured in acres
Sediment Defection Berm		X	X	X
Side Channel	X	X	X	
Depressional Wetland		X		
Reforestation				X

The TSP includes the following features:

- Construction of a sediment deflection berm;
- Excavation of side channel to increase depth and width, with benching on either side where opportunistic;
- Reforestation throughout the study area; and
- Depressional wetlands.

There are two entrances to the existing side channel. The upper entrance would be excavated to 0 feet low water reference plane (LWRP) with a depth of approximately 10 feet at 10+LWRP and a bottom width of approximately 80 feet. The fine sediment material excavated from the side channel would be used to construct the sediment deflection berm. The sediment deflection berm would be constructed to an elevation of 20% chance of annual exceedance. The sediment deflection berm would tie into the Bois Brule levee. A vegetation free zone of 50 feet is required to ensure the plantings on the berm do not negatively impact the integrity of the existing levee. Excess material from the side channel would be placed back in the river. Reforestation of hard mast tree species would be planted throughout the study area and on the sediment deflection berm, totaling approximately 61 acres. Twenty-one acres of depressional wetlands are planned. The wetlands would be excavated to a bottom elevation of approximately 358 feet NAVD88. The following table documents the specific designs including acres and cut and fill for each proposed feature of the TSP.

Table 20. Crains Island HREP Feature summary of the TSP.

Feature Name	Feature Footprint (AC)	Reforest. Area (AC)	Protected From Coarse Sediment Area (AC)	Wetlands (AC)	Side Channel (AC)	*Total Habitat Area (AC)*	Fill (Cubic Yards)	Cut (Cubic Yards)
SD Berm and Upper Entrance Fill	38.03	38.03	191.84	2.04		*231.92*	326,407	
Side Channel Excavation	73.40				66.20	*66.20*		1,877,906
Dredged Material Placement	43.40						1,492,373	
Lower Entrance Fill	2.31						22,725	
Reforestation		18.44				*18.44*		
Depressional Wetlands	23.65	4.52		19.13		*23.65*	37,807	185,037
Total:	180.80	60.99	191.84	21.18	66.20	*340.21*	1,879,312	2,062,943

The berm would start from the existing Bois Brule levee and curve towards the side channel, running parallel to the side channel. The proposed measure would have a 4:1 slope on the exterior with an 8:1 slope on the interior to minimize scouring when overtopped by flood events. The top of the berm would be constructed to a 20% chance of annual exceedance elevation of 374.48 NAVD 88 at a length of 13,500 feet long. The cross-sectional width of the sediment deflection berm would be approximately 150 feet wide at the base. This measure maximizes the area with protection from coarse sediment material deposition and increase fine sediment deposition.

Reforestation would be completed for approximately 61 acres in the Project Area, with approximately 38 acres on the sediment deflection berm and the remaining in areas with appropriate fine sediment soils for hard mast tree species.

The proposed side channel feature would have an excavated depth of the bottom of the side channel approximately 20 ft. deeper than the existing bottom with a final elevation of 337ft NAVD88. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. The bottom width would be approximately 80 ft. with side slopes of 1 ft. vertical on 3 ft. horizontal, extending approximately 120 ft. on each side. Removal of remnant wood pile river training structures within the excavation area would be completed. This feature involves excavation of the side channel with benching where opportunistic. Benching involves one or more terraces of approximately 20 feet in width placed roughly midway through the bank. Benches would be placed where they are sustainable for the 50 year evaluation period and not on the outside bends where flows are higher. This feature is most effective by maximizing the fisheries habitat benefits throughout the entire side channel. Excavated material would be used for construction of the sediment deflection berm and dredge material would be placed adjacent to Crains Island.

The wetland feature would create approximately 21.18 acres of wetland habitat within the Project Area. These features would be approximately 6 feet deep, with the bottom elevation at approximately 358 ft. NAVD 88. This would allow the bottom portion of the wetlands to receive ground water input from the river and contain water approximately 80% of the time, barring extreme drought periods.

5.1 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.

Location

The entire Crains Island HREP is located within the floodplain of the Mississippi River between river miles 103.5 and 105.5. Land surface elevation 337 – 395 feet NAVD 88.

Survey Data

Survey data utilized included the following:

Single beam hydrographic surveys:

- October 06, 2015
- December 03, 2015
- December 07, 2015

Multibeam hydrographic surveys:

- January 17, 2013
- May 28, 2014
- July 16, 2014
- June 08, 2015
- June 10, 2015
- July 24, 2015

Bare earth LiDAR (Light Detection And Ranging):

- December 13, 2012

Aerial Color Photography

- November 27, 2012

It is recommended that the following surveys be collected during P&S prior to construction in order to obtain more accurate quantities:

- LiDAR survey and aerial photography survey of project area.
- Comprehensive hydrographic survey of side channel and adjacent main channel.
- Forest Inventory.
- Channel stability analysis of side channel

Access

Access to the site and proposed land-based features will be accomplished by land from the Bois Brule Levee, in Missouri. Dredging and dike modifications, where practicable, will be conducted from the Mississippi River using floating barge. Additional discussion on access is included in Appendix M – Civil Engineering and Appendix E – Real Estate Plan.

Excavated Material / Disposal

Excavated material would be required to construct the sediment deflection berm. Prior to construction, sampling of the proposed excavations would be performed and evaluated for 401 Clean Water Act compliance per the Inland Testing Manual (ITM). During construction, if contaminated material is identified, USACE would stop work and follow steps outlined in ER 1165-2-132.

The remaining material not utilized for the construction of the sediment deflection berm will be placed on an existing dredge disposal site located at RM 103.3 (494,000 CY) and behind 4 existing chevron dikes at RM 103.4 (65,000 CY), RM 103.7 (76,000 CY), RM 104.0 (174,000 CY), and RM 104.4 (162,000). Additionally a new disposal site would be constructed at RM 105.5 (521,000 CY). In total, this would include approximately 1,492,000 CY of material.

Public Access and Safety

Safety and security are important parameters, which would be detailed during the Plans and Specifications Phase. Of specific concern will be the coordination of regional hunting seasons with the construction season.

Hydrology / Hydraulics

5.1.1.1 Side Channel

Deepening the existing side channel is designed to improve aquatic habitat at much lower flows on the Mississippi River. This will extend the amount of time the channel is submerged. To determine the proper design depth, four existing side channels in the Mississippi River near Crains Island were analyzed and a bottom elevation of 337.79 (+0 LWRP) was selected. The current channel bottom at Crains Island is exceeded only 33% of the time (250,000 cfs). The average flows through the months of August and February are well below the values needed to inundate the current channel. Deepening the side channel to the proposed depth of 0 LWRP will allow the bottom to be exceeded 98% of the time (66,700 cfs). A rating curve from USGS was used to obtain the flows listed at Chester Gage. See Appendix C – Hydrology and Hydraulics for details on elevations, discharges, stages, and percent exceedance. Table 21 Side channel results for Low Flows Model shows the side channel would have between 0.32 and 5.32 feet per second depending on the scenario.

Another primary consideration for design of this side channel is allowing debris and drift to pass through the chute without getting caught up and clogging it causing decreased flow velocities and sedimentation. Recommendations on channel bottom width, side slopes, and sinuosity from USACE, Kansas City District were incorporated into the design. The second entrance to the side channel was modified from its original conception based on HEC-RAS[16] 2D model results in order to increase flows in that part of the channel.

In addition, historical documentation shows that seven wooden pile structures were built between 1928 and 1968 within the proposed footprint of the side channel excavation. These structures would be removed using land-based equipment prior to the excavation of the actual side channel.

[16] HEC-RAS – Hydrologic Engineering Center River Analysis System is a tool that allows users to perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling.

Table 21. Side channel results from Low Flows Model.

Scenario	Stage at Chester (LWRP= - 0.4)	Stage at Red Rock Landing (LWRP= 2.1)	Flow at Chester (cfs)	Velocity (ft/s)
LWRP +3	2.6	5.1	87,500	0.32
LWRP + 4	3.6	6.1	95,200	0.37
LWRP +5	4.6	7.1	103,000	0.47
LWRP +10	9.6	12.1	150,000	1.41
LWRP +15	14.6	17.1	212,000	2.38
LWRP +20	19.6	22.1	289,000	3.13
LWRP +25	24.6	27.1	378,000	3.91
LWRP +30	29.6	32.1	472,000	4.52
50% ACE flow	30	32.5	480,000	4.52
LWRP +35	34.6	37.1	579,000	4.94
20% ACE flow	36.2	38.7	619,000	5.09
20% ACE +2' flow	38.2	40.7	676,000	5.32

5.1.1.2 Sediment Deflection Berm

The sediment deflection berm is designed to improve aquatic and floodplain forest habitat by deflecting coarse sediment material (i.e. sand) and reducing high flows in the Project Area. The original alignment and height of the sediment deflection berm was modified though the study process to account for impacts to the 1% annual chance exceedance event. Figure 23 shows results from the HEC-RAS 2D model, which demonstrates the progression of backing of water behind the berm as river stages rise. This backwater is expected to allow increased settling time for fine sediments to deposit, which would improve soils over time for hard mast tree establishment.

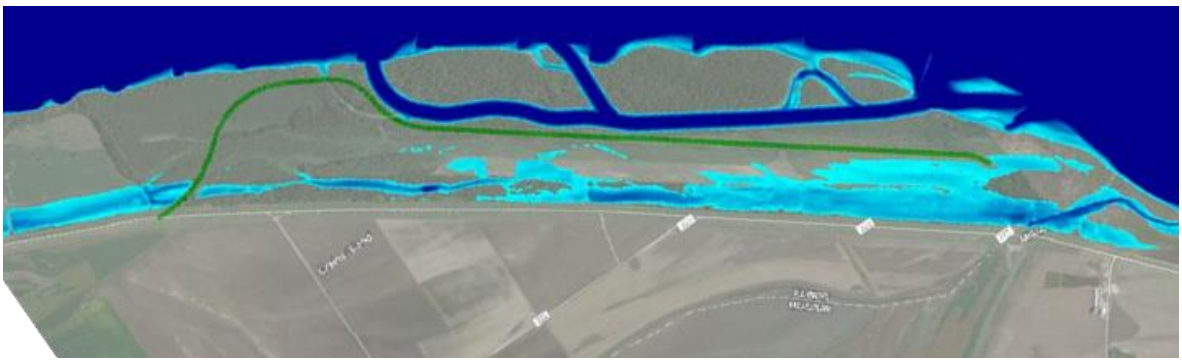

Figure 23. HEC-RAS depth plot in ft at 24.6 on the Chester gage. (+25 LWRP). Green line represents proposed sediment deflection berm.

Model results show that the berm would prevent flow entering upstream until overtopped. Reducing flow would consequently reduce the course sediment from the main channel to the Project Area. The velocities behind the berm drop from 1-2 ft/s down to nearly 0 ft/s. The drop in velocity, which changes the capacity of the water to hold sediment, should allow suspended sediment to deposit behind the berm (Figure 24).

Available analyses and other considerations are discussed in more detail in Appendix C – Hydrology and Hydraulics.

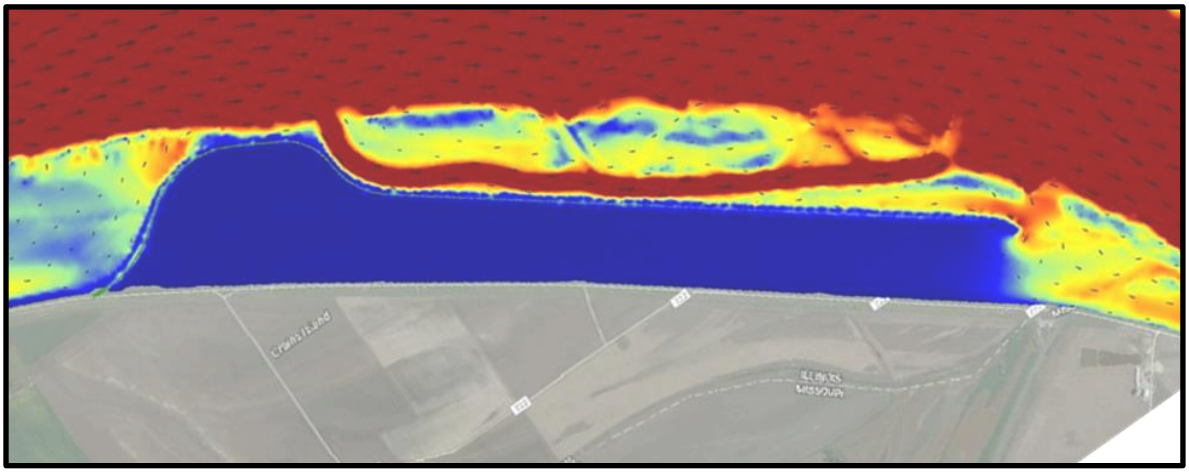

Figure 24. HEC-RAS proposed condition velocity (ft/s) at a 20% annual exceedance just prior to overtopping the sediment deflection berm.

Geotechnical Considerations

Key features of the project include enlarging the existing side channel in depth and width for side channel habitat, construction of a sediment deflection berm to reestablish floodplain forest habits, and establishment of depressional wetlands.

The side channel and depressional wetland features included in this project are planned to lower the ground surface elevation 8 to 15 feet from that of the existing grade. An interim planning buffer of 600 feet is being used at this time, which does not allow planned work to be within 600 feet of the Bois Brule riverside levee toe. The 600 feet buffer is the most critical effective seepage source distance used in past designs for this area, and it has been determined to not increase the risk of under seepage for the levee.

The sediment deflection berm project feature ties into the existing Bois Brule Levee. The deflection berm will be planted to encourage hardwood growth, however no planting can take place within 50 feet of the toe of the existing levee to prevent root damage to the levee. In addition, a woody vegetation-free zone would need to be maintained.

Available analyses and other considerations are discussed in more detail in Appendix B – Geotechnical Considerations.

5.2 Construction Considerations

Protected Species

5.2.1.1 Bald Eagles

Consideration (in coordination with the USFWS) will be given during P&S preparation sequencing construction activities in a manner that minimizes impacts.

5.2.1.2 Indiana bat and Northern long-eared bat

Specific conditions on the construction work that would require tree clearing activities be scheduled outside April 1 thru September 30 when the bats are known to inhabit summer habitat. If tree clearing activities must occur during this period, coordination with USFWS will occur. At a minimum, a site visit by a team of biologists will be required to determine if any

roost trees are among those trees proposed for removal. If removal of a roost tree is proposed, then the District must enter into Section 7 consultation with the USFWS. The consultation will determine if the proposed action is likely to jeopardize the continued existence of the Indiana bat or Northern long-eared bat.

5.2.1.3 Pallid Sturgeon

Consideration (in coordination with the USFWS, IDNR, and MDC) will be given during P&S preparation for sequencing construction activities in a manner that minimizes impacts.

5.2.1.4 Least Tern

Consideration (in coordination with the USFWS) will be given during P&S preparation for sequencing construction activities in a manner that minimizes impacts and increases habitat benefits.

5.2.1.5 Migratory Wildlife

The development of P&S will attempt to minimize disruption of migratory wildlife during fall and early winter.

Permits/Approvals

5.2.1.6 Section 10/404 Approval and 401 Water Quality Certification

Laws of the United States and the State of Illinois have assigned USACE and Illinois EPA and Illinois DNR with specific and different regulatory roles designed to protect the waters within and on the State's boundaries. Protecting Illinois' waters is a cooperative effort between the applicant and regulatory agencies.

The basis for USACE regulatory functions over public waterways was formed in 1899 when Congress passed the Rivers and Harbors Act of 1899. Until 1968, the Rivers and Harbors Act of 1899 was administered to protect only navigation and the navigable capacity of this Nation's waters. In 1968, in response to a growing national concern for environmental values, the policy for review of permit applications with respect to Sections 9 and 10 of the Rivers and Harbors Act was revised to include additional concerns (fish and wildlife, conservation, pollution, aesthetics, ecology, and general welfare) besides navigation. This new type of review was identified as a "public interest review."

USACE' regulatory function was expanded when Congress passed the Federal Water Pollution Control Act Amendments of 1972. The purpose of the Federal Water Pollution Control Act was to restore and maintain the chemical, physical, and biological integrity of this Nation's waters. Section 402 of the Act established the National Pollutant Discharge Elimination System (NPDES) to regulate industrial and municipal source discharges of pollutants into the Nation's waters. The NPDES permit program is administered by the Illinois EPA (ILEPA) and should not be confused with USACE Section 404 permit program. Section 404 of the Federal Water Pollution Control Act (now called the Clean Water Act due to amendments in 1977) established a permit program to be administered by USACE to regulate the nonpoint source discharges of dredged or fill material into waters of the United States.

The IDNR is the state agency that administers permit programs for conserving and protecting Illinois' water, recreational and environmental resources, and for the prevention of damage resulting from unwise floodplain development under Illinois state law. All proposed features have been designed to be in voluntary compliance with the policies behind Illinois state law.

Under Illinois state law, the IDNR-Office of Water Resources (IDNR-OWR) has authority to regulate construction on all floodplains and floodways in the state, per the Rivers, Lakes, and

Streams Act of Illinois. The IDNR-OWR administrative rules explain when a permit must be obtained for various types of floodway/floodplain-development. Any person who plans to perform or allow such floodplain construction has a duty to contact the IDNR to determine if a floodplain construction permit is required under Illinois law. The District will coordinate with IDNR as required by all laws applicable to the Project.

The District is compliant with Section 404 of the Clean Water Act based upon the 404(b)(1) evaluation (Appendix O, *Clean Water Act*). ILEPA Section 401 water quality certification is mandatory for all projects requiring a Federal Section 404 permit. Section 401 water quality certification is the ILEPA's concurrence that a project is consistent with the state's water quality standards. Short- and long-term impacts to water quality and water-related uses are evaluated in the Section 401 certification review. A Section 401 water quality certification would be obtained as part of the 404(b)(1) process.-

5.2.1.7 National Pollutant Discharge Elimination System (NPDES)

A storm water discharge or NPDES permit for construction activities will be required. Effective March 10, 2003, the NPDES storm water discharge permit is required when a construction activity disturbs more than one acre. The construction contract for the Project will trigger the need for the contractor to apply for this permit. With or without the permit, USACE requires an environmental plan that addresses contaminants as well as erosion control measures. The work near the River would require extra care and erosion control measures. Contract requirements should require the use of erosion control measures to control erosion and sedimentation of soil prior to establishment of vegetation. The contractor would be required to prepare an erosion control plan to ensure that unprotected soil is not allowed to leave the Project work limits. The contractor would be required to comply with all local codes and permit requirements.

5.2.1.8 Section 408

Through the Civil Works program USACE serves the public by providing the Nation with quality and responsive management of the Nation's water resources. As a result, USACE, in partnership with stakeholders, has constructed many Civil Works projects across the Nation's landscape. Given the widespread location of these projects, many embedded within communities, over time there may be a need for others outside of USACE to alter or occupy these projects and their associated lands. Reasons for alterations could include improvements or making repairs to the projects; relocation of part of the project; or installing utilities or other non-project features. Because these projects are in place for the benefit of the public, USACE will ensure that any alteration proposed will not be injurious to the public interest and will not affect USACE project's ability to meet its authorized purpose. Section 14 of the Rivers and Harbors Act of 1899, as amended, and codified in 33 USC 408 (Section 408) provides that the Secretary of the Army may, upon the recommendation of the Chief of Engineers, grant permission to other entities for the permanent or temporary alteration or use of any USACE Civil Works project

As part of Plans and Specifications, a Section 408 permit will be required for connecting the sediment deflection berm to the Bois Brule levee as part of the Crains Island HREP. Coordination has been made with the Boise Brule levee district and the USACE St. Louis District PDT. No concerns have been identified at this time.

Construction Schedule Constraints

Scheduling of construction contracts would depend on availability of funds, and based on expected funding, it is likely that the contract would be awarded in at least two construction contracts.

The following information indicates various scheduling constraints and must be confirmed and

evaluated during P&S.

- No clearing of trees greater than 3 inches in diameter shall be allowed between April 1 and September 30 (During Indiana Bat and Northern-Long-Eared bat breeding and rearing season). Coordination with USFWS and ILDNR prior to any tree cutting may be required.
- Coordination with USFWS personnel is required prior to working during the seasonal waterfowl and deer hunting seasons. During peak hunting weekends or dates, all construction activities may be required to cease for a short period of time.
- No clearing of trees where roosting or occupied nests exist shall be allowed when bald eagles or red-shouldered hawks are present in the area. Although there are known nest sites, currently, none are known to exist within 660 feet of the selected measures. If any nesting activity is observed, no construction activities within 660 feet of the nest shall be allowed.
- In accordance with Executive Order 13186, take of migratory birds protected under the Migratory Bird Treaty Act should be avoided or minimized, to the extent practicable, to avoid adverse impact on migratory bird resources.

Construction Sequence

The probable construction sequence for the TSP features is summarized in Table 22. Phase 1 river-based work includes notching two stone dikes at the proposed side channel exit.

Phase 2, land-based work includes depressional wetland construction, side channel excavation along the edges, and sediment deflection berm construction. Phase 3, reforestation includes tree planting on the sediment deflection berm and interior of the sediment deflection berm. Phase 4, dredging includes dredging of the side channel with simultaneous placement of the material adjacent to the Project Area. Multiple features may be packaged into multiple contracts or multiple task orders under a single contract depending on the amount of construction funding available. Refer to Appendix M, Civil Engineering for more details.

Table 22. Construction work items for the TSP.

Sequence	Construction	Duration	Start	Finish
Phase 1	River Based work	360 days	10/2/2018	2/15/2019
Phase 2	Land Based work	660 days	10/1/2018	5/9/2021
Phase 3	Reforestation	320 days	10/1/2019	12/22/2020
Phase 4	Dredging	420 days	10/1/2020	5/22/2022

5.3 Operational Considerations

Operation and maintenance of UMRR habitat projects is similar to that undertaken by the project partner day-to-day management of wildlife areas and other public use areas. The purpose of assigning OMRR&R costs is to ensure commitment and accountability to the UMRR HREP by the USFWS. USFWS will be responsible for 100% of the OMRR&R of the project features. Total estimates of annual operation costs for the TSP are shown in Section 7.1. A detailed OMRR&R Manual will be provided after construction is completed and project officially turned over to the USFWS.

5.4 Maintenance Considerations

Maintenance may include performing inspections or routine tree planting maintenance activities. The estimated annual maintenance costs are presented in Chapter 7, Cost Estimates. Maintenance requirements will be further detailed in the Project's OMRR&R Manual after construction.

5.5 Repair, Rehabilitation, and Replacement Considerations

Repair, rehabilitation, and replacement considerations may extend outside the typical 50-year period of analysis. The USFWS is expected to maintain the HREP project until it is no longer authorized and should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. Rehabilitation cannot be accurately measured during the design or construction phase. Rehabilitation is reconstructive work that significantly exceeds the annual operation and maintenance requirements and is needed as a result of major storm or flood events. Repair, Rehabilitation, and Replacement considerations are presented in Chapter 7, Cost Estimates.

5.6 Value Engineering

A Functional Analysis Value Engineering Workshop was held (27-31 July 2015) prior to the development of this report. Fourteen technical experts from the Missouri Department of Conservation, Illinois Department of Natural Resources, USFWS, and USACE attended the workshop to provide input on project objectives, potential project features, future conditions of the site, and to identify resource issues. A copy of the executive summary is provided in Appendix A - *Coordination*. A full copy of the Value Engineering Functional Analysis report is available upon request. In addition, development of this report was actively coordinated throughout the planning process with the project partner, USFWS, as well as other natural resource agencies. The Value Management Plan is part of the administrative record and available upon request.

6 SCHEDULE FOR DESIGN AND CONSTRUCTION

The following presents the schedule for the completion of the feasibility study (Table 23). The proposed Project construction schedule is shown in Table 24.

Table 23. Schedule for Crains Island.

Event	Scheduled Date
District Quality Control #1 – Feasibility	December 2015
District Quality Control #2 - Feasibility	February 2017
Agency Technical Review of Draft Report #1	May 2017
MSC Decision Milestone	September 2017
Public and Agency Review of Draft Report	October 2017
Submit Final Feasibility Report to Mississippi Valley Division (MVD)	February 2018
Approval of Final Feasibility Report from MVD	April 2017
Execute the Memorandum of Agreement with Sponsor	June 2018
Initiate Design	July 2018
Complete Construction	December 2025
Complete OMRR&R Manual	March 2025

Table 24. Tentative Project Design and Construction Schedule for Crains Island HREP Phase I.

TASK	#of DAYS	START DATE	END DATE
Plans & Specs Start	180	Mar-18	Aug-18
35%	60	Oct-18	Nov-18
65%	60	Nov-18	Jan-19
95%	60	Jan-19	Mar-19
DQC	45	Mar-19	May-19
ATR	60	May-19	Jul-19
BCOE	60	Jul-19	Sep-19
CT to Prepare for IFB/RFP	14	Sep-19	Sep-19
IFB/RFP	30	Sep-19	Oct-19
Bid Opening	1	Oct-19	Oct-19
Award	15	Oct-19	Nov-19
Notice to Proceed	15	Nov-19	Nov-19
Finish Construction	365	Nov-19	Nov-20
As Built Drawings	30	Nov-20	Dec-20

7 COST ESTIMATES

Table 25 shows the Project first cost. The detailed estimate of the project design and construction costs are provided in *Appendix I – Cost Estimate*; however, due to the sensitivity of providing this detailed cost information, which could bias construction contract bidding, this material has been omitted in the public document. Quantities and costs may vary during final design. All cost estimates are calculated using the FY2018 fiscal year pricing.

Table 25.Project First Cost Estimate. (FY2018 Price Level – 50 year period of analysis using 2.875% discount rate and 4 phase construction)

Account Code	Feature	Project First Cost
01	Lands and Damages (LEERD)	$14,000*
06	Fish & Wildlife Facilities	$28,057,000
30	Planning, Engineering, & Design	$5,509,000
31	Construction Management	$2,983,000
	Total First Costs	$36,562,000
	Interest During Construction	$1,102,000
	Investment Cost	$37,664,000
	Annualized Investment Cost	$ 1,429,000
	Annualized OMRR&R	$11,000
	Project Annual Cost	$ 1,440,000

* Project features are on federal land, and managed as a national wildlife refuge; therefore 100% federally funded.

7.1 Operation, Maintenance Considerations

The proposed project features have low annual OMRR&R requirements. For analysis purposes, the costs presented for OMRR&R used the 50-year period of analysis. However, the USFWS is expected to operate and maintain the project until it is no longer authorized, which includes mowing the woody vegetation-free area on the levee where an easement would be required for the areas where the sediment deflection berm ties into the Boise Brule levee. Refer to Chapter 11, Real Estate Requirements for more details. The estimated total average annual OMRR&R cost (with 30% contingency) of the TSP cost is $11,050 (Table 26). USFWS is 100% responsible for OMRR&R costs. These quantities and costs may change during final design. A complete list of OMRR&R needs will be provided in the OMRR&R Manual following construction.

Table 26. Estimated Annual Operation and Maintenance Costs (October 2016 price levels).

O&M Item	Quantity	Unit	Unit Price ($)	Total Cost ($)
Site Inspection	10	Hours	50	$500
Mowing	80	Hours	100	$8,000
			Subtotal	$8,500
			Contingencies (30%)	$2,550
			ANNUAL TOTAL O&M COST	**$11,050**

7.2 Repair, Rehabilitation, and Replacement Considerations

The USFWS is expected to operate and maintain the Project per the agreed terms in the Memorandum of Agreement (Appendix K, *draft* MOA), and should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. Table 27 lists the major Project components and their associated frequencies of repair, rehabilitation, and replacement. Estimates of these costs will be included in the O&M and RR&R Manual.

Table 27. Repair, Rehabilitation, and Replacement Considerations.

Component	Frequency
Repair, Rehabilitate, Replace Side Channel	Every 75 years
Repair, Rehabilitate, Replace Sediment Deflection Berm	Every 60 years
Repair, Rehabilitate, Replace Depressional Wetlands	Every 60 years

7.3 Monitoring and Adaptive Management Considerations

Costs for monitoring and adaptive management are listed in

Feature	Performance Indicator	Activity	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Sub-total
Side Channel	Fish diversity	UMRR-LTRM fisheries survey	9,000	9,000			9,000			9,000			9,000		45,000
	Flow and connectivity	Gage data analysis		1,000		1,000					1,000				3,000
	Side channel habitat depth and diversity	Hydrographic /ADCP Survey and ISOPAC analysis		15,000		15,000					15,000				45,000
	AM feature: Installation of scouring rock structures									72,000					72,000
	Woody debris	Visual observation				1,000			1,000			1,000			3,000
	AM measure: Woody debris removal									100,000					100,000
Sediment deflection berm	Soil composition	Soil core samples	10,000										10,000		20,000
	AM feature: Evaluate hydrology of site and consider longer evaluation period to capture more high flow events												5,000		5,000
Depressional wetland	Wetland topographic diversity	Elevation survey		1,000		1,000			1,000			1,000			4,000
	Wetland water presence	Visual observation		1,000		1,000			1,000			1,000			4,000
	AM feature: re-excavate wetlands and/or increase exterior berm height									50,000					50,000
Refore stat	Forest Community	Forest monitoring			3,000				3,000						6,000

	Diversity														
	AM feature: supplemental planting and more robust deer protection and maintenance									40,000					40,000
	Performance Evaluation Report	Inspection and report writing							10,000					10,000	20,000
	Subtotal of AM Measures														$267,000
	Subtotal of Monitoring														$130,000
	SUBTOTAL														$417,000
	Contingencies (27%) & Escalation (1.8%)														$120,096
	TOTAL														$537,096

Table 36. Crains Island HREP conceptual monitoring schedule and estimated monitoring costs. All features will be monitored for success and further details are provided in Chapter 11 – *Project Performance Evaluation and Adaptive Management*, and in *Appendix J – Monitoring and Adaptive Management*. The estimated cost of the proposed monitoring and adaptive management plan are included in the total project cost estimate but they are not included in the annualized OMRR&R cost discussed above. The estimated total monitoring and adaptive management costs with contingencies for 10 years is $537,096 and is included in total project costs, with an average annualized cost of $20,381 (FY 2018 discount interest rate of 2.875%). A detailed cost estimate for monitoring and adaptive management is located in Section 10 (

Feature	Performance Indicator	Activity	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Sub-total
Side Channel	Fish diversity	UMRR-LTRM fisheries survey	9,000	9,000			9,000			9,000			9,000		45,000
	Flow and connectivity	Gage data analysis		1,000		1,000					1,000				3,000
	Side channel habitat depth and diversity	Hydrographic /ADCP Survey and ISOPAC analysis		15,000		15,000					15,000				45,000
	AM feature: Installation of scouring rock structures									72,000					72,000
	Woody debris	Visual observation				1,000			1,000			1,000			3,000
	AM measure: Woody debris removal									100,000					100,000
Sediment deflection berm	Soil composition	Soil core samples	10,000										10,000		20,000
	AM feature: Evaluate hydrology of site and consider longer evaluation period to capture more high flow events												5,000		5,000

Depressional wetland	Wetland topographic diversity	Elevation survey		1,000		1,000			1,000			1,000			4,000
	Wetland water presence	Visual observation		1,000		1,000			1,000			1,000			4,000
	AM feature: re-excavate wetlands and/or increase exterior berm height									50,000					50,000
Reforestation	Forest Community Diversity	Forest monitoring			3,000				3,000						6,000
	AM feature: supplemental planting and more robust deer protection and maintenance									40,000					40,000
	Performance Evaluation Report	Inspection and report writing							10,000					10,000	20,000
	Subtotal of AM Measures														$267,000
	Subtotal of Monitoring														$130,000
	SUBTOTAL														$417,000
	Contingencies (27%) & Escalation (1.8%)														$120,096
	TOTAL														$537,096

Table 36. Crains Island HREP conceptual monitoring schedule and estimated monitoring costs.

8 ENVIRONMENTAL EFFECTS*

Chapter 2 identified the existing conditions of the resources at Crains Island. Chapter 8 describes the environmental consequences of the proposed action alternatives and is organized by the same resource topics as described in Chapter 2. The depth of analysis of the alternatives corresponds to the scope and magnitude of the potential environmental impact. This chapter provides the scientific and analytic basis where data exists and as well as qualitative analyses for the comparison of alternatives and describes the probable consequences (impacts and effects) of each alternative on the selected environmental resources. The purpose of characterizing the environmental consequences is to determine whether the resources, ecosystems, and human communities of concern are approaching conditions where additional stresses will have an important cumulative effect (CEQ 1997).

The TSP would result in positive long-term benefits to aquatic habitat, wetland habitat, and floodplain forest in Crains Island. No federally protected species would be negatively affected. Due to construction, the Project would result in short-term decreases in water quality, air quality, and aesthetics and disturb the area wildlife and public use. Long-term benefits to area habitats would far outweigh the short-term impacts. No negative social or economic impacts would result. No impacts to historic and cultural resources are anticipated. A summary of environmental effects of the considered alternatives is presented in Table 28.

This chapter compares the effects of the No Action Alternative, the TSP (Alternative 2A), Alternative 2B, and Alternative 9. All other alternatives will not be discussed explicitly because the TSP and Alternative 2B contain all measures that would be in the remaining alternatives in Chapter 4 and is assumed would be captured in the discussion. Alternative 9 is also analyzed separately because the wetland measure is independent of all other measures contained within the TSP and Alternative 2B. When environmental effects of these alternatives are the same, they will be discussed collectively.

- No Action
- Alternative 2A (TSP)
- Alternative 2B
- Alternative 9

Table 28. Summary and comparison of environmental effects of Considered Alternatives

		No Action	Alternative 2A (TSP)	Alternative 2B	Alternative 9
Natural Resources	Floodplain Habitat	Negative	Positive	Positive	Positive
	Hydrology & Hydraulics	Negative	Positive	Positive	Positive
	Aquatic & Wetland Resources	Negative	Positive	Positive	No Effect
	Geology & Soils	Negative	Positive	Positive	No Effect
	Fish & Wildlife	Negative	Positive	Positive	Positive
	IL Resources of Concern	No Effect	Positive	Positive	Positive
	T&E Species	Negative	Positive	Positive	Positive
	Invasive Species	No Effect	Positive	Positive	Positive
	Water Quality	Negative	Positive	Positive	Positive
	Air Quality	No effect	No Effect	No Effect	No Effect
	HTRW	No effect	No Effect	No Effect	No Effect
	Historic & Cultural Resources	No effect	No Effect	No Effect	No Effect
	Socioeconomic	No effect	Positive	Positive	Positive
	Aesthetic	No effect	Positive	Positive	Positive
	Noise Levels	No effect	No effect	No effect	No effect
	Environmental Justice	No effect	No Effect	No Effect	No Effect

8.1 Floodplain Habitat

Impacts of No Action Alternative – Under the No Action Alternative, the Project Area would continue to receive coarse sediment deposition during high flow events. The deposition of sand throughout the project area would continue to increase habitat fragmentation by preventing the natural successional processes from occurring to achieve a diverse floodplain forest community. Currently, the sandy soil conditions throughout the project area create conditions in which only a limited variety of floodplain tree species can survive, specifically willow (*Salix* spp.) and silver maple (*Acer saccharinum*) that can sustain the droughty soil conditions associated with high compositions of sand. Under these conditions, the current forest community in the project area would likely persist into the near future with limited species diversity. The forested areas within the Project Area would continue a cycle of early forest succession, limiting the eventual establishment of a late successional hard mast forest community. The eventual limitation of a hard mast forest community not only limits that quality and quantity of a highly productive and beneficial forest community throughout the Project Area, but also throughout the MMR. Hard mast forest communities would continue to be extremely limited throughout the MMR and would not be able to provide the numerous benefits to the floodplain. Therefore, this alternative would have a negative effect on floodplain habitat.

Impacts of Tentatively Selected Plan – Under the TSP, the floodplain forested habitat would be expected to improve over time. The construction of the sediment deflection berm would improve approximately 109.67 acres protected from coarse sediment deposition and

simultaneously allow for the deposition of fine sediment throughout the same area. These conditions would allow for the increase of favorable soils for hard mast tree establishment to develop over time. The project area would then be able to proceed through successional stages with the eventual establishment of a hard mast forest community. Habitat fragmentation would be reduced with the establishment of a hard mast forest community throughout the area interior of the sediment deflection berm, creating approximately 109.67 acres of contiguous forest habitat from the current patchy early successional forest community.

The location of the sediment deflection berm was chosen to maximize the interior area that would be improved. The constructed berm would be approximately 40 acres, of which approximately 49.77 acres would need to be cleared for construction. The 49.77 acres that would be cleared for construction consist of willow (*Salix* spp.) and silver maple, varying in size from approximately 4 inches DBH (diameter at breast height) to approximately 30 inches DBH. Although this forest community is not considered mature, but early successional, the area would be impacted due to removal and construction activities. However, the cleared 49.77 acres would be offset by 109.67 acres of improved forest community as mentioned above. In addition, the approximate 40 acres of the berm itself and approximate 20 acres within the site would be reforested directly following construction with hard mast tree species. Through the habitat evaluation and quantification process, the Fox Squirrel HSI which evaluated forest habitat, generated 76 net AAHUs over the No Action Alternative. (Appendix G, *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on floodplain habitat.

Impacts of Alternative 2B – Under Alternative 2B, the floodplain forested habitat would be expected to improve over time. The construction of the sediment deflection berm would improve approximately 69.57 acres protected from coarse sediment deposition and simultaneously allow for the deposition of fine sediment throughout the same area. These conditions would allow for the increase of favorable soils for hard mast tree establishment to develop over time. The project area would then be able to proceed through successional stages with the eventual establishment of a hard mast forest community. Habitat fragmentation would be reduced with the establishment of a hard mast forest community throughout the area interior of the sediment deflection berm, creating approximately 69.57 acres of contiguous forest habitat from the current patchy early successional forest community.

The location of the sediment deflection berm was chosen to maximize the interior area that would be improved. The constructed berm would be approximately 80 acres, of which approximately 89.77 acres would need to be cleared for construction. The 89.77 acres that would be cleared for construction consist of willow (*Salix* spp.) and silver maple, varying in size from approximately 4 inches DBH (diameter at breast height) to approximately 30 inches DBH. Although this forest community is not considered mature, but early successional, the area would be impacted due to removal and construction activities. However, the cleared 89.77 acres would be offset by 69.57 acres of improved forest community as mentioned above. In addition, the approximate 80 acres of the berm itself and approximate 20 acres within the site would be reforested directly following construction with hard mast tree species. Through the habitat evaluation and quantification process, the Fox Squirrel HSI which evaluated forest habitat, generated 91 net AAHUs over the No Action Alternative. (Appendix G, *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on floodplain habitat.

Impacts of Alternative 9 – Under Alternative 9, impacts would be similar to the No Action Alternative. This Alternative had no forestry component and therefore was not evaluated for the forest habitat cover type (0 net AAHUs generated from the Fox Squirrel HSI). Therefore, this alternative would have a positive effect on floodplain habitat.

8.2 Hydrology & Hydraulics

Impacts of No Action Alternative - Within the Project Area, the side channel habitat has decreased in depth resulting in loss of connectivity within the main channel for most of the year. The two entrances of the side channel within the Project Area are impeded due to sediment deposition and/or expansive woody pile deposition/log jam. The large woody debris depositional area would continue to propagate downstream and potentially fill in the side channel completely. Therefore, this alternative would have a negative effect on hydrology and hydraulics.

Impacts of Tentatively Selected Plan and Alternative 2B - Positive impacts would result from the TSP and Alternative 2B, resulting from the side channel excavation. The benching would increase bathymetric diversity within the Project and allow for established vegetation to be overtopped at different periods, depending on flow. The wide and deep side channel design would allow enough velocities throughout limiting sediment deposition and excessive woody debris deposition. The water depth of the proposed side channel would be approximately 5 ft. deep 85% of the time and have water approximately 98% of the time. This greatly improves depth and connectivity to the main channel, where the side channel bottom elevation is only exceeded approximately 33% of the time. Overall, the TSP and Alternative 2B improve the flow and sediment transport which would improve the hydrology and hydraulics within the entire Project. Therefore, this alternative would have a positive effect on hydrology and hydraulics.

Impacts of Alternative 9 – For Alternative 9, impacts would be similar to the No Action Alternative. Therefore, this alternative would have no effect on hydrology and hydraulics.

8.3 Aquatic & Wetland Resources

Impacts of No Action Alternative – Within the side channel, which was historically connected to the river during average flow periods, sedimentation has occurred and excessive woody debris has accumulated, thus eliminating connectivity to the river except during periods of above average flows. Without the project, the area's aquatic resource would likely continue to deteriorate given the lack of flow, low dissolved oxygen, high temperatures during the growing season, and lack of depth. Likewise, the wetland resources would continue to be limited in the area with low dissolved oxygen and high temperatures during the growing season. These conditions limit fish communities with the side channel area and macro and micro-invertebrate production and sustainability for the aquatic and wetland resources, which ultimately negatively impacts the entire ecosystem within the MMR. The lack of fisheries resources throughout the project area would continue into the future. The fisheries resources would continue to be poor due to the lack of connectivity and flow within the side channel to the river, occurring only at 33% of the time. The lack of wetland resources throughout the project area would continue into the future. Without the project, the fisheries and wetland resources would be expected to continue to degrade. Fish species diversity is expected to further decline until the side channel becomes terrestrial habitat and completely loses the ability to support fisheries resources and wetland habitat would continue to lack suitability for wildlife resources throughout the area. Therefore, this alternative would have a negative effect on aquatic and wetland resources.

Impacts of Tentatively Selected Plan and Alternative 2B – Short-term negative impacts to aquatic resources, such as increased water turbidity, would be expected due to construction activities. However, these impacts would be localized and temporary in nature. In the long-term, the project would improve aquatic resources. Specifically, restoring connectivity and depth of approximately 66 acres of the side channel to the main river would improve dissolved oxygen, temperatures, and depths throughout the year. This would allow aquatic organism access to the aquatic habitat that does not currently exist, providing benefits to the project area as well as the

MMR. The depth diversity that would be restored with the benching in the side channel design would promote plant growth that would allow for improved habitat for macro and micro-invertebrates. The increased aquatic depth would provide refugia for a suite of aquatic organisms and fisheries resources. The fisheries habitat availability would be greatly improved. The improvement in side channel connectivity would allow fish species to utilize the area approximately 98% of the time. This improvement of depth would likely improve temperatures conditions by reducing temperatures during the growing season as well as maintaining temperatures sufficient to provide overwintering fish habitat as ambient air temperatures are reduced during the winter. The improved depth and connectivity of the side channel would likely improve dissolved oxygen concentrations, which will improve habitat quality and diversity throughout the year as fish seek out these types of habitats during winter. The increased connectivity and flow in the project area would likely improve nursery function for riverine species that utilize off-channel habitats for spawning as well as rearing habitat for younger fish. This type of side channel habitat is in limited supply in the MMR and would serve as an important fisheries habitat throughout the lifecycle of multiple species. Through the habitat evaluation and quantification process, the Smallmouth Buffalo HSI model generated 57 AAHUs for both the TSP and Alternative 2B over the No Action (Appendix G, *Habitat Evaluation & Quantification*).

Although wetlands within the project area would be impacted with the construction of the sediment deflection berm, this would account for approximately 40 acres for the TSP and approximately 80 acres for Alternative 2B. However, the impacts would be offset by both the restoration of approximately 21 acres of constructed wetlands as well as enhancing approximately 109 acres for the TSP and 70 acres for Alternative 2B of abandoned agricultural fields and early successional floodplain forest. In addition, for the TSP, 61 acres of hard mast trees would be planted on the sediment deflection berm (38 acres) and within the Project Area (23 acres). For Alternative 2B, 101 acres of hard mast trees would be planted on the sediment deflection berm (70 acres) and within the Project Area (23 acres). Overall, the wetland impacts would be outweighed by improvement of 70 acres that otherwise would continue to persist as degraded habitat. Through the habitat evaluation and quantification process, the Bullfrog HSI model generated 17 net AAHUs for both the TSP and Alternative 2B over the No Action (Appendix G, *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on aquatic and wetland resources.

Impacts of Alternative 9 - For Alternative 9, short-term negative impacts to aquatic and wetland resources, such as increased water turbidity, would be expected due to construction activities. However, these impacts would be localized and temporary in nature. In the long-term, the project would improve aquatic and wetland resources. Approximately 21 acres of restored wetland acres would restore the Project Area. Alternative 9 generated 17 net AAHUs with the bull frog model over the No Action (Appendix G, *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on aquatic and wetland resources.

8.4 Geology & Soils

Impacts of No Action Alternative – No major impacts to geology and soils would be expected, although breaches and adjacent scour would continue to occur with overtopping flood events.

No impacts to acres that qualify as prime farmland would be expected because these acres are currently forested and not farmed; therefore, the No Action Alternative would not contribute to conversion of farmland to nonagricultural uses. Areas designated as prime farmland are currently in forest and would remain in forest. Therefore, this alternative would have a negative effect on geology and soils.

Impacts of Tentatively Selected Plan and Alternative 2B – Temporary, minor impacts to geology and soils would be expected due to construction activities and project features. Dredging of the side channel, construction of the sediment deflection berm, and excavation of the wetland features would impact existing topography and drainage. Fine sediment loads, specifically silt, from the Mississippi River would be deposited behind the sediment deflection berm during high flow events to 109.67 acres. Contrarily, coarse sediments, specifically sand, would be deposited upstream of the sediment deflection berm and no longer transported and deposited throughout the Project Area.

No impacts to acres that qualify as prime farmland would be expected because these acres are currently forested and not farmed; therefore, the project would not contribute to conversion of farmland to nonagricultural uses. Areas designated as prime farmland are currently in forest and would remain in forest. Therefore, this alternative would have a positive effect on geology and soils.

Impacts of Alternative 9 - For Alternative 9, impacts would be similar to the No Action Alternative. However, temporary impacts to geology and soils would be expected due to construction activities.

No impacts to acres that qualify as prime farmland would be expected because these acres are currently forested and not farmed; therefore, the project would not contribute to conversion of farmland to nonagricultural uses. Areas designated as prime farmland are currently in forest and would remain in forest. Therefore, this alternative would have no effect on geology and soils.

8.5 Fish & Wildlife

Impacts of No Action Alternative – Fish and wildlife would be negatively impacted through the continued degraded aquatic and ecosystem structure and function within the project area, including forested wetlands, emergent wetlands, and side channel habitats. With continued degradation of ecosystem function and structure, fish and wildlife use of the area is expected to decline if no improvements are made. Therefore, this alternative would have a negative effect on fish and wildlife.

Impacts of Tentatively Selected Plan and Alternative 2B – Due to improved soil composition, the hard mast forest community would develop over time and increase habitat quality, result in increased food resource production, and increase access for a variety of resident and migratory wildlife species. Habitat fragmentation would decline in the future, improving contiguous forest habitat to 109.67 acres needed by many neotropical migrant and resident species. Reforestation would result in an increase in forest diversity and mast production, benefitting a variety of wetland wildlife resources directly with reforestation of 60.99 acres for the tentatively selected plan and 101 acres for alternative 2B. Construction activity may lead to short-term negative effects as well as indirect effects to wildlife. Wildlife would most likely avoid or be displaced from the areas under construction. However, the long-term impacts of the proposed project features should off-set any short-term or indirect effects caused by construction by providing improved habitat and ecosystem resources for wildlife resources. The improvement to the side channel habitat would benefit a multitude of native large riverine fishes due to increased connectivity, depth, and velocity. Through the habitat evaluation and quantification process, all three HSI models were used to assess the varying habitat cover types that benefit fish and wildlife species (wetland, forest, and aquatic). The models generated 151 net AAHUs for the TSP and 165 net AAHUs over the No Action Alternative (Appendix G, *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on fish and wildlife.

Impacts of Alternative 9 – For Alternative 9, impacts would be similar to the No Action Alternative. However, construction activity may lead to short-term negative effects as well as indirect effects to wildlife. Fish and wildlife would most likely avoid or be displaced from the areas under construction. However, the long-term impacts of the proposed project features should off-set any short-term or indirect effects caused by construction by providing improved habitat and ecosystem resources for fish wildlife resources. Alternative 9 generated a total of 17 net AAHUs over the No Action Alternative (Appendix G, *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on fish and wildlife.

8.6 Illinois Resources of Concern

In accordance with voluntary compliance of the protection of Illinois state resources, the following evaluation was conducted in this section.

Impacts of No Action Alternative - The three protected resources in the vicinity of the Project include (1) Chester South Geological Area Illinois Natural Areas Inventory Site, and (2) Mississippi River – Mudds Landing Illinois Natural Areas Inventory Site, and (3) the American eel. The first two resources are historic sites and are outside the Project Area and would likely continue with the No Action Alternative. No impacts would be associated with the American eel under the No Action Alternative. Therefore no impacts Illinois state resources of concern are anticipated with the No Action Alternative.

Impacts of Considered Action Alternatives - The two historic site resources are outside the Project Area and would not be affected by any considered alternative. The American eel would likely benefit from all Action Alternatives other than Alternative 9, which did not have side channel excavation. The increased aquatic habitat from these proposed Action Alternatives would likely improve habitat that can be utilized by the American eel. Therefore, the considered action alternatives would have no impact on the American eel. In addition, no impacts to Illinois state resources of concern are anticipated under the considered action alternatives.

8.7 Federally Threatened & Endangered Species

In accordance with the Endangered Species Act, a list of federally threatened and endangered species was obtained from the USFWS. This satisfies the "request for species list requirements" for ESA Section 7 Consultation. This section along with Section 2.9 will also serve as the effects determination portion of the Biological Assessment required by the Endangered Species Act. The Indiana bat, northern long-eared bat, gray bat, least tern, grotto sculpin, pallid sturgeon, and small whorled pogonia are listed as federally threatened or endangered species for Randolph County, Illinois.

Indiana Bat

Impact of No Action Alternative - Under the No Action Alternative, the forest community with limited age structure and diversity in the Project Area would persist into the near future. However, given the even-aged forest community limited in species and structural diversity, available suitable Indiana bat habitat would not persist into the future. Given the proximity to adjacent upland forest habitat, Indiana bats that could be present in the Project Area would likely relocate to suitable habitat within the proximity. Therefore, this alternative "may affect but is not likely to adversely affect" the Indiana bat.

Impacts of Tentatively Selected Plan – The hard mast forest restoration portion of the Project as discussed in 8.1 would improve habitat for the Indiana bat. Although approximately 49.77 acres of trees would be cleared for construction, which could serve as potential roost and foraging habitat for the Indiana bat, approximately 60.99 acres would be reforested. In addition,

the sediment deflection berm would improve soil conditions for approximately 109.67 acres of forested areas to allow for successful recruitment of hard mast trees over time, thereby improving the overall forest community over a longer period with increased species, age, and structural diversity to yield suitable roost habitat through time and into the future. Further, during clearing, dead trees, split trees, trees that have cavities, and trees with exfoliating bark would be favored for retention. Tree clearing associated with the project would occur during the non-roost season, April 1 through September 30. Areas that have known roosts would be delineated and avoided. Indiana bat habitat assessments and presence/absence surveys would be conducted as needed per USFWS requests. In addition, the wetland feature would improve foraging habitat for the Indiana bat as they would be composed of areas with standing water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Several components of the TSP could have site-specific impacts on Indiana bats and Indiana bat habitat but are not anticipated to individually or cumulatively have an adverse impact on the population as a whole. Therefore, the TSP "may affect but is not likely to adversely affect" the Indiana bat.

Impacts of Alternative 2B – The hard mast forest restoration portion of the Project as discussed in 8.1 would improve habitat for the Indiana bat. Although approximately 89.77 acres of trees would be cleared for construction, which could serve as potential roost and foraging habitat for the Indiana bat, approximately 101 acres would be reforested. In addition, the sediment deflection berm would improve soil conditions for approximately 69.57 acres of forested areas to allow for successful recruitment of hard mast trees over time, thereby improving the overall forest community over a longer period with increased species, age, and structural diversity to yield suitable roost habitat through time and into the future. Further, during clearing, dead trees, split trees, trees that have cavities, and trees with exfoliating bark would be favored for retention. Tree clearing associated with the project would occur during the non-roost season, April 1 through September 30. Areas that have known roosts would be delineated and avoided. Indiana bat habitat assessments and presence/absence surveys would be conducted as needed per USFWS requests. In addition, the wetland feature would improve foraging habitat for the Indiana bat as they would be composed of areas with standing water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Several components of the Alternative 2B could have site-specific impacts on Indiana bats and Indiana bat habitat but are not anticipated to individually or cumulatively have an adverse impact on the population as a whole. Therefore, Alternative 2B"may affect but is not likely to adversely affect" the Indiana bat.

Impacts of Alternative 9 – For Alternative 9, impacts would be similar to the No Action Alternative. However, the wetland feature would improve foraging habitat for the Indiana bat as they would be composed of areas with standing water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Alternative 9 could have site-specific impacts on Indiana bats and Indiana bat habitat but is not anticipated to individually or cumulatively have an adverse impact on the population as a whole. Therefore, the Alternative 9 "may affect but is not likely to adversely affect" the Indiana bat.

Northern Long-Eared Bat

Impact of No Action Alternative - Under the No Action Alternative, the forest community with limited age structure and diversity in the Project Area would persist into the near future. However, given the even-aged forest community limited in species and structural diversity, available suitable northern long-eared bat habitat would not persist into the future. Given the proximity to adjacent upland forest habitat, northern long-eared bats that could be present in the Project Area would likely relocate to suitable habitat within the proximity. Therefore, this

alternative "may affect but not likely to adversely affect" the northern long-eared bat.

Impacts of Tentatively Selected Plan – The hard mast forest restoration portion of the Project as discussed in 8.1 would improve habitat for the northern long-eared bat. All dead trees, split trees, trees that have cavities, and trees with exfoliating bark would be favored for retention. Northern long-eared bat habitat assessments and presence/absence surveys would be conducted as needed per USFWS requests. Several components of the TSP could have site-specific impacts on northern long-eared bats and their habitat, but are not anticipated to individually or cumulatively have an adverse impact on the population as a whole. Areas that have known roosts would be delineated and avoided. Tree clearing associated with the project would occur during the non-roost season, April 1 through September 30. In addition, the wetland feature would improve foraging habitat for the northern long-eared bat as they would be composed of areas with standing water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Several components of the Alternative 2B could have site-specific impacts on northern long-eared bat and northern long-eared bat habitat but are not anticipated to individually or cumulatively have an adverse impact on the population as a whole. Therefore, the TSP "may affect but is not likely to adversely affect" the northern long-eared bat.

Impacts of Alternative 2B – The hard mast forest restoration portion of the Project as discussed in 8.1 would improve habitat for the northern long-eared bat. All dead trees, split trees, trees that have cavities, and trees with exfoliating bark would be favored for retention. Northern long-eared bat habitat assessments and presence/absence surveys would be conducted as needed per USFWS requests. Areas that have known roosts would be delineated and avoided. Tree clearing associated with the project would occur during the non-roost season, April 1 through September 30. In addition, the wetland feature would improve foraging habitat for the northern long-eared bat as they would be composed of areas with sanding water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Several components of the Alternative 2B could have site-specific impacts on northern long-eared bats and their habitat, but are not anticipated to individually or cumulatively have an adverse impact on the population as a whole. In addition, the wetland feature would improve foraging habitat for the northern long-eared bat as they would be composed of areas with standing water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Therefore, Alternative 2B "may affect but is not likely to adversely affect" the northern long-eared bat.

Impacts of Alternative 9 – For Alternative 9, impacts would be similar to the No Action Alternative. However, the wetland feature would improve foraging habitat for the northern long-eared bat as they would be composed of areas with standing water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Alternative 9 could have site-specific impacts on northern long-eared bats and northern long-eared bat habitat but is not anticipated to individually or cumulatively have an adverse impact on the population as a whole. Therefore, Alternative 9 "may affect but is not likely to adversely affect" the northern long-eared bat.

Gray Bat

Impact of No Action Alternative – No caves would be impacted under the No Action Alternative. Given the even-aged forest community limited in species and structural diversity, available foraging habitat may be impacted in the future. However, these impacts would be localized and foraging habitat would exist outside of the Project Area. Therefore, there would be no effect on the gray bat.

Impacts of Considered Action Alternatives – No caves would be impacted under any of the considered alternatives. However, tree clearing associated with side channel dredging, construction of the sediment deflection berm, and construction of the wetland feature could have site-specific short-term impacts on gray bat foraging habitat but are not anticipated to individually or cumulatively have an adverse impact on the population as a whole. Moreover, the wetland feature would improve foraging habitat for the gray bat as they would be composed of areas with sanding water that would be conducive for drinking water as well as support aquatic insects that would be utilized for forage. Therefore, all of the considered alternatives "may affect but are not likely to adversely affect" the gray bat.

Least Tern

Impact of No Action Alternative – No sandbars exist within the Project Area. Therefore, it is anticipated that the No Action Alternative would have no effect on the least tern.

Impacts of Considered Action Alternatives – Although no sandbars exist within the Project Area, sandbars upstream and downstream are present within the vicinity. No least tern nesting has been documented in this area. However, least terns could utilize these areas during migration. Effects associated with construction activities such as increased noise, turbidity, are localized and temporary in nature. There is an opportunity to use the placement of the dredge material to incorporate higher elevation disconnected islands to benefit the least tern and serve as possible nesting habitat. Therefore, the TSP and Alternative 2B "may affect but not likely to adversely affect" the least tern. Alternative 9 would have "no effect" on the least tern as it does not include any placement of material near potential least tern habitat.

Grotto Sculpin

Impact of No Action Alternative – No caves, cave streams, or springs would be impacted under the No Action Alternative. Therefore, it is anticipated that there would be no effect on the grotto sculpin.

Impacts of Considered Action Alternatives - No caves, cave streams, or springs would be impacted under any of the considered alternatives. Therefore, it is anticipated that there would be "no effect" on the grotto sculpin.

Pallid Sturgeon

Impact of No Action Alternative – Under the No Action Alternative, connectivity between the main-channel of the MMR would not be improved. The side channel would continue to become isolated and disconnected, other than during high flow events, which would limit the pallid sturgeon from accessing this off-channel habitat. Although under this scenario, the pallid sturgeon would be further limited in its habitat availability, overall it is anticipated that this alternative would have "no effect" on the pallid sturgeon.

Impacts of Tentatively Selected Plan and Alternative 2B – The side channel feature was developed to directly benefit fisheries resources, which would thereby improve pallid sturgeon habitat. The increased connectivity to the main channel of the MMR would improve pallid sturgeon access to this important off-channel habitat for longer durations throughout its lifecycle. Increased depth, flow, and improved temperatures during the growing season as well as overwintering opportunities would increase pallid sturgeon habitat in the MMR, which is currently limited. Considered alternatives may have temporary short-term adverse impacts during construction on water quality and increased turbidity. However, overall these adverse impacts would likely not have an effect on the pallid sturgeon. Therefore, the considered alternatives "may affect, but are not likely to adversely affect" the pallid sturgeon.

Impacts of Alternative 9 - For Alternative 9, conditions would be similar to the No Action Alternative. However, temporary short-term adverse impacts during construction on water quality and increased turbidity may occur. However, overall these adverse impacts would likely not have an effect on the pallid sturgeon. Therefore, Alternative 9 "may affect, but not likely to adversely affect" the pallid sturgeon.

Small Whorled Pogonia

Impacts of No Action Alternative – This species preferred habitat; older hardwood stands of beech, birch, maple, oak, and hickory that have an open understory, does not exist within the Project Area. Therefore, it is anticipated that there would be "no effect" on the small whorled pogonia.

Impacts of Considered Action Alternatives - Suitable habitat does not exist within the Project Area. Therefore, it is anticipated that there would be "no effect" on the small whorled pogonia.

8.8 Invasive Species (Executive Order 13112)

Impacts of No Action Alternative – The project area's invasive species would likely continue to persist with or without the project. Therefore, this alternative would have no effect on invasive species.

Impacts of Considered Action Alternatives – With or without the project, invasive species currently present would likely continue to persist. With the considered alternatives, improving the side channel, forest, and wetland habitats needed by native species should assist the native species in competing with the non-natives species. Alternative 9 would have less capacity to support native vegetation since the wetland feature is less restored area than the TSP and Alternative 2B. Therefore, this alternative would have a positive effect on the area by decreasing invasive species.

8.9 Water Quality

Impacts of No Action Alternative – The project area's water quality would likely remain similar to current conditions. The side channel portion with water (approximately 5 acres) would continue to have low dissolved oxygen, shallow depth, and be disconnected from the river. Therefore, this alternative would have a negative effect on water quality.

Impacts of Tentatively Selected Plan and Alternative 2B – Long-term water quality improvements would be expected as a result of side channel depth and connectivity improvements. Improved side channel habitat would improve dissolved oxygen, reduce temperatures during the growing season, and increase depth of the side channel area for approximately 66 acres. The construction of the sediment deflection berm allows for water to back into the site, slow water velocities, and drop fine sediment during high flow events. The capture of sediment from the river could improve the water quality of the Mississippi River outside of the project area by decreasing sediment load, which would otherwise be deposited downstream and re-suspended during dredging or additional high flow events. Further, the wetlands restored would act as a filters, reducing the nutrient loading during high flow events. Short-term minor increases in turbidity would occur due to construction activities. A Clean Water Act Section 401 Water Quality Certification and Best Management Practices would be followed in order to minimize water quality impacts during construction. Therefore, this alternative would have a positive effect on water quality.

Impacts of Alternative 9 - The wetlands restored would act as a filters, reducing the nutrient loading during high flow events. Short-term minor increases in turbidity would occur due to

construction activities. Therefore, this alternative would have a positive effect on water quality.

8.10 Air Quality

Impacts of No Action Alternative – The Project Area's air quality would likely remain similar to current conditions. Therefore, this alternative would have no effect on air quality.

Impacts of Considered Action Alternatives – Minor, temporary increases in airborne particulates would be anticipated to occur as a result of mobilization and use of construction equipment. No air quality standard violations would be anticipated for any considered alternative. None of the considered action alternatives would be expected to have any long-term adverse effects on the air quality of Randolph County, Illinois. Therefore, the considered alternatives would have no effect on air quality.

8.11 Greenhouse Gas & Climate Change

Impacts of No Action Alternative - With the No Action greenhouse gas emissions for the Project are expected to be similar to current conditions. With the No Action Alternative, climate change could potentially impact the Project through increased frequency of high water events related to expected increased precipitation. High water events would increase the risk of river borne sediments depositing within the side channel leading to a faster loss of the side channel through time. Therefore, this alternative would have no effect on greenhouse gas and climate change.

Impacts of Tentatively Selected Plan and Alternative 2B - With the TSP and Alternative 2B, minor greenhouse gas emissions due to equipment used for construction activities and transporting of material are expected. The dredging depth took into account potential impacts of climate change (increased sediment deposition due to increased flooding). However, these impacts would be localized and temporary in nature. Therefore, this alternative would have no effect on greenhouse gas and climate change.

Impacts of Alternative 9 – Minor greenhouse gas emissions due to equipment used for construction activities and transporting of material are expected. However, these impacts would be localized and temporary in nature. Therefore, this alternative would have no effect on greenhouse gas and climate changes.

8.12 Hazardous Toxic & Radioactive Waste

Impacts of No Action Alternative – No HTRW impacts would be expected. As noted in *Appendix D - HTRW* localized instances of residential and yard waste dumping have occurred near roadside ditches. This would be expected to continue in the future. If any HTRW matter is encountered during construction of this project, the USACE will be contacted to coordinate the handling and disposal of the material. However, no project features are located near any known HTRW concerns. Therefore, this alternative would have no effect HTRW.

Impacts of Considered Action Alternatives – A short-term risk for a fuel spill during construction activities would exist for all alternatives. The contractor would be required to have a spill clean-up plan and utilize best management practices during construction. Over the 50-year period of analysis, no rises in risks for HTRW concerns are expected. Therefore, this alternative would have no effect HTRW.

8.13 Historic & Cultural Resources

Impacts of No Action Alternative – No impacts to cultural or historical resources are anticipated. Therefore, this alternative would have no effect on historic and cultural resources.

Impacts of Considered Action Alternatives – The considered alternatives include a variety of features. Proposed features include vegetative plantings, side channel excavation, tree clearing, construction of a sediment deflection berm, and wetland restoration. Some of these features would result in new ground disturbance. No features in any of the considered alternatives are expected to have a negative impact on the historic or cultural resources of the site due to past agricultural practices and past ground disturbances. Therefore any site disturbances would have already occurred with previous land use.

A letter dated 28 July 2016 was sent to the Illinois State Historic Preservation Office (SHPO) describing the project. USACE received a letter dated 4 August 2016 from the SHPO stating that the Project Area has not been surveyed and may contain prehistoric/historical archaeological resources with recommendation for a Phase I archaeological reconnaissance survey to locate, identify, and record all archaeological resources within the Project Area (*Appendix F - Historic & Cultural Resources*). USACE complied and completed a Phase I archaeological reconnaissance survey in November 2016 in which there were no findings of prehistoric/ archaeological resources. In a letter dated 21 December 2016 SHPO concurred that no historic properties are affected and therefore they had no objections. If project plans change, information documenting the revisions will be resubmitted to SHPO for further review.

There is potential for historical shipwrecks to be buried near the river and the side channel. The proposed side channel dredging would result in ground disturbance but primarily with material within the existing side channel itself. The location of the project features would be in areas of low cultural resource site potential, so the proposed project is unlikely to have any impacts to historic properties. Should resources be found during construction, investigation and consultation with the Illinois Historic Preservation Office will be pursued to avoid or mitigate any impacts to historic properties.

The results of tribal coordination efforts resulted in a response letter received from the Osage Nation, United Keetoowah Band of Cherokee Indians in Oklahoma, Peoria Tribe of Indians in Oklahoma, and Delaware Tribe (Appendix F, *Historic and Cultural Resources*) requesting to receive copies of any cultural resource survey reports regarding the project; and anticipate reviewing and commenting on any materials for the proposed project in the future. The District will continue to coordinate as the project goes forward.

In the event any cultural properties are located, these will be evaluated for National Register eligibility, in consultation with the Illinois Historic Preservation Officer, and appropriate mitigation completed before construction. If sites will be impacted, the tribes who have indicated they have an interest in the area will be contacted, and consultation will take place. Should an inadvertent discovery of human remains occur, then Section 3 of the Native American Graves Protection and Repatriation Act (P.L. 101-601) will be followed on federal lands.

Therefore, the considered action alternatives would have no effect on historic and cultural resources.

8.14 Socioeconomic

Impacts of No Action Alternative – No impact to socioeconomic resources would be expected. Human use of the project area would likely continue to decline as the ecosystem resources degrade. Therefore, this alternative would have no effect on socioeconomics.

Impacts of Considered Action Alternatives - The considered alternatives have no measurable impacts on community cohesion, property values, industrial growth, life, health, safety, or privately-owned farms. The increase in recreational use with these alternatives would likely increase community, regional, and business growth, and tax revenues.

No public opposition has been expressed nor is any expected. In the long-term, habitat improvement would increase wetland wildlife and fish populations and diversity. This would in turn increase outdoor recreational opportunities including bird watching, hunting, and fishing. In the short-term, construction activities would likely disturb recreational activities within the project area but could also create short-term employment opportunities.

Employment opportunities are evaluated using USACE Institute for Water Resources and the Louis Berger Group regional economic impact modeling tool called RECONS (Regional ECONomic System). This modeling tool automates calculations and generates estimates of jobs and other economic features such as income and sales associated with USACE's annual Civil Works program spending.

The analysis evaluated economic impacts at three levels of geography: region, state, and nation. For this project, the region and state impact areas are: Rural Area of the State of Illinois.

The economic impact modeling was only performed on the TSP. The USACE is planning on expending an average of $1,251,800 on this project annually (April 2017 price estimate). Of this annual project expenditure, $17,950,840 will be captured within the regional impact area. The remainder of the expenditure will be passed through to the state or the nation. Construction funds expended on various services and products are expected to generate additional economic activity featured in both output and jobs (Table 29). In terms of the other considered alternatives, Alternative 2B would provide similar economic impacts as the TSP, while Alternative 9A would be expected to be less due to less construction features involved. Therefore, the considered alternatives would have a positive effect on socioeconomics.

Table 29. Summary of economic impact of the $1,251,800 in average annual construction funding of the region, state, and nation during project construction.

	REGION	STATE	NATION
Local Capture	$17,950,840	$37,284,152	$37,645,332
Total Output	$23,698,841	$78,042,810	$108,962,235
Total Jobs	212	626	783
Total Labor Income	$7,154,304	$28,393,026	$37,194,845
Total GRP	$10,081,351	$40,896,308	$56,047,590

8.15 Aesthetic

Impacts of No Action Alternative – A decline in aesthetics may occur due to the degrading floodplain forest habitat, declining wildlife populations, and further degradation of the side channel. Therefore, this alternative would have no effect on aesthetic resources.

Impacts of Considered Action Alternatives – Aesthetics would be temporarily impacted by the presence of construction equipment, removal of trees, and the creation of noise, fumes, and dust during the implementation phase. Once the activities have been completed, none of the considered alternatives would likely be considered as aesthetically unpleasant, as the project area forest community would improve over time as the forest community shifts to a larger composition of hard mast tree species. As a result, impacts to aesthetics would be temporary, minor, and local in nature. Therefore, the considered action alternatives would have a positive effect on aesthetic resources.

8.16 Noise Levels

Impacts of No Action Alternative – No change in noise levels would be expected. Therefore, this alternative would have no effect on noise levels.

Impacts of Considered Action Alternatives – The construction of the considered alternatives would generate a temporary increase in noise levels from various types of construction equipment and machinery. This may lead to temporary displacement of some wildlife species. These temporary disturbances would be minimized with Best Management Practices. No long-term impacts would be expected. Therefore, the considered action alternatives would have no effect on noise levels.

8.17 Environmental Justice

Impacts of No Action Alternative – No change in environmental justice would be expected. Therefore, this alternative would have no effect on environmental justice.

Impacts of Considered Action Alternatives – No differential impacts to minority or low-income populations are expected with any of the considered alternatives. Short-term increases in employment could be realized during construction. Therefore, the considered action alternatives would have no disproportionately high and adverse environmental effects on minority or low-income populations.

8.18 Probable Unavoidable Adverse Impacts (on all resources) for Action Alternatives

Temporary, unavoidable adverse impacts including increased turbidity, noise, and clearing of vegetation would result from construction activities. Turbidity and noise levels would return to normal when construction is completed and vegetation established. Borrow areas, constructed sediment deflection berm, and any other disturbed areas would be re-vegetated after construction with native vegetation. These impacts would be expected to be less with Alternative 9 than the TSP and Alternative 2B. However, benefits to floodplain habitat, wildlife, aquatic resources, water quality, fisheries and endangered species would outweigh these unavoidable adverse impacts. All seasonal construction restrictions recommended by USFWS will be adhered to for protection of threatened and endangered species. These probable and avoidable adverse impacts would be minimized by use of best management practices during construction.

8.19 Relationship of Short-Term and Long-Term Productivity (on all resources) for Action Alternatives

Impacts of Tentatively Selected Plan and Alternative 2B - Construction activities would temporarily disrupt fish, wildlife, and human recreational use in the immediate vicinity of the project area. Construction activities would likely provide positive, short-term economic opportunities and a few jobs for the surrounding communities. Constructing the sediment deflection berm may remove approximately 50 acres of floodplain forests that currently exists. In the long-term, 170 acres would be improved with increased forest diversity and increase in hard mast species throughout. Clearing of approximately 43 acres for side channel dredging exists within the project but would be offset by the increased amount of connected and flowing side channel habitat, which would be increased by 66 acres. This increase would greatly improve the aquatic ecosystem diversity throughout the MMR. Overall, the long-term health and productivity of the project area's ecosystem is anticipated to increase with the project. Additionally, the ecosystem benefits served by the project would accumulate over time. Therefore, short-term human use impacts would be offset by long-term increases in productivity.

Impacts of Alternative 9 – Impacts would be similar to the TSP and Alternative 2B. However, there would be expected to be less disturbance during construction activities due to

the smaller size. Overall, the long-term health and productivity and ecosystem benefits would increase over the No Action Plan but would not be as high as the TSP or Alternative 2B. Therefore, short-term human use impacts would not be offset by long-term increases in productivity.

8.20 Irreversible and Irretrievable Commitment to Resources (on all resources) for Considered Action Alternatives

Irreversible commitments are those that cannot be reversed, except perhaps in the extreme long run (Shipley 2010). Simply stated, once the resource is removed it can never be replaced. For the action alternatives considered, there are no irreversible commitments to natural resources. This proposed project is in the planning stage. Money has been expended to complete this planning document and pre-project monitoring. No construction dollars, which are considered irreversible, have been expended for the project.

Irretrievable commitments are those that are lost for a period of time (Shipley 2010). Construction activities of any of the considered action alternatives will temporarily disrupt natural resource productivity. The construction activities signal an irretrievable loss in exchange for the benefits of the habitat improvements.

8.21 Compliance with Environmental Statutes

All considered action alternatives were subject to compliance review with all applicable environmental regulations and guidelines.

Table 30 provides a list of environmental protection statutes and other environmental requirements which were considered during the development of this report. The table reports the applicability or compliance of the TSP as it relates to each statue and requirement for the current stage of planning.

Table 30. Federal policy compliance status.

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

[1] Also included for compliance are all regulations associated with the referenced laws. All guidance associated with the referenced laws were considered. Further, all applicable Corps of Engineers laws, regulations, policies, and guidance have been complied with but not listed fully here.
[2] Full compliance after submission for public comment and signing of FONSI.
[3] This list of Executive Orders is not exhaustive and other Executive Orders not listed may be applicable.

9 CUMULATIVE EFFECTS*

This chapter identifies possible cumulative effects of the considered alternatives when combined with past trends and other ongoing or expected future plans and projects.

9.1 Cumulative Effects Overview

Cumulative effects result from the proposed action when added to other past, present, and reasonably foreseeable actions or projects. Cumulative effects are not caused by a single project, but they include the effects of a particular project in conjunction with other projects (past, present, and future) on the particular resource. Cumulative effects are studied to enable the public, decisions–makers, and project proponents to consider the "big picture" effects of a project on the community and the environment. In a broad sense, all impacts on affected resources are probably cumulative; however, the role of the environmental analyst is to narrow the focus of the cumulative effects analysis to important issues of national, regional, or local significance (CEQ 1997).

The Council on Environmental Quality (CEQ) issued a manual entitled *Considering Cumulative Effects Under the National Environmental Policy Act* (1997). This manual presents an 11-step procedure for addressing cumulative impact analysis. The cumulative effects analysis for the Crains Island HREP followed these 11 steps shown in Table 31. The following subsections are organized by the three main components–scoping, describing the affected environment, and determining the environmental consequences. The following chapter is summarized in Table 34 (at the end of this chapter).

Table 31. CEQ's Approach for Assessing Cumulative Effects.

Component	Steps
Scoping	1. Identify resources
	2. Define the study area for each resource
	3. Define the time frame for analysis
	4. Identify other actions affecting the resource
Describing the Affected Environment	5. Characterize resource in terms of its response to change and capacity to withstand stress
	6. Characterize stresses in relation to thresholds
	7. Define baseline conditions
Determining the Environmental Consequences	8. Identify cause-and-effect relationships
	9. Determine the magnitude and significance of cumulative effects
	10. Assess the need for mitigation of significant cumulative effects
	11. Monitor and adapt management accordingly

9.2 Scoping for Cumulative Effects

Bounding Cumulative Effects Analysis

Cumulative effect analysis requires expanding the geographic boundaries and extending the time frame to encompass additional effects on the resources, ecosystems, and human communities of concern.

9.2.1.1 Identifying Geographic Boundaries

The geographic boundary for each resource is listed in Table 32. The geographic boundaries for each resource were determined by the distribution of the resource itself, and the area within that

distribution where the resource could be affected by the project in combination with other past, present, and reasonably foreseeable actions.

Table 32. Geographic Boundaries for Cumulative Effects.

Resource	Geographic Boundary
Floodplain Habitat	The MMR
Aquatic	The MMR
Geology & Soils	Randolph County
Wildlife	The MMR
IL Species of Concern	Total range
Threatened & Endangered Species	Total range
Fisheries	The MMR
Water Quality	The MMR
Air Quality	Randolph County
HTRW	The MMR
Historic & Cultural Resources	Randolph County
Socioeconomics	Randolph County
Aesthetics	Randolph County
Noise Levels	Randolph County

The MMR hydrology is affected by several inputs including the UMR, Missouri River, and Kaskaskia River. Thus a natural geographic boundary for several of the resources are identified in Table 32. Geographic Boundaries for Cumulative Effects.. For select resources, Randolph County was used for analysis, while for other resources the entire MMR watershed for the area was used. There are also several protected areas within the MMR watershed, which are identified in Figure 25.

9.2.1.2 Identifying Timeframe

The timeframe for the cumulative effects analysis for each resource begins when past actions began to change the status of the resource from its original condition, setting the long-term trend currently evident and likely to continue into the reasonably foreseeable future. For all resources, the timeframe began in the early-19th century when the region began to be altered by non-indigenous settlers, and it ends in 2072 (end of 50-year period of analysis for the project).

Identifying Past, Present, and Reasonably Foreseeable Future Action

The PDT used information from field surveys, discussions with project partner, scoping meeting discussions, and literature searched to access the existing conditions of the resource. After assessing the existing conditions as described in Chapter 2, the PDT identified present and foreseeable actions.

"Reasonably foreseeable actions" were defined as actions or projects with a reasonable expectation of actually happening, as opposed to potential developments expected only on the basis of speculation. Accordingly, the PDT applied the following criteria when determining reasonably foreseeable actions:

- Actions on an agency's list of proposed actions
- Actions where scoping has started
- Actions already permitted
- Ongoing activities such as the Regulating Works Project, UMR Biological Opinion Program, and other restoration projects within the UMRR program in the Project vicinity such as Harlow Island, Wilkinson Island, and Oakwood Bottoms.

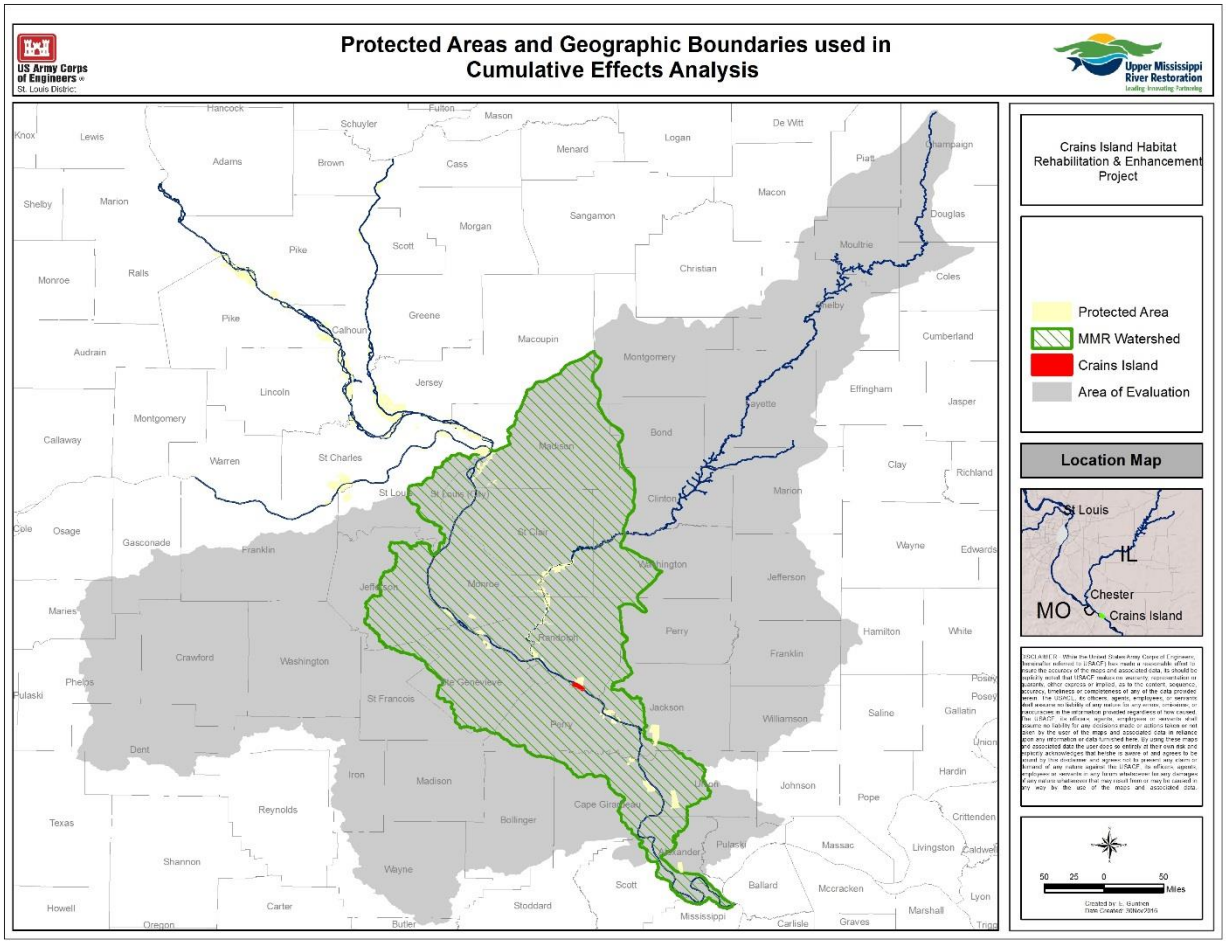

Figure 25. Geographic boundary for Cumulative Effects for the Crains Island HREP. MMR Watershed HUC (Hydrologic Unit Code) 4

9.3 Cumulative Effects by Resource

The remainder of this chapter describes the cumulative effects analysis for each of the considered resources from Chapters 2 and 8. Table 33 is a checklist identifying potential incremental cumulative effects on the resources affected by Crains Island HREP. A summary of the cumulative effects is provided at the end of this chapter (Table 34). If a resource is not identified to have any cumulative effects, then this resource was not discussed in detail within the chapter. The cumulative effects analysis discussed future conditions as follows:

- Without the project – No USACE Action
- With the project – All considered action alternatives (including the TSP) are discussed as a whole unless otherwise noted.

Table 33. Checklist for identifying potential cumulative effects of Crains Island HREP.

Resource	Without Project	With Project Construction	With Project Operation	Past Actions	Other Present Actions	Other Future Actions	Project's Incremental Cumulative Impact
Floodplain Habitat	S	S[1]	+	H	+	☐	+
Aquatic	S	S[1]	+	H	+	☐	+
Geology & Soils	☐	S[1]	☐	M	☐	☐	☐
Fish and Wildlife	M	S[1]	+	H	+	☐	+
IL Species of Concern	S	S[1]	+	M	☐	☐	+
T&E Species	M	S[1]	+	H	☐	☐	+
Water Quality	S	S[1]	☐	M	☐	☐	+
Air Quality	☐	S[1]	☐	S	☐	☐	☐
HTRW	☐	S[1]	☐	☐	☐	☐	☐
Historic & Cultural Resources	☐	☐	☐	S	☐	☐	☐
Socioeconomics	☐	+	☐	☐	☐	☐	☐
Aesthetics	☐	S[1]	☐	☐	☐	☐	☐
Noise Levels	☐	S[1]	☐	☐	☐	☐	☐

KEY: ☐ = no change S = slight adverse effect S[1] = temporary, slight adverse effect
M = moderate adverse effect H = high adverse effect + = beneficial effect

Floodplain Habitat

Past actions have degraded wetland resources within the MMR watershed through floodplain disconnection, floodplain constriction, clearing of forested areas, agricultural practices, increased water input to the system, altered hydrology due to dam construction upstream, and spread of invasive species. Resource managers have projected the continued decline and identified a need for improved management of floodplain forests within the MMR (Theiling *et al.* 2000). Land management activities have occurred in the "Protected Areas" shown in Figure 25, which are composed of state and federally owned public land. The U.S. Fish and Wildlife Service established the Middle Mississippi River National Wildlife Refuge on May 31, 2000 (USFWS 2015). The refuge lands were purchased in response to the flood of 1993. The refuge currently consists of seven divisions that total nearly 7,000 acres (Meissner Island Division, River Mile (RM) 153.5–155.5L – 78 acres; Harlow Island Division, RM 140.5-144R - 1,255 acres; Beaver Island Division, RM 116-118R - 245 acres; Horse Island Division, RM 111-112R - 2,110 acres; Rockwood Island Division RM 99-104L – 722 acres; Crain Island Division, RM 104-107; Wilkinson Island Division, RM 88.5-93L - 2,532 acres) spread out along the MMR. Much of the refuge land had previously been cut off from the floodplain by private levees protecting agricultural land. Potential Future restoration projects include:

- Harlow Island HREP
- Wilkinson Island HREP
- Oakwood Bottoms HREP
- Horseshoe Lake HREP

Without Project: The project area would continue to receive coarse sediment deposition during high flow events. The deposition of sand throughout the project area would continue to increase

habitat fragmentation by preventing the natural successional processes from occurring to achieve a diverse floodplain forest community. Currently, the sandy soil conditions throughout the project area create conditions in which only a limited variety of floodplain tree species can survive, specifically willow (*Salix* spp.) and silver maple (*Acer saccharinum*) that can sustain the droughty soil conditions associated with high compositions of sand. Under these conditions, the current forest community in the project area would likely persist into the near future with limited species diversity, and a continued lack of a diverse hard mast forest community would continue throughout the MMR.

Considered Action Alternatives: No negative cumulative impacts would be expected from any of the considered action alternatives, combined with other present actions by others, and reasonably foreseeable actions. The proposed project features should have positive long-term benefits to the floodplain habitat within the Crains Island project area and will contribute to improving habitat within the watershed.

Aquatic Resources

Past and present actions have degraded aquatic resources within the Middle Mississippi River. Many cumulative effects are discussed in WEST (2000) and in site specific environmental assessments (SSEAs) for all new Regulating Works Project construction prior to the completion of the Supplemental Environmental Impact Statement (SEIS), which are incorporated by reference and will not be repeated here. The SSEAs finalized to date include the following:

- Mosenthein-Ivory Landing Phase 4 (April 2014)
- Eliza Point-Greenfield Bend Phase 3 (April 2014)
- Dogtooth Bend Phase 5 (April 2014)
- Mosenthein-Ivory Landing Phase 5 (June 2015)
- Boston Bar Side Channel Restoration and Island Creation Project (April 2016)
- Grand Tower Phase 5 (June 2016)
- Dogtooth Bend Phase 6 (July 2016)

USACE will continue the operation and maintenance of the 9-foot navigation channel project. This includes continuation of dredging, placement of material, and construction and maintenance of river training structures. The USACE Master Plan for the Mississippi River (RM 300-0) identifies all known plans for new channel improvement structures and revetments or modifications to existing structures and revetments within the St. Louis District USACE through the year 2017. In summary, the assessment acknowledges the changes brought about by the construction of the 9-foot Navigation Channel Project in conjunction with other impacts occurring throughout the watershed resulting in declines in fish, aquatic vegetation, and backwaters/secondary side channels.

Without Project: The existing side channel within the Project Area would continue to degrade due to lack of flow, depth, and connectivity with the main channel of the Middle Mississippi River. The continued deterioration of aquatic resources would have a negative impact on the Middle Mississippi River region.

Considered Action Alternatives: No negative cumulative impacts would be expected from the considered action alternatives, combined with other present actions by others, and reasonably foreseeable actions. Present and proposed restoration efforts, including the considered action alternatives, will improve the aquatic resources throughout the MMR.

Fish & Wildlife

The side channel area within the project area currently cannot support fish during normal flow

conditions. However, they may occur within the area during high flow events, but may become stranded when flows recede. Past actions within the MMR have negatively impacted the fisheries resources. Present and future actions, including the considered action alternative are aimed to offset these past negative actions to fisheries resources.

The Crains Island Project Area and other floodplain conservation areas provide mid-migration habitat for the Mississippi Flyway, one of the major migratory bird flight corridors in North America. The Mississippi River and floodplain are the center of this flyway. This mid-migration habitat is recognized as significant for neotropical migrants as well as migratory waterfowl. Past actions within the watershed have deteriorated the physical habitat (both floodplain forest and wetland), which in turn negatively affects the wetland wildlife using that habitat. Present and future actions, including the considered action alternatives, are aimed to offset these past negative actions to wetland wildlife caused by habitat loss, fragmentation, and degradation.

Without Project: The continued deterioration of the physical habitat (both floodplain forest and wetland) within the Project Area would have negative impacts on the management of the project area and its contribution to wildlife resources within the Middle Mississippi River watershed. With no improvements and little to no land management activities to benefit ecosystem function and structure, wetland wildlife use of the project area is expected to decline. Limited staff and budget dictate that management on the refuge includes minimal upkeep, including access for the public. It is also expected that with the declines in wildlife use within the refuge, the public use of the project area would also decline. In addition, the fisheries resources throughout the project area would likely continue to be highly degraded due to poor aquatic habitat conditions due to lack of depth, flow, and connectivity.

Considered Action Alternatives: No negative cumulative impacts would be expected from any of the considered action alternatives on fish and wildlife, combined with other present actions by others, and reasonably foreseeable actions. The considered action alternatives aim to restore and improve the ecosystem which will provide positive effects to the wetland wildlife resources using the project area. The considered action alternative should have long-term benefits to the fisheries resources throughout the MMR through improved aquatic habitat and floodplain connectivity. The considered action alternatives, along with other present and foreseeable future restoration projects, will have a positive impact to the fish and wildlife resources within the MMR.

Illinois Resources of Concern

Several Illinois species of concern are identified for Randolph County, Illinois (see sections 2.4.2 and 8.1.5 above). These species have been adversely impacted by habitat loss, fragmentation, degradation, and conversion throughout the range of each of these species. Several of these species (*i.e.*, pallid sturgeon, common gallinule, northern long-eared bat, and Indiana bat) prefer floodplain and aquatic habitats. These habitat types have been dramatically lost throughout the Upper Mississippi River Basin (Theiling *et al.* 2000). Present and future actions, including the considered action alternatives, are aimed to offset these past negative actions to Illinois species of concern caused by habitat loss, fragmentation, degradation, and conversion.

Without Project: The quality and quantity of wetland ecosystem resources would continue to decline. This would result in loss of important habitat (*e.g.*, nesting and rearing habitat) required by Illinois species of concern.

Considered Action Alternatives: No negative cumulative impacts would be expected from any of the considered action alternatives. The considered action alternatives aim to restore and improve the ecosystem which will provide positive effects to the Illinois species of concern using

the Project Area. The considered action alternatives, along with other present and foreseeable future restoration projects, should counter some of the long-term adverse impacts to the Illinois species of concern, such as habitat fragmentation and loss, and the general declines of these species.

Threatened & Endangered Species

The federally listed threatened and endangered species discussed in sections 2.9 and 8.7 above have been adversely impacted by habitat loss, fragmentation, degradation, and conversion throughout the range of each of these species (i.e., Indiana bat, northern long-eared bat, gray bat, least tern, grotto sculpin, pallid sturgeon, and small whorled pogonia). Present and future actions, including the considered action alternatives, are aimed to offset some past negative actions to threatened and endangered species caused by habitat loss, fragmentation, degradation, and conversion.

Without Project: The quality and quantity of ecosystem resources would continue to decline within the project area as well as surrounding areas. This would result in continued loss of important habitat required by the federally listed threatened and endangered species throughout each species' range.

Considered Action Alternatives: With the project, no negative cumulative impacts would be expected to occur for Indiana bat, northern long-eared bat, gray bat, least tern, grotto sculpin, pallid sturgeon, and small whorled pogonia. With the considered action alternatives, habitat and natural resources required by some or all of these species are expected to improve. The considered action alternatives, along with other present and foreseeable future restoration projects may affect, but are not likely to adversely affect these species long-term.

Water Quality

Past actions have degraded water quality within the MMR, past and present laws and regulations have led to improved water quality; however, site-specific problems will likely persist into the future. Within the project area, the water quality of the aquatic habitat suffers from lack of connectivity with the main river channel, low dissolved oxygen and shallow water depth making conditions unfavorable for species depending on aquatic habitat. Present and future actions, including the considered action alternatives, are aimed to offset these past negative actions and improve the water quality within the project area, which will improve the water quality within the MMR.

Without Project: The Project Area's water quality would likely remain similar to current conditions. The interior water bodies would continue to have low dissolved oxygen, shallow depth, and be isolated from the river.

Considered Action Alternatives: No negative cumulative impacts to water quality would be expected long-term. Increases in suspended sediment may be seen during construction and dredging activities, but will be localized and temporary in nature. In addition, the features proposed aim to improve water quality by improving depth, flow, and connectivity of existing water bodies, which should improve dissolved oxygen levels throughout the year.

Table 34. Summary of Cumulative Effects.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action
Floodplain Habitat	Loss of floodplain habitat in MMR watershed through floodplain disconnection by levee construction, floodplain constriction, clearing of forested areas, agricultural practices, increased water input to the system, altered hydrology due to dam construction upstream, and spread of invasive species.	Habitat restoration and land mgmt through USACE, other federal, state, and private programs; native species continue to be impacted by exotic species; continued implementation of Biological Opinion Program	Continued habitat restoration and land mgmt through USACE, other federal, state, and private programs; new exotic species likely to be introduced; continued implementation of Biological Opinion Program	Current forest community in the MMR would likely persist into the near future with limited species diversity, and a continued lack of a diverse hard mast forest community, limiting habitat availability for native species.	Improved floodplain forest community over time as well as improved aquatic habitat will likely benefit native species throughout the MMR.
Aquatic Resources	Past actions discussed in WEST 2000. The construction of the 9-foot Navigation Channel Project in conjunction with other impacts occurring throughout the watershed resulting in declines in fish, aquatic vegetation, and backwaters/secondary side channels.	Maintenance of current habitat conditions due to maintenance of 9-foot navigation channel; habitat restoration through USACE, other federal, state, and private programs; native species continue to be impacted by exotic species; continued implementation of Biological Opinion Program	Continued maintenance of habitat conditions due to maintenance of 9-foot navigation channel; continued habitat restoration through USACE, other federal, state, and private programs; new exotic species likely to be introduced; continued implementation of Biological Opinion Program	Side channel within the MMR would continue to be limited compared to historic conditions due to lack of flow, depth, and connectivity with the main channel of the Middle Mississippi River. The continued deterioration of aquatic resources would have a negative impact on the Middle Mississippi River region.	No negative cumulative impacts would be expected from the considered action alternatives, combined with other present actions by others, and reasonably foreseeable actions. Present and proposed restoration efforts, including the considered action alternatives, will improve the aquatic resources throughout the MMR
Water Quality	Increasing human populations and industrialization result in increased water quality problems. Establishment of Clean Water Act, NEPA, USEPA, state environmental agencies and associated regulations greatly improve conditions.	Continued population growth and development result in increased potential for water quality impacts. Continued regulation enforcement and societal recognition prevent water quality degradation	Continued regulation enforcement and societal recognition. Continued population growth and development result in increased potential for water quality impacts	Likely similar conditions with localized impacts to water quality due to low dissolved oxygen.	Localized, temporary increase in suspended sediment concentrations during construction activities. Overall improvement in water quality with completion of project.
Air Quality	Increasing human populations and industrialization result in deterioration of air quality. Establishment of Clean Air Act, NEPA, USEPA, air quality standards improve conditions. Attainment status in work area.	Continued population growth and development result in increased potential for air quality impacts. Continued regulation enforcement and societal recognition. Continued attainment status in work area.	Continued population growth and development result in increased potential for air quality impacts. Continued regulation enforcement and societal recognition. Continued attainment status in work area.	Minor and local impacts due to use of agricultural machinery and urban areas in the vicinity	Temporary, minor, local impacts to air quality due to use of construction equipment.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action
Geology, Soils & Prime Farmland	Increasing human populations and industrialization result in loss of prime farmland and increased pressure on marginal lands	Population growth and development result in increased potential for prime farmland impacts.	Population growth and development result in increased potential for prime farmland impacts	No loss of prime farmland within the Project Area are not anticipated.	No direct or indirect conversion of prime or unique farmland to nonagricultural use.
Demo-graphics & Environmental Justice	Rural land with relatively low population densities and relatively high percentage of population living below poverty level. Urbanized areas with relatively high population densities with populations living above and below poverty level.	Continued rural land with low population densities and continued urban land with high population densities	Continued rural land with low population densities and continued urban land with high population densities	Likely no change from present.	Potential for business economy to benefit with proposed action
Fish and Wildlife (including threatened and endangered species)	Loss of floodplain forest community diversity due to clearing and constriction; in MMR, loss of floodplain habitat due to levees, agriculture, urbanization; USACE, other federal, state, and private habitat restoration and land mgmt programs reverse habitat loss; introduction of exotic species/reduced native species biomass; recognition of T&E species through Endangered Species Act; listing of multiple T&E species in Mississippi River; implementation of District Biological Opinion Program	Maintenance of current habitat conditions due to maintenance of 9-foot navigation channel; habitat restoration and land mgmt through USACE, other federal, state, and private programs; native species continue to be impacted by exotic species; continued implementation of Biological Opinion Program	Continued maintenance of habitat conditions due to maintenance of 9-foot navigation channel; continued habitat restoration and land mgmt through USACE, other federal, state, and private programs; new exotic species likely to be introduced; continued implementation of Biological Opinion Program	Fish and wildlife associated with floodplain forest in the vicinity of the work area expected to be similar to current conditions. T&E bat species may be impacted over time from the lack of available roost trees within the floodplain; may affect but not likely to adversely affect threatened and endangered species	Improved floodplain forest community over time as well as improved aquatic habitat will likely benefit T&E species; may affect but not likely to adversely affect threatened and endangered species anticipated
Historic and Cultural Resources	Historic and cultural resources subjected to natural processes and manmade actions (e.g., erosion, floodplain development); recognition of importance of historic and cultural resources through National Historic Preservation Act (and others)	Historic and cultural resources continue to be impacted by human activities as well as natural processes; continued societal recognition of importance of historic and cultural resources	Historic and cultural resources continue to be impacted by human activities as well as natural processes; continued societal recognition of importance of historic and cultural resources	Unlikely to affect known and unknown historic and cultural resources	No known historic resources would be affected. Impacts to unknown historic and cultural resources unlikely.
Climate Change & Greenhouse Gas Emissions	Increasing human populations and industrialization result in increased greenhouse emissions. Establishment of Clean Air Act, NEPA, USEPA, air quality standards improve conditions	Continued population growth and development result in increased potential for increased greenhouse gas emission impacts. Continued regulation enforcement and societal recognition	Continued population growth and development result in increased potential for increased greenhouse gas emission impacts. Continued regulation enforcement and societal recognition. Increased precipitation and frequency of high water events	Possible decrease in greenhouse gas absorbing capacities as floodplain forest continues to decline	Minor greenhouse gas emissions due to equipment used for construction activities. Forest community restoration could potentially decrease future greenhouse gas emissions by increasing the ability to absorb CO_2

10 PROJECT PERFORMANCE EVALUATION AND ADAPTIVE MANAGEMENT

This chapter summarizes the project performance evaluation and adaptive management needed to assess the habitat changes resulting from the implementation of the HREP. The project objectives have been documented in Chapter 3 of this report, and the performance assessment is designed to gauge progress toward meeting these objectives.

Per Section 2039 of WRDA 2007, monitoring for ecosystem restoration studies will be conducted to determine Project success, and is defined as:

> *The systematic collection and analysis of data that provides information useful for assessment of Project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain Project benefits.*

The implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires that an adaptive management plan be developed for all ecosystem restoration projects. At the programmatic level for UMRR, knowledge gained from monitoring one project can be applied to other projects. Opportunities for this type of adaptive management are common within the UMRR.

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties. This can include incomplete description and understating of relevant ecosystem structure and function; imprecise relationships among project management actions and corresponding outcomes; engineering challenges in implementing project alternatives; and ambiguous management and decision-making processes.

Lessons learned in designing, construction, and operating similar restoration projects within the UMRS have been incorporated into the planning and design of the HREP to ensure that the TSP represents the most effective design and operation to achieve project objectives. As with other HREPs implemented through UMRR, a monitoring and performance assessment plan has been developed, and the results of the plan will be used to measure success of the project and determine whether adjustments in operation may be made to promote its success.

The monitoring and adaptive management plan was developed with input from state and Federal resource agencies and is detailed in *Appendix J – Monitoring and Adaptive Management*. Performance indicators were developed to measure the success of project objectives. The indicators were developed to be specific, measureable, attainable, realistic, and timely. The project objectives, performance indicators, monitoring target, time of effect, frequency of monitoring, adaptive management triggers, and responsibilities of monitoring and data collection for the Crains Island HREP are summarized in Table 35. Per Section 2039 guidance, monitoring costs (not to exceed 10 years after project construction) were considered as part of project cost.

The monitoring information will be compiled, reviewed, and summarized in a Performance Evaluation Report that will be written 5 years after data collection has started. This report will evaluate the performance of the constructed features in meeting the objectives of the Crains Island HREP.

Table 35. Project objectives, indicators, and time before the effects of the Crains Island HREP become apparent.

Objective	Performance Indicator	Monitoring Target (Desired Outcome)	Action Criteria (AM triggers)	Responsible Party	AM Measure
Restore side channel connectivity, depth, and structural diversity	Fish species assemblage within Side Channel	An increase by more than 20% of native species should be realized within 5 years of construction completion.	Apply adaptive management actions if any of the monitoring targets fall outside the desired thresholds	USACE	Consideration of installation of scouring rock structures should be evaluated by USACE and project partner.
	Flow and connectivity	At least 1 ft/sec velocity and connectivity to the main channel.	Velocity of at least 1 ft/sec and connectivity between the Side Channel and the Mississippi river is not achieved for at least 30 days between May 1 and August 31 at LWRP +10.	USACE	
	Habitat depth and diversity	Side Channel bottom depth of at least 5 feet at LWRP[1] +5 should be realized upon construction completion.	If depth is lost (<4 feet average depth) in the side channel	USACE	
	Woody Debris	Limit woody debris buildup	If woody debris accumulates across >80% of the side channel at any point	USACE	Consideration of excavating the woody debris would be evaluated by USACE and project partner
Increase acreage protected from coarse sediment deposition as measured in acres	Soil Composition	Increase percent soil composition of silt/loam by 5% every 10 years	Less than 5% increase in soil composition of silt/loam over 10 years	USACE	Evaluate hydrology of site and consider longer evaluation period to capture more inundation periods
Restore wetland ecosystem resources as measured in acres	Topographic diversity	Difference of 3 feet from the top of slope to bottom of wetland area	Less than 3 feet difference from bottom to ground elevation	USACE	USACE and the sponsor would evaluate excavation of the wetland feature
	Water presence	Standing water present between May 1 and August 31.	Standing water is not present for at least 15 consecutive days between May 1 and August 31	USACE	
Restore floodplain forest communities as measured in acres	Survival and growth of existing and planted forest within the project area	Increase quantity and quality of floodplain forest on Crains Island and survivability of planted trees.	70% survivorship of planted trees	USACE	USACE and the sponsor would evaluate replanting and/or install more robust deer guards to reduce antler rubbing, and/or additional mowing and/or herbicide to reduce competition

Table 36. Crains Island HREP conceptual monitoring schedule and estimated monitoring costs. Construction completion is set at year 0.

Feature	Performance Indicator	Activity	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Sub-total
Side Channel	Fish diversity	UMRR-LTRM fisheries survey	9,000	9,000			9,000			9,000			9,000		45,000
	Flow and connectivity	Gage data analysis		1,000		1,000					1,000				3,000
	Side channel habitat depth and diversity	Hydrographic /ADCP Survey and ISOPAC analysis		15,000		15,000					15,000				45,000
	AM feature: Installation of scouring rock structures									72,000					72,000
	Woody debris	Visual observation				1,000			1,000			1,000			3,000
	AM measure: Woody debris removal									100,000					100,000
Sediment deflection berm	Soil composition	Soil core samples	10,000										10,000		20,000
	AM feature: Evaluate hydrology of site and consider longer evaluation period to capture more high flow events												5,000		5,000
Depressional wetland	Wetland topographic diversity	Elevation survey		1,000		1,000			1,000			1,000			4,000
	Wetland water presence	Visual observation		1,000		1,000			1,000			1,000			4,000
	AM feature: re-excavate wetlands and/or increase exterior berm height									50,000					50,000
Reforestation	Forest Community Diversity	Forest monitoring			3,000				3,000						6,000
	AM feature: supplemental planting and more robust deer protection and maintenance									40,000					40,000
	Performance Evaluation Report	Inspection and report writing							10,000					10,000	20,000
														Subtotal of AM Measures	$267,000
														Subtotal of Monitoring	$130,000
														SUBTOTAL	$417,000
														Contingencies (27%) & Escalation (1.8%)	$120,096
														TOTAL	$537,096

11 REAL ESTATE REQUIREMENTS

The Crains Island HREP is part the UMRR Program authorized by Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended. The Project is located on the Mississippi River between river miles 103.5 and 105.5.

The majority of lands are presently owned by the United States and are under the control of the USFWS. As such, the Project would be a 100% Federal cost. A road easement will be acquired by USFWS for access from the Boise Brule levee.

There are no proposed Public Law 91-646 relocations as there are no acquisitions required.

All dredged materials would be placed within navigational servitude and Project waters.

Access to the Project would be by land from the Boise Brule levee for earthwork while hydraulic dredging would be accessed through the MMR, located adjacent to the Project Area. An easement would be needed. Refer to Appendix E – *Real Estate Plan* for more details.

There are no known hazardous, toxic, or radioactive sites within the Project Area.

Additional real estate requirements are provided in Appendix E - *Real Estate Plan*.

12 IMPLEMENTATION RESPONSIBILITIES

This chapter discusses the implementation responsibilities for the USFWS (Project Partner) and USACE. The responsibility for plan implementation and construction falls to the Corps of Engineers as the lead Federal agency. After construction of the project, project OMRR&R would be required for features of the project as discussed previously in the OMRR&R considerations (Chapter 7) of this report. The USFWS would be responsible for OMRR&R of the project.

Should rehabilitation that exceeds the annual maintenance requirements be necessary (as a result of a specific flood or storm event), a mutual decision between the participating agencies would be made whether to rehabilitate the damaged portions of the project. If rehabilitated, the federal share of rehabilitation would be the responsibility of the Corps of Engineers.

Performance evaluation, which includes monitoring of physical/chemical conditions and some biological parameters, would be a Corps of Engineers responsibility, as outlined in Chapter 11 of this report.

Appendix K – Memorandum of Agreement, contains a draft copy of the formal agreement that would be entered into by the Corps of Engineers and the USFWS before implementation of the project. This draft Memorandum of Agreement (MOA), describes obligations for constructing, operation, and maintaining the implemented features of the Crains Island HREP. This draft MOA is used in lieu of a separate List of Items of Local Cooperation normally used in Specifically Authorized and Cost Shared projects because:

1. This project is 100% federally funded (per Section 906(e) of WRDA 1986) because it is taking place on lands managed as a national wildlife refuge.
2. The project has no local sponsor because the project is 100% federally funded.
3. OMRR&R is also a 100% federal cost when the project is located on federal lands, and therefore, per Section 107(b) of WRDA 1992, OMRR&R costs shall be borne by the Federal agency that is responsible for fish and wildlife management activities on such lands (here, the USFWS).

USACE will develop an OMRR&R Manual for the project and will provide the manual to USFWS at project completion and turnover. The MOA shall remain in effect for a period of no more than 50 years after initiation of construction of the project.

12.1 U.S. Army Corps of Engineers

USACE is responsible for Project management and coordination with the USFWS and other affected agencies. USACE will submit the feasibility report; program funds; finalize plans and specifications, complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration. Section 906(e)(3) of WRDA 1986 states that the first cost funding for restoration measures will be 100% Federal cost because the Project measures will be located on Federally-owned lands, managed as a national wildlife refuge. USACE has agreed to support this HREP's monitoring and data collection needs as outlined earlier in this report.

12.2 U.S. Fish and Wildlife Service

The USFWS is the Project sponsor and has provided technical and other advisory assistance during all phases of the Project and will continue to provide assistance during Project implementation. The Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) of the Project is the responsibility of the USFWS in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. The annual OMRR&R costs are estimated at $11,050. These functions will be further specified in the Project OMRR&R Manual to be provided by USACE prior to final acceptance of the Project by the sponsor. The USFWS has agreed to support this HREP's monitoring and data collection needs as outlined earlier in this report.

The USFWS is the Federal sponsor in the Project and is responsible for providing comments for this Project pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and the Endangered Species Act of 1973, as amended (See Appendix B, *Coordination*).

13 CONCLUSION*

The ecosystem structure and function of the Crains Island HREP is not being fully realized due to human activity over the past two centuries within the Middle Mississippi River (MMR) basin, floodplain, and channel, which has altered the hydrology and biotic communities historically present in the Project. These alterations have reduced the diversity and quality of aquatic side channels, floodplain forest habitat, and wetland habitat. These stressors are likely to continue, as will the decline of the quality of aquatic side channel, floodplain forest, and wetland habitat.

The Tentatively Selected Plan (TSP) (Alternative 2A), shown in Figure ES-1, for the Crains Island HREP consists of multiple measures to restore and improve the aquatic ecosystem structure and function by implementation of the following restoration measures:

- Sediment deflection berm
- Increase side channel depth and width, benching on either side where opportunistic
- Reforestation throughout the study area
- Depressional wetlands

The TSP best meets the study objectives and has sponsor support from USFWS. Implementation of the TSP would increase the quality and quantity of ecosystem resources and meet the needs for a large variety of native aquatic species. Restoring flow and connectivity of the side channel and the main channel of Mississippi River would contribute to overwintering fish habitat as well as feeding areas for migratory wildlife. Providing bathymetric diversity and flow within the side channel would provide important side channel habitat within the MMR. And restoring floodplain forest and wetland habitat would allow the Project to realize the highest benefit to fish and wildlife. The Project outputs are also consistent with the goals and objectives of the UMRR Program.

Assessment of the future-with-project scenario shows definite increases in total habitat units over the 50-year period of analysis for all evaluated species. These increases represent quantification of the projected outputs – improved habitat quality and increased preferred habitat quantity.

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CERTIFICATION OF LEGAL REVIEW

The Crains Island Habitat Rehabilitation and Enhancement Project Draft Feasibility Report with Integrated Environmental Assessment, including all associated documents required by law and regulation, have been fully reviewed by the Office of Counsel, St. Louis District and is approved as legally sufficient.

_____ _____

Date

Office of Counsel, St. Louis District
William P. Levins

_____

Office of Counsel, St. Louis District
Keli N. Broadstock, Asst. District Counsel

UPPER MISSISSIPPI RIVER RESTORATION PROGRAM
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

CRAINS ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

RECOMMENDATIONS

I have weighed the outputs to be obtained from the full implementation of the Crains Island HREP against its estimated cost and have considered the various alternatives proposed, impacts identified, and overall scope. In my judgment, this Project, as proposed, justifies the expenditures of Federal funds. I recommend that the Division Engineer approve the proposed Project to include:

- Sediment deflection berm
- Increase side channel depth and width, benching on either side where opportunistic
- Reforestation throughout the study area
- Depressional wetlands

The total Federal estimated Project cost, including general design and construction management, is $36,652,000.

_____ _____

Date

BRYAN K. SIZEMORE
COL, EN
Commanding

UPPER MISSISSIPPI RIVER RESTORATION PROGRAM
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

CRAINS ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

DRAFT FINDING OF NO SIGNIFICANT IMPACT

I have reviewed the information provided within this Feasibility Report with Integrated Environmental Assessment, along with data obtained from Federal and State agencies having jurisdiction by law or special expertise, and from the interested public. I find that the proposed habitat restoration project in Randolph County, Illinois, would not significantly affect the quality of the human environment. Therefore, it is my determination that an Environmental Impact Statement is not required. This determination may be re-evaluated if warranted by further developments.

The "No Federal Action" alternative was evaluated and is unacceptable to recommend as it does not meet the Project goal and objectives. An array of restoration measures was considered from which action alternatives were derived. The measures include:

- Sediment deflection berm
- Increase side channel depth and width, benching on either side where opportunistic
- Reforestation throughout the study area
- Depressional wetlands

Factors considered in making a determination that an Environmental Impact Statement was not required are as follows:

1. The Project is anticipated to improve the habitat value of Crains Island for aquatic and fisheries resources, floodplain forest communities and wetlands.
2. Aside from temporary disturbance, no long-term adverse impacts to natural or cultural resources are anticipated. No Federally-protected species would be adversely affected by the proposed action.
3. The Project complies with Sections 401 and 404 of the Clean Water Act.
4. The Project complies with Section 106 of the National Historic Preservation Act.
5. No significant social or economic impacts to the Project Area are expected.
6. No hazardous or toxic waste issues are expected.
7. No adverse significant cumulative impacts are anticipated.

_____
Date

_____
BRYAN K. SIZEMORE
COL, EN
Commanding