UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

BEAVER ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 513.0-517.0
CLINTON COUNTY, IOWA

FINAL

JUNE 2017

US Army Corps
of Engineers ®
Rock Island District

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EXECUTIVE SUMMARY

The *Beaver Island Habitat Rehabilitation and Enhancement Project* (HREP) (Project) is located in Clinton County, Iowa, between the cities of Camanche and Clinton, in Pool 14 between Upper Mississippi River (UMR) river miles 513.0 and 517.0. All Project lands are in Federal ownership and are managed by the U.S. Fish and Wildlife Service (USFWS) as part of the UMR National Wildlife and Fish Refuge.

The Project area is comprised of 1,678 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. Human activity, such as channel manipulation for navigation purposes, over the past two centuries within the UMR basin, floodplain, and channel has altered the hydrology, topography, and biotic communities present in the Project area. These alterations have reduced the diversity and quality of aquatic habitat, reduced the acreage and diversity of the native floodplain forest and reduced the acreage and diversity of isolated ephemeral wetlands. While these stressors are likely to continue, as will the decline of the quality of aquatic, wetland and floodplain habitat, this Project provides an opportunity to improve the quality and diversity of critical habitats.

The goals of the Project are to restore and protect off-channel aquatic, wetland, and floodplain forest habitats. The objectives identified to meet these goals are to:

1) increase year-round aquatic habitat diversity, as measured by acres and native fish use of spawning, rearing and overwintering habitat;

2) diversify floodplain forest habitat on Beaver Island, as measured in acres of elevated topography and number of hard mast tree species present in Project area; and

3) increase structure and function of side channel habitat, as measured by native freshwater mussel use.

For planning purposes, the period of analysis was established as 50 years. The following enhancement measures were considered to achieve the Project goals and objectives:

- excavate channels in backwater areas
- construct elevated berms using excavated channel material
- plant mast producing trees on the elevated berms

- use timber stand improvement techniques
- place a rock closure structure on the island's upstream end
- construct a chevron, place bank protection, and provide mussel substrate at Albany Island

Cost and habitat benefits were estimated for each measure. Habitat benefits were estimated using Habitat Evaluation Procedures. Cost-effectiveness and incremental analyses were conducted to identify cost effective plans and reveal changes in cost for increasing levels of environmental outputs. The Recommended Plan provides 210.2 net Average Annual Habitat Units of habitat.

The Recommended Plan, shown on Figure ES-1, would restore backwater habitat by excavating backwater channels to a depth of 8 feet or more below flat pool to provide overwintering and year-round habitat for fish. Excavated material will be used to construct land berms to enhance topographic diversity. The land berms will be planted with native floodplain forest vegetation and trees. Other timber stand improvement actions will also occur such as tree releases, girdling, and interspersed tree plantings. A rock closure structure will be constructed at the entrance to Upper Cut on Beaver Island's upstream end to reduce overwintering water velocities and sediment deposition. A rock chevron, bank protection, and substrate will be placed on Albany Island to protect and enhance an existing mussel bed.

Implementation of the Recommended Plan will increase the quality and quantity of preferred habitat at this location. The Project outputs meet site management goals and objectives and support the overall goals and objectives of the Upper Mississippi River Restoration (UMRR) and the UMR National Wildlife and Fish Refuge.

Section 906(e) of the 1986 Water Resources Development Act specifies that first cost funding for enhancement measures "located on lands managed as a national wildlife refuge" will be 100% Federal. All Project measures would be located on federally-owned lands managed through a cooperative agreement with the USFWS; responsibility for the operation, maintenance, and repair of the lands will be the responsibility of the USFWS

The Rock Island District's District Engineer has reviewed the Project outputs, a gain of 210.2 net Average Annual Habitat Units, and determined that implementation of the Recommended Plan is in the Federal interest. Therefore, the District Engineer recommends construction approval for the Beaver Island HREP at an estimated construction expense of $17.4 million, including contingency and adaptive management measures. The estimated Total Project Cost, including planning, engineering and design; adaptive management measures; construction management; and contingency is $21.5 million.

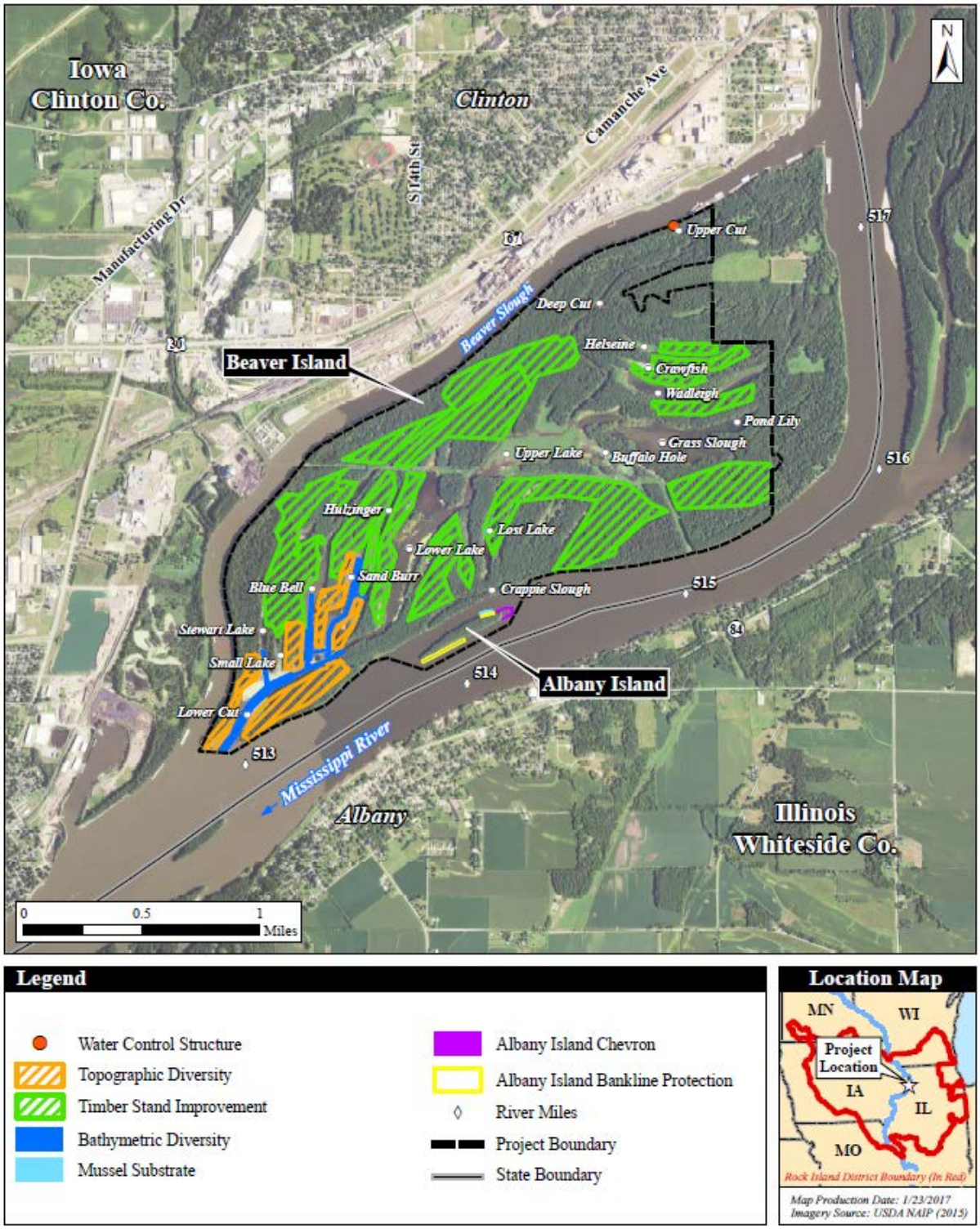

Figure ES-1. Project Measures

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I. INTRODUCTION

A. Location

The *Beaver Island Habitat Rehabilitation and Enhancement Project* (HREP) (Project) area is located in the upper third of Pool 14 along the right descending bank of the Upper Mississippi River (UMR), adjacent to the City of Clinton in Clinton County, Iowa, between river miles (RM) 513.0 and 517.0 (Figure I-1). Areas considered as part of this Project and described as the Project area include Beaver Island, Beaver Slough, Albany Island, and Albany Slough (Figure I-2). The Project area contains about 1,678 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. At low flow, there are 178 acres of aquatic habitat compared to 1,500 acres of floodplain habitat. Figures I-1, I-2, and Plate 6, C-101 provide vicinity and specific location maps for Beaver Island. All plates referenced in this document are included in Appendix O, *Plates* (Plate 1, G-002 and Plate 2, G-003 provide an index and legend).

The Project lands, part of the UMR National Wildlife Refuge System, are federally-owned by the U.S. Fish and Wildlife Service (USFWS) and U.S. Army Corps of Engineers (Corps), Rock Island District (District). The Corps-owned lands are out granted to the USFWS for management through a cooperative agreement dated February 14, 1963, and an amended cooperative agreement dated July 31, 2001.

B. Purpose and Need

The District proposes to rehabilitate and enhance Beaver Island through construction of measures which will increase the quality of year-round habitat for the fish community, increase floodplain forest vegetation diversity, and improve the overall structure and function of Beaver Island habitat. In general, the Project is comprised of moderate to poor quality habitat. Human activity, such as channel modification and infrastructure, over the past two centuries within the UMR basin, floodplain, and channel has altered the hydrology, topography, and biotic communities historically present. These alterations have reduced the diversity and quality of aquatic habitat, and reduced the acreage and diversity of the native floodplain forest. While these stressors are likely to continue, as will the decline of quality aquatic and floodplain habitat, this Project provides an opportunity to improve the quality and diversity of critical habitats.

This Feasibility Report with Integrated Environmental Assessment is drafted to present a detailed account of the planning, engineering, construction details, and environmental considerations which resulted in the Recommended Plan.

The need for rehabilitation and enhancement of the Site is based on the following factors:

- The existing aquatic habitat currently lacks adequate fish overwintering habitat (i.e., depth and flows) important for year-round habitat functioning. Without action, the available overwintering habitat will continue to decrease.
- The existing topography lacks forest diversity and a significant amount of the island is inundated during a typical flooding event. Consequently, floodplain forest regeneration, growth, and survival are reduced. Without action, floodplain habitat will decrease in diversity through succession to silver maple, open canopy, and/or reed canary grass (invasive species).
- Albany Slough, the existing secondary channel habitat, has degrading geomorphologic features, structure, and function. Over time the Island is likely to continue eroding, which would have major detrimental effects on existing mussel communities inhabiting the side channel and the fish species which serve as hosts to mussel larva. The highest mussel richness is found in the Mississippi ecoregion. Currently more than half of the 78 known species are in some form of Federal or state listing.

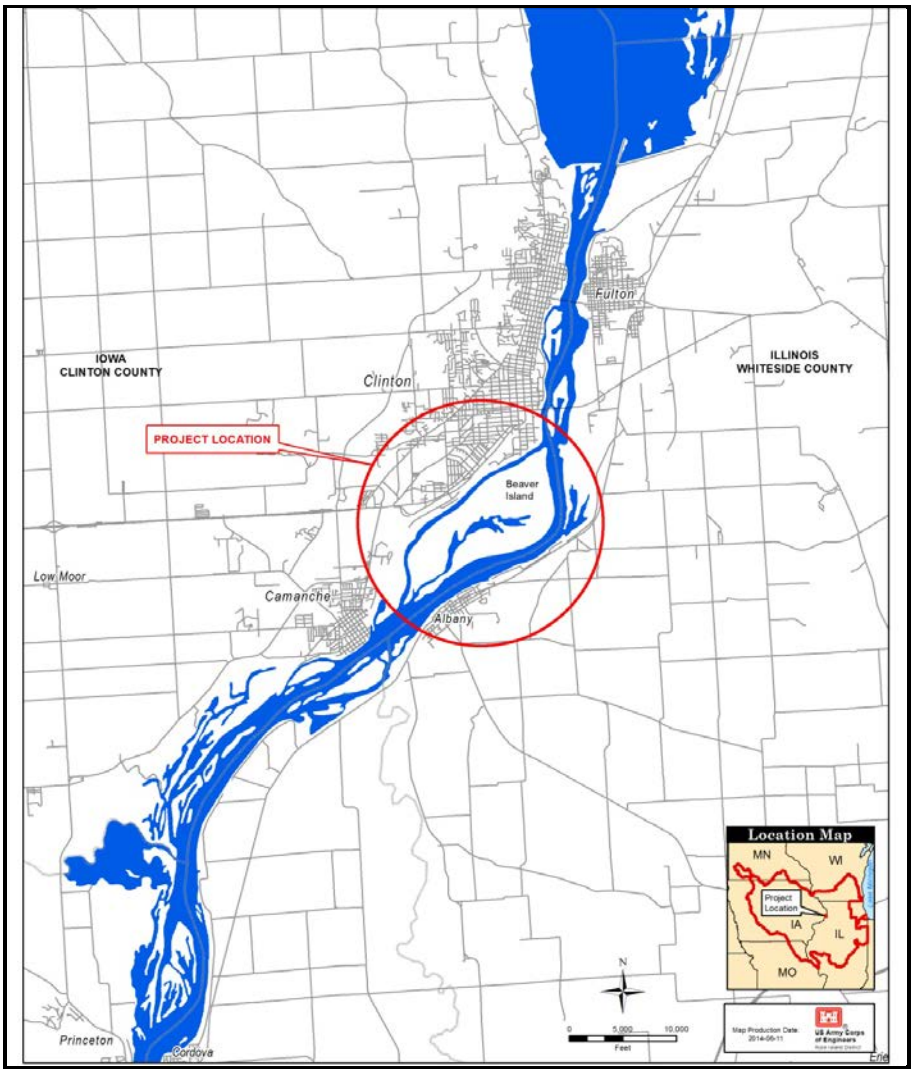

Figure I-1. Vicinity Map

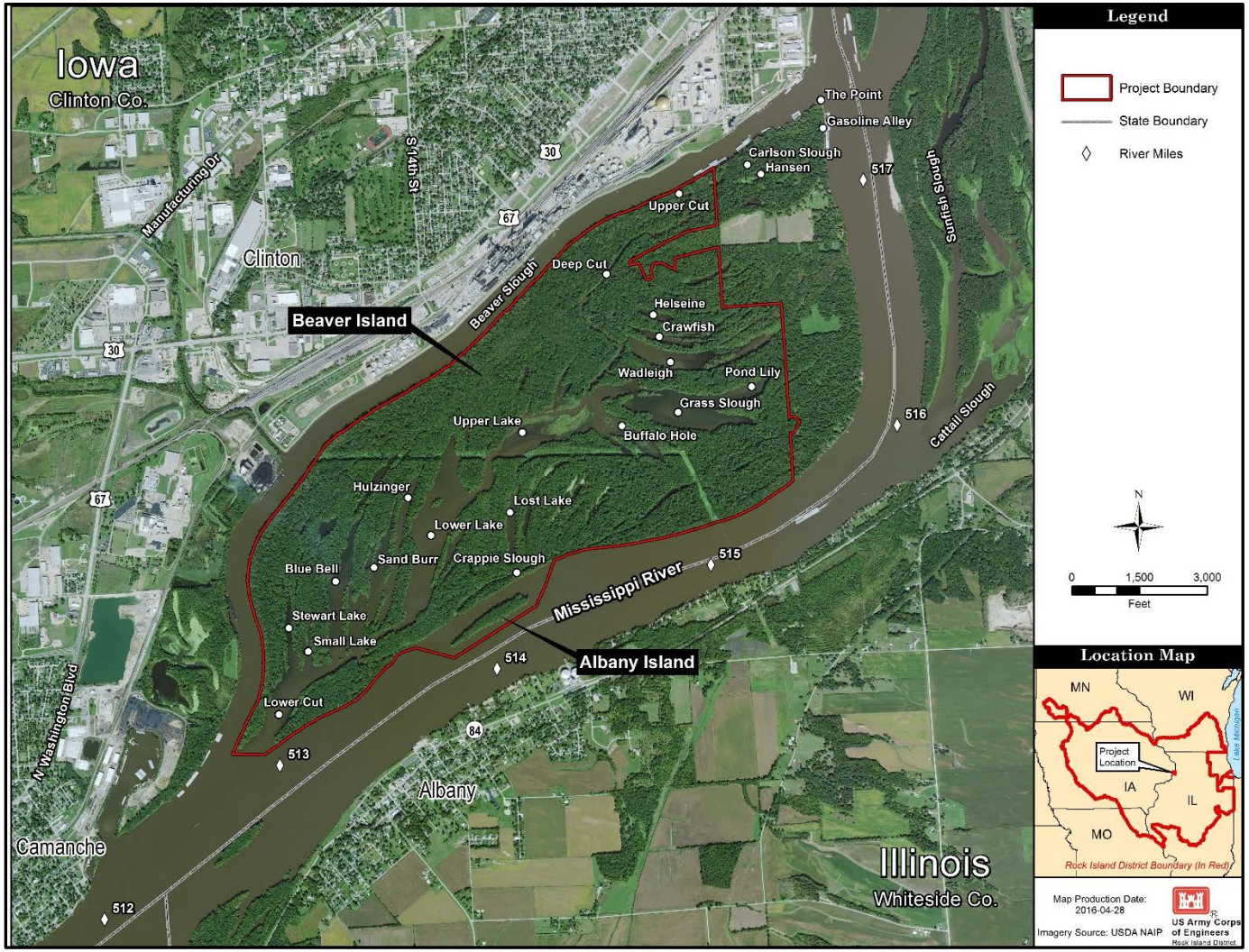

Figure I-2. Project Area Map

C. Project Selection

The Upper Mississippi River Restoration (UMRR) Program, authorized by the Water Resources Development Act (WRDA) of 1986 under Section 1103 and extended indefinitely by the WRDA of 1999, is a Federal-State partnership program for planning, construction and evaluation of fish and wildlife habitat rehabilitation projects and for monitoring the natural resources of the river system. It is a regional program that includes the Corps' St. Paul, Rock Island and St. Louis Districts. Interagency groups in each of the Corps districts, such as the Fish and Wildlife Interagency Committee (FWIC) and River Resources Coordinating Team (RRCT), identify, prioritize and select the rehabilitation projects. Field managers from the aforementioned interagency groups determine the areas that have degraded aquatic and wetland habitats and which objectives are priority for the area. The Federal Sponsor, the USFWS, with support from the non-Federal Sponsor, the Iowa Department of Natural Resources (IADNR), nominated the Beaver Island HREP for inclusion in the Corps' Upper Mississippi River Restoration (UMRR). The FWIC then ranked the Project habitat benefits based on critical habitat needs along the Mississippi River and the Illinois Waterway (IWW). After considering resource needs and deficiencies pool by pool, the Project was recommended and supported by the FWIC and the RRCT as providing significant aquatic, wetland, and floodplain benefits with opportunities for habitat enhancement. Development of this Feasibility Report was actively coordinated with the USFWS and IADNR. Coordination occurred during team meetings, phone conversations, and on-site visits to the Project area (Appendix A, *Correspondence*).

D. Scope of Study

The scope of this study focuses on proposed Project measures that would improve aquatic and floodplain habitat and enhance overall resource values. The Project is consistent with agency management goals and was planned for the benefit of resident and migratory birds, fish, and other wildlife.

Aerial photography, topographic surveys, wildlife and fisheries surveys, and habitat quantification procedures were completed to support the planning and assessment of proposed Project alternatives. The USFWS and IADNR have made wildlife observations within the Project area. These observations, along with future studies and monitoring, will assist in evaluating Project performance.

Field surveys and inventories, aerial photography, Light Detection and Ranging (LiDAR), bathymetry, hydraulic modeling, and habitat quantification procedures were completed to support the planning and assessment of proposed Project alternatives. Soil borings were taken to determine sediment types. Baseline water quality monitoring was performed to define present water quality conditions. A forest inventory was conducted in 2015 to evaluate the species composition and average age of the existing forest.

E. Discussion of Prior Studies, Reports, and Existing Water Projects

The following summarizes prior studies and reports and existing projects completed using UMRR authorities. Additional literature cited can be found in Appendix L and at the end of each Appendix.

Dredged Material Management Program, Pool 14, Beaver Island Reach Dredged Material Management Plan (DMMP). This DMMP is located in Clinton County, Iowa, in the vicinity of the Beaver Island HREP at RMs 513.4 through 519.9. The Plan was completed in September 2003 and identified a long-term maintenance plan for areas of the Beaver Island Reach of the UMR (including Albany Lower, Beaver Island and Joyce's Island dredge cuts).

Upper Mississippi River System-Environmental Management Program, Pool 14, Princeton Refuge Habitat Rehabilitation and Enhancement Project. This HREP is located in Scott County, Iowa, downstream of the Beaver Island HREP at RMs 504.0 through 506.4. The Definite Project Report was completed in 1995, and construction was completed by 2002. The operation and maintenance report was completed in 2002. An initial Performance Evaluation Report was completed in 2001.

Upper Mississippi River System-Environmental Management Program, Pool 13, Potters Marsh Habitat Rehabilitation and Enhancement Project. This HREP is located in Carroll and Whiteside Counties, Illinois, upstream of the Beaver Island HREP at RMs 522.5 through 526.0. The Definite Project Report was completed in 1992. The operation and maintenance report was completed in 1997. Performance Evaluation Reports were completed in 1998, 2002, and 2003.

Upper Mississippi River Restoration-Environmental Management Program, Pool 18, Huron Island Habitat Rehabilitation and Enhancement Project. This HREP is located in Des Moines County, Iowa, downstream of the Beaver Island HREP at RMs 421.2 through 425.4. The DPR was completed in 2013. Huron Island is currently under construction.

Status and Trends of Selected Resources of the Upper Mississippi River System: A Report of the Long Term Resource Monitoring Program. US Geological Survey (USGS), Upper Midwest Environmental Sciences Center, La Crosse, WI. 2008. Monitoring data is summarized for 24 indicators of the ecological condition of the UMRS and Illinois River into one report, alongside historical observation and other scientific findings. This report also serves as background material for the Corps' periodic Reports to Congress that provide recommendations for future environmental management of the UMRS.

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, 2000. This report describes the critical elements of a strategy for the operation and maintenance of the natural resources of the UMRS and its tributaries including the setting of restoration goals and objectives.

Upper Mississippi River System Habitat Needs Assessment: Summary Report 2000. Corps, St. Louis District, St. Louis, MO, 2000. The summary report and its supporting technical report were the result of a system-wide analysis of historical, existing, and forecasted habitat conditions. The information in the report was developed to help guide future HREPs on the UMRS.

Conservation Priorities for Freshwater Biodiversity in the Upper Mississippi River Basin, R. Weitzell, E. McKhoury, P. Gagnon, B. Schreurs, D. Grossman, and J. Higgins, Nature Serve and The Nature Conservancy, July 2003. This study evaluates the components and patterns for the freshwater biodiversity of the UMR Basin and identifies the most significant places to focus conservation opportunities.

Upper Mississippi River Environmental Design Handbook. Corps, Rock Island District, Rock Island, IL, August 2006. This Design Handbook of the UMRR evaluates project features and incorporates lessons learned throughout the life of the program.

Upper Mississippi River Restoration Environmental Management Program Environmental Design Handbook. Corps, Rock Island District, Rock Island, IL, December 2012. This Design Handbook of the UMRR evaluates project features and incorporates lessons learned throughout the life of the program.

2004 Report to Congress, Upper Mississippi River System Environmental Management Program. Corps, 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. Corps, 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.

Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study, Feasibility Report 2004. Corps, Rock Island, St. Paul, 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, Corps, 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.

UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan. U.S. Fish and Wildlife Service, 2006. This plan guides the administration and management of the UMR National Wildlife and Fish Refuge and contains 43 measureable objectives and associated implementation strategies.

F. Authority

The UMRR's original authorizing legislation was the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), Section 1103. The UMRR was originally comprised of five elements: HREPs;

Long-Term Resource Management (LTRM); Recreation Projects; Economic Impacts of Recreation; and Navigation Monitoring. Currently, the UMRR is comprised of two elements: (1) plan, construct, and evaluate measures for fish and wildlife habitat improvement through HREPs; and (2) monitor the natural resources of the river system through the LTRM element. The other UMRR elements have either been successfully completed or are now carried out under other authorities.

The original authorizing legislation has been amended several times since its enactment. The 1990 WRDA, Section 405, extended the original UMRR authorization an additional 5 years to fiscal year 2002, which allowed for ramping up of the program. The 1992 WRDA, Section 107, amended the original authorization by allowing limited flexibility in how funds are allocated between the HREP program and the LTRM element. The 1992 WRDA also assigned sole responsibility for operation and maintenance (O&M) of habitat Projects to the agency that manages the lands on which the Project is located. The 1999 WRDA, Section 509, reauthorized UMRR as a continuing authority with reports to Congress every 6 years and changed the cost sharing percentage from 25% to 35%. Beaver Island is located on federally-owned refuge lands so the Project is 100% federally-funded. 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. The text of the original authorization is as follows:

Upper Mississippi River Restoration Program Authorization

Section 1103 of the Water Resources Development Act of 1986 (P.L. 99-662) as amended by
Section 405 of the Water Resources Development Act of 1990 (P.L. 101-640),
Section 107 of the Water Resources Development Act of 1992 (P.L. 102-580),
Section 509 of the Water Resources Development Act of 1999 (P.L. 106-53),
Section 2 of the Water Resources Development Technical Corrections of 1999 (P.L. 106-109), and
Section 3177 of the Water Resources Development Act of 2007 (P.L. 110-114).

Additional Cost Sharing Provisions

Section 906(e) of the Water Resources Development Act of 1986 (P.L. 99-662) as amended by
Section 221 of the Water Resources Development Act of 1999 (P.L. 106-53).

SEC. 1103. UPPER MISSISSIPPI RIVER PLAN.

(a)(1) This section may be cited as the "Upper Mississippi River Management Act of 1986".

(2) To ensure the coordinated development and enhancement of the Upper Mississippi River system, it is hereby declared to be the intent of Congress to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system. Congress further recognizes that the system provides a diversity of opportunities and experiences. The system shall be administered and regulated in recognition of its several purposes.

(b) For purposes of this section --

(1) the terms "Upper Mississippi River system" and "system" mean those river reaches having commercial navigation channels on the Mississippi River main stem north of Cairo, Illinois; the Minnesota River, Minnesota; Black River, Wisconsin; Saint Croix River, Minnesota and Wisconsin; Illinois River and Waterway, Illinois; and Kaskaskia River, Illinois;

(2) the term "Master Plan" means the comprehensive master plan for the management of the Upper Mississippi River system, dated January 1, 1982, prepared by the Upper Mississippi River Basin Commission and submitted to Congress pursuant to Public Law 95-502;

(3) the term "GREAT I, GREAT II, and GRRM studies" means the studies entitled "GREAT Environmental Action Team--GREAT I--A Study of the Upper Mississippi River", dated September 1980, "GREAT River Environmental Action Team--GREAT II--A Study of the Upper Mississippi River", dated December 1980, and "GREAT River Resource Management Study", dated September 1982; and

(4) the term "Upper Mississippi River Basin Association" means an association of the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, formed for the purposes of cooperative effort and united assistance in the comprehensive planning for the use, protection, growth, and development of the Upper Mississippi River System.

(c)(1) Congress hereby approves the Master Plan as a guide for future water policy on the Upper Mississippi River system. Such approval shall not constitute authorization of any recommendation contained in the Master Plan.

(2) Section 101 of Public Law 95-502 is amended by striking out the last two sentences of subsection (b), striking out subsection (i), striking out the final sentence of subsection (j), and redesignating subsection "(j)" as subsection "(i)".

(d)(1) The consent of the Congress is hereby given to the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, or any two or more of such States, to enter into negotiations for agreements, not in conflict with any law of the United States, for cooperative effort and mutual assistance in the comprehensive planning for the use, protection, growth, and development of the Upper Mississippi River system, and to establish such agencies, joint or otherwise, or designate an existing multi-State entity, as they may deem desirable for making effective such agreements. To the extent required by Article I, section 10 of the Constitution, such agreements shall become final only after ratification by an Act of Congress.

(2) The Secretary is authorized to enter into cooperative agreements with the Upper Mississippi River Basin Association or any other agency established under paragraph (1) of this subsection to promote and facilitate active State government participation in the river system management, development, and protection.

(3) For the purpose of ensuring the coordinated planning and implementation of programs authorized in subsections (e) and (h)(2) of this section, the Secretary shall enter into an interagency agreement with the Secretary of the Interior to provide for the direct participation of, and transfer of funds to, the Fish and Wildlife Service and any other agency or bureau of the Department of the Interior for the planning, design, implementation, and evaluation of such programs.

(4) The Upper Mississippi River Basin Association or any other agency established under paragraph (1) of this subsection is hereby designated by Congress as the caretaker of the master plan. Any changes to the master plan recommended by the Secretary shall be submitted to such association or agency for review. Such association or agency may make such comments with respect to such recommendations and offer other recommended changes to the master plan as such association or agency deems appropriate and shall transmit such comments and other recommended changes to the Secretary. The Secretary shall transmit such recommendations along with the comments and other recommended changes of such association or agency to the Congress for approval within 90 days of the receipt of such comments or recommended changes.

(e) Program Authority

(1) Authority

(A) In general. The Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, may undertake, as identified in the master plan

(i) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement; and

(ii) implementation of a long-term resource monitoring, computerized data inventory and analysis, and applied research program, including research on water quality issues affecting the Mississippi River (including elevated nutrient levels) and the development of remediation strategies.

(B) Advisory committee. In carrying out subparagraph (A)(i), the Secretary shall establish an independent technical advisory committee to review projects, monitoring plans, and habitat and natural resource needs assessments.

(2) REPORTS. — Not later than December 31, 2004, and not later than December 31 of every sixth year thereafter, the Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall submit to Congress a report that —

(A) contains an evaluation of the programs described in paragraph (1);

(B) describes the accomplishments of each of the programs;

(C) provides updates of a systemic habitat needs assessment; and

(D) identifies any needed adjustments in the authorization of the programs.

(3) For purposes of carrying out paragraph (1)(A)(i) of this subsection, there is authorized to be appropriated to the Secretary $22,750,000 for fiscal year 1999 and each fiscal year thereafter.

(4) For purposes of carrying out paragraph (1)(A)(ii) of this subsection, there is authorized to be appropriated to the Secretary $10,420,000 for fiscal year 1999 and each fiscal year thereafter.

(5) Authorization of appropriations.—There is authorized to be appropriated to carry out paragraph (1)(B) $350,000 for each of fiscal years 1999 through 2009.

(6) Transfer of amounts.—For fiscal year 1999 and each fiscal year thereafter, the Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, may transfer not to exceed 20 percent of the amounts appropriated to carry out clause (i) or (ii) of paragraph (1)(A) to the amounts appropriated to carry out the other of those clauses.

(7)(A) Notwithstanding the provisions of subsection (a)(2) of this section, the costs of each project carried out pursuant to paragraph (1)(A)(i) of this subsection shall be allocated between the Secretary and the appropriate non-Federal sponsor in accordance with the provisions of section 906(e) of this Act; except that the costs of operation and maintenance of projects located on Federal lands or lands owned or operated by a State or local government shall be borne by the Federal, State, or local agency that is responsible for management activities for fish and wildlife on such lands and, in the case of any project requiring non-Federal cost sharing, the non-Federal share of the cost of the project shall be 35 percent.

(B) Notwithstanding the provisions of subsection (a)(2) of this section, the cost of implementing the activities authorized by paragraph (1)(A)(ii) of this subsection shall be allocated in accordance with the provisions of section 906 of this Act, as if such activity was required to mitigate losses to fish and wildlife.

(8) None of the funds appropriated pursuant to any authorization contained in this subsection shall be considered to be chargeable to navigation.

(f) (1) The Secretary, in consultation with any agency established under subsection (d)(1) of this section, is authorized to implement a program of recreational projects for the system substantially in accordance with the recommendations of the GREAT I, GREAT II, and GRRM studies and the master plan reports. In addition, the Secretary, in consultation with any such agency, shall, at Federal expense, conduct an assessment of the economic benefits generated by recreational activities in the system. The cost of each such project shall be allocated between the Secretary and the appropriate non-Federal sponsor in accordance with title I of this Act.

(2) For purposes of carrying out the program of recreational projects authorized in paragraph (1) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $500,000 per fiscal year for each of the first 15 fiscal years beginning after the effective date of this section.

(g) The Secretary shall, in his budget request, identify those measures developed by the Secretary, in consultation with the Secretary of Transportation and any agency established under subsection (d)(1) of this section, to be undertaken to increase the capacity of specific locks throughout the system by employing nonstructural measures and making minor structural improvements.

(h)(1) The Secretary, in consultation with any agency established under subsection (d)(1) of this section, shall monitor traffic movements on the system for the purpose of verifying lock capacity, updating traffic projections, and refining the economic evaluation so as to verify the need for future capacity expansion of the system.

(2) Determination.

(A) In general. The Secretary in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall determine the need for river rehabilitation and environmental enhancement and protection based on the condition of the environment, project developments, and projected environmental impacts from implementing any proposals resulting from recommendations made under subsection (g) and paragraph (1) of this subsection.

(B) Requirements. The Secretary shall

(i) complete the ongoing habitat needs assessment conducted under this paragraph not later than September 30, 2000; and

(ii) include in each report under subsection (e)(2) the most recent habitat needs assessment conducted under this paragraph.

(3) There is authorized to be appropriated to the Secretary such sums as may be necessary to carry out this subsection.

(i) (1) The Secretary shall, as he determines feasible, dispose of dredged material from the system pursuant to the recommendations of the GREAT I, GREAT II, and GRRM studies.

(2) The Secretary shall establish and request appropriate Federal funding for a program to facilitate productive uses of dredged material. The Secretary shall work with the States which have, within their boundaries, any part of the system to identify potential users of dredged material.

(j) The Secretary is authorized to provide for the engineering, design, and construction of a second lock at locks and dam 26, Mississippi River, Alton, Illinois and Missouri, at a total cost of $220,000,000, with a first Federal cost of $220,000,000. Such second lock shall be constructed at or in the vicinity of the location of the replacement lock authorized by section 102 of Public Law 95-502. Section 102 of this Act shall apply to the project authorized by this subsection.

SEC. 906(e). COST SHARING.

(e) In those cases when the Secretary, as part of any report to Congress, recommends activities to enhance fish and wildlife resources, the first costs of such enhancement shall be a Federal cost when--

(1) such enhancement provides benefits that are determined to be national, including benefits to species that are identified by the National Marine Fisheries Service as of national economic importance, species that are subject to treaties or international convention to which the United States is a party, and anadromous fish;

(2) such enhancement is designed to benefit species that have been listed as threatened or endangered by the Secretary of the Interior under the terms of the Endangered Species Act, as amended (16 U.S.C. 1531, et seq.), or

(3) such activities are located on lands managed as a national wildlife refuge.

When benefits of enhancement do not qualify under the preceding sentence, 25 percent of such first costs of enhancement shall be provided by non-Federal interests under a schedule of reimbursement determined by the Secretary. Not more than 80 percent of the non-Federal share of such first costs may be satisfied through in-kind contributions, including facilities, supplies, and services that are necessary to carry out the enhancement project. The non-Federal share of operation, maintenance, and rehabilitation of activities to enhance fish and wildlife resources shall be 25 percent.

II. AFFECTED ENVIRONMENT

A. Resource History of the Project Area

The Mississippi River, and what is presently Pool 14, has been very important to the social and economic development of the region. The earliest native cultures and explorers used the river for its ease of transportation. Historical surveys indicate the area contained a mix of bottomland forests with a high proportion of oaks and other mast trees. River channels, seasonally flooded backwaters, floodplain lakes, and marshes were prevalent throughout the area.

Channel manipulations to clear the channel and improve navigation began around 1825. Measures to deepen the channel occurred from the 1880s until present. Completion of the Lock and Dam system, specifically Lock and Dam 14 in 1939, increased water levels significantly. This changed the free-flowing river to a series of reservoirs and stabilized water levels over time, which adversely affected the biological resources of the river. The impacts of channel modification have contributed to a decrease in habitat structure, bottomland hardwood regeneration, and the amount of aquatic backwater habitat and isolated wetland habitat. This has led to a decrease in the habitat associated with each land cover type, as well as the fish and wildlife dependent on the habitat.

B. Description of Project Area and Current Management

The Project area encompasses approximately 1,678 acres of the 2,000-acre Beaver Island. The remainder of the island is in private ownership. Beaver Island and Albany Island are the main islands, while Beaver Slough, Grass Slough and Lower Lake are the major water bodies. Management of the Project was out granted to the USFWS in 1963 (amended in 2001), but the Corps retains the forestry management responsibility on Corps fee title lands. While the USFWS conducts no active habitat management on Beaver Island and there are no water control structures or other infrastructure in place to maintain, it does enforce a Closed Area that prohibits all migratory bird hunting, restricts boat motors and is a Voluntary Avoidance Area from October 15 to the end of Iowa's duck hunting season. The Closed Area provides a waterfowl sanctuary during the hunting season. A No Motor Area, located within the Closed Area, prohibits use of motors for all water conveyances (outboard, airboats, jet skis, etc.) and no land vehicles, including ATVs, are allowed on Beaver Island within the Refuge Area. The No Motor Area is in place to minimize disturbance to waterfowl. Current Corps forestry management practices include planned tree harvesting rotations, sapling plantings, and follow-up maintenance of understory herbaceous vegetation. Typically, this is done on a small scale (12- to 25-acre plots).

C. Floodplain Resources

All elevations (Figure II-1) used in this report are expressed using the North American Vertical Datum of 1988 (NAVD88), unless otherwise stated. Beaver Island contains approximately 1,500 acres of floodplain habitat (Table II-1), which was considered to be above an elevation of 572.15. Based on a 2015 forest community survey, the floodplain located within the Project area is comprised of 1,425 acres (95%) of broad-leaved deciduous forest habitat and about 75 acres (5%) of open canopy habitat (15 acres of which are reed canary grass, an invasive species). Sections II.C.1. and C.2. on the following pages further describe the forest and wildlife communities and the habitat each community offers.

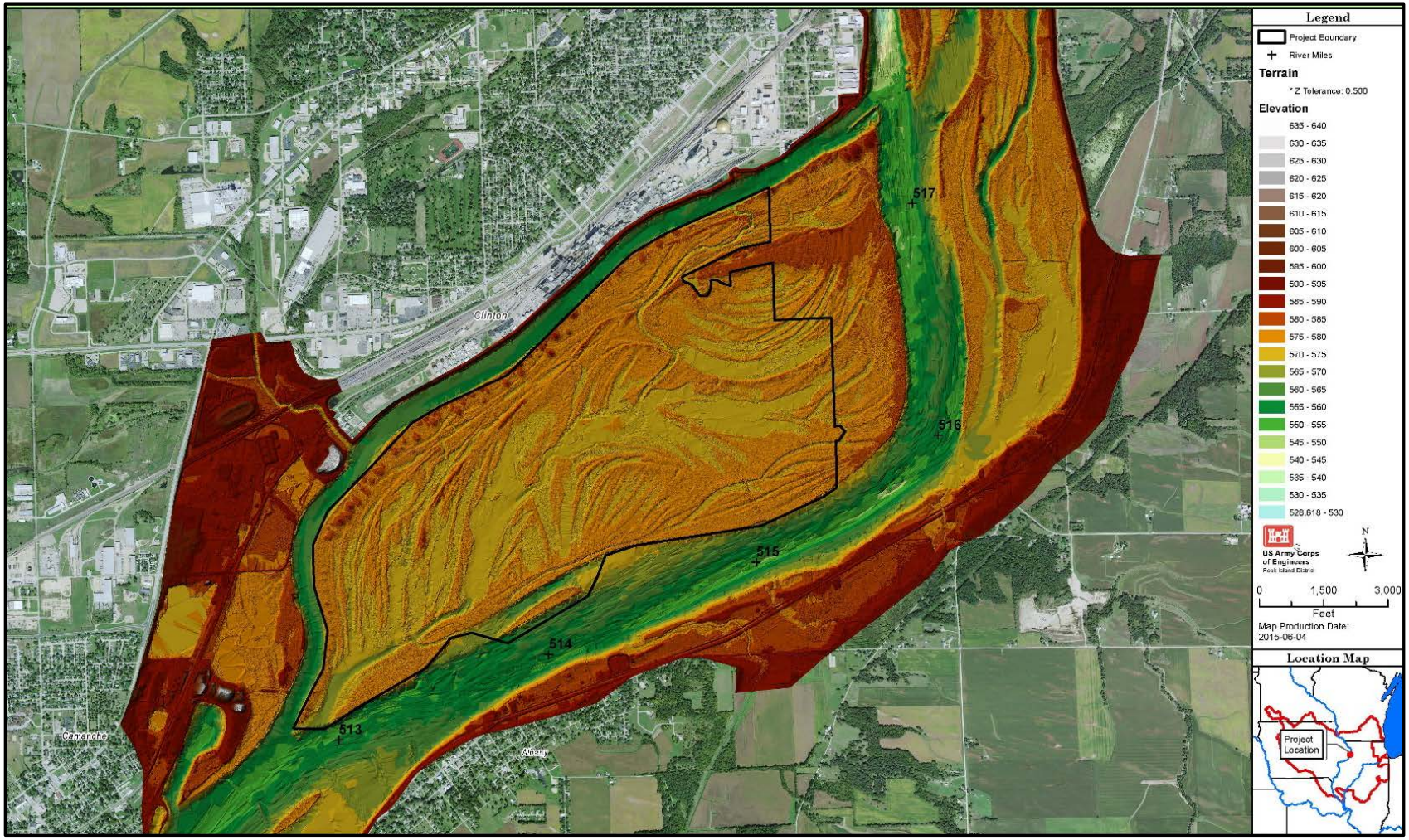

Figure II-1. Topographic and Bathymetric Elevation Map for Beaver Island

Table II-1. Beaver Island Floodplain Habitat Elevation Intervals,
Acres above Water Surface (WS) Per Elevation Range, Percent of Total Area, and Cumulative Percent

Elevation Contour	Acres	Total	Cumulative
572 - 573’	411.0	27.4%	27.4%
573 - 574'	362.0	24.1%	51.5%
574 - 575'	278.0	18.5%	70.0%
575 - 576'	201.0	13.4%	83.4%
576 - 577'	144.0	9.6%	93.0%
577 - 578'	61.0	4.1%	97.1%
>578'	43.0	2.9%	100.0%
Total Above WS	1500.0	100.0%	--

1. Forest Diversity and Habitat. Large floodplain forests like Beaver Island are distinctive features of the landscape. As dynamic habitats, exposed to frequent disturbances, they provide scarce resources for many groups of animals.

Following lock and dam construction on the UMR, water levels in Pool 14 are generally higher over the entire year, flood pulses are higher, and periods of very low flow formerly common in the fall have been eliminated. Consequently, the majority of the island is located at or below an elevation of 576 feet, as shown in Table II-1, which is an elevation shown to be the threshold for optimal survival, growth, and sustainability of mast tree (i.e., nut producing tree) production (DeJager et al. 2012; Guyon et al. 2012). Nut producing trees are critical food sources for many species of waterfowl and floodplain wildlife.

Approximately 17% of the island is at an elevation (>576 feet) suitable to contain nut producing trees, compared to the reference condition (i.e., pre-dam) of about 47.0% (Appendix D, *Habitat Evaluation, Benefits Quantification and Incremental Analysis*, and Appendix H, *Hydrology and Hydraulics)*. During a 2015 forest inventory, mast tree species recorded totaled 10 different species in the overstory including red oak and black walnut (Figure II-2 and Table II-2). Those species are not normally found in the floodplain in this region due to flood intolerance. Additionally, the areas with mast trees present were on average over 88 years (ranged 1874 to 1964) old and contained little production in the understory. This lack of production is directly related to increased water inundation and duration. Additional tree species found during this inventory can be found in Table II-2.

The existing stands of even-aged mature silver maple are a concern. Mortality can be expected at nearly the same time for the forest, resulting in open canopies with little to no understory available to generate forest regrowth. This encourages the growth of non-desirable herbaceous vegetation, which prevents recruitment of desirable tree species through direct competition with tree saplings. Examples of this cycle are at numerous locations in the UMRS where natural mortality of mature trees has resulted in dense stands of the invasive reed canary grass and limited recruitment of desirable trees.

The largest concern is without intervention, the Project area is likely to experience forest fragmentation and an influx of invasive species; essentially transitioning from forest to grassland over time (Guyon et al. 2012). Consequently, neotropical and other migratory birds, Indiana bats, and the other floodplain species that rely on the forest resources will be severely impacted.

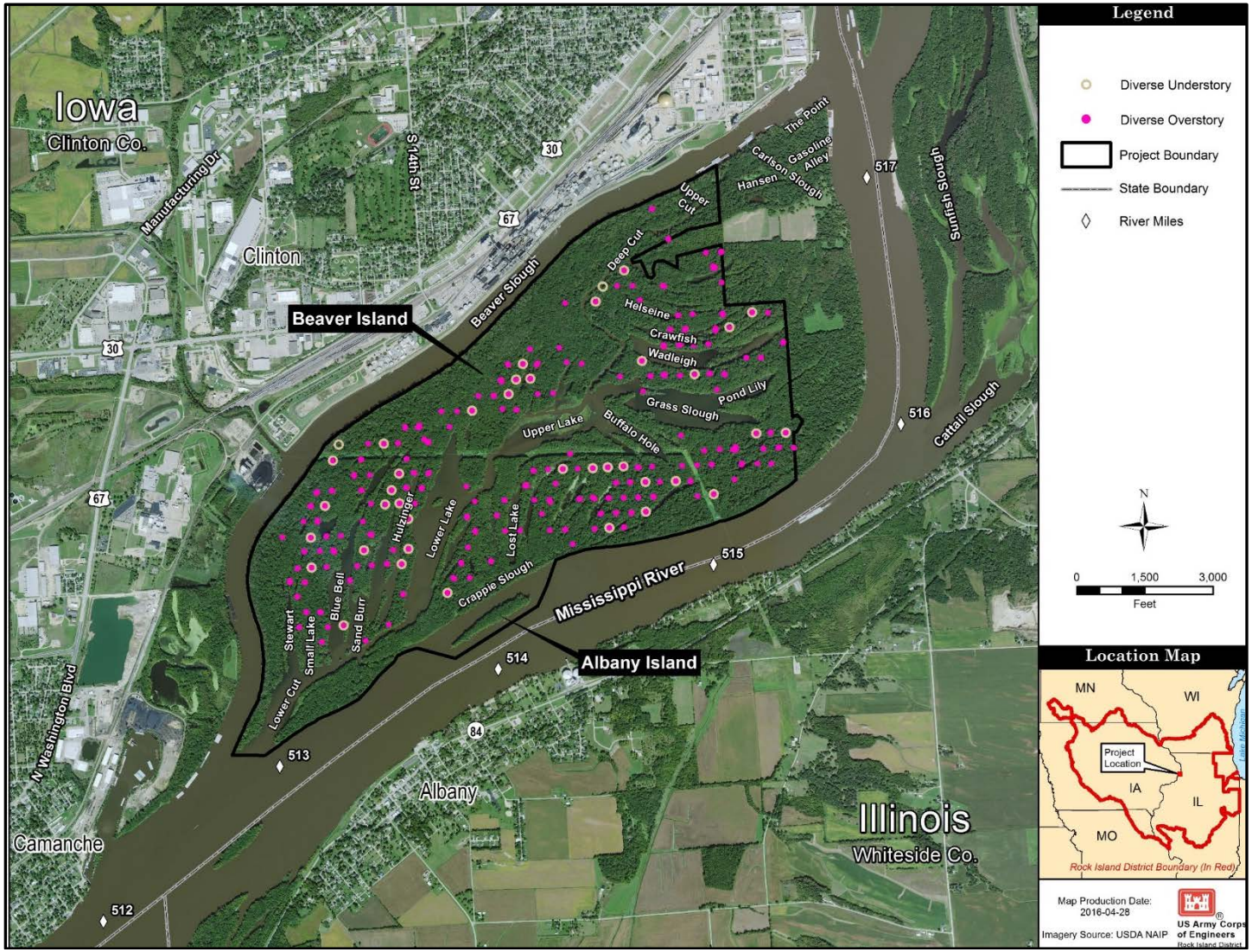

Figure II-2. Broad-Scale Results of the Beaver Island Forest Inventory Conducted in 2015

Table II-2: Overstory and Understory Woody Tree and Shrub Species

Common Name	Scientific Name	USDA Code
American Elm	*Ulmus americana*	ULAM
Bitternut Hickory	*Carya cordiformis*	CACO15
Black Elderberry	*Sambucus spp.*	SAMBU
Black Walnut	*Juglans nigra*	JUNI
Black Willow	*Salix nigra*	SANI
Boxelder	*Acer negundo*	ACNE12
Bur Oak	*Quercus macrocarpa*	QUMA2
Bush Honeysuckle	*Diervilla lonicera*	DILO
Buttonbush	*Cephalanthus occidentalis*	CEOC2
Coralberry	*Symphoricarpos orbiculatua*	SYOR
Cottonwood	*Populus deltoides*	PODE3
Eastern Wahoo	*Euonymus atropurpureus*	EUATA2
Green Ash	*Fraxinus pennsylvanica*	FRPE
Grey Dogwood	*Cornus racemosa*	CORA6
Hackberry	*Celtis occidentalis*	CEOC
Hawthorn	*Crataegus spp.*	CRATA
Honey Locust	*Gleditsia triacanthos*	GLTR
Kentucky Coffetree	*Gymnocladus dioica*	GYDI
Pin Oak	*Quercus palustris*	QUPA2
Red Mulberry	*Morus rubra*	MORU2
Red Oak	*Quercus rubra*	QURU
River Birch	*Betula nigra*	BENI
Shellbark hickory	*Carya laciniosa*	CALA21
Silver Maple	*Acer saccharinum*	ACSA2
Swamp White Oak	*Quercus bicolor*	QUBI
White Mulberry	*Morus alba*	MOAL

2. Wetlands Diversity and Habitat. In general, floodplain wetlands were defined as areas lying between 572–576 feet (Table II-1). Below this elevation is open water aquatic habitat, addressed in Section II.D., *Aquatic Resources*. Approximately 47% of the floodplain habitat is classified as palustrine seasonally flooded broad-leaved deciduous forest, and 53% is considered to be palustrine temporary flooded broad-leaved deciduous forest. Several palustrine semi-permanently flooded emergent wetlands ranging in size from 0.5 to 4.5 acres are found in low-lying depressions sporadically located throughout the Project area.

The USFWS investigated the quantity and quality of wetlands for herptiles in the Project area in April 2015. Herptile sites are present in the vicinity with various wetlands scattered throughout. Some are isolated potholes, others are meandering waterways, and some are very good wetlands. After a high water event, the diversity and number of potholes would greatly increase.

3. Bat Habitat. Bats typically travel, forage, and roost within a variety of interconnected forested habitats, including riparian corridors, bottomlands, and uplands. Trees in excess of 16 inches in diameter at breast height (DBH) are considered optimal for maternity colony roosts, but trees in excess of 9 inches DBH appear to provide suitable maternity roosting habitat. Exfoliating bark, cavities of dead and live trees, and snags (i.e., dead trees or dead portions of live trees) are ideal bat habitat.

Beaver Island contains numerous large trees and snags that potentially serve as roosting habitat, and open forest dominated by large trees adjacent to open water, which provides excellent foraging habitat for the Indiana bat, northern long-eared bat, and other bat species.

Field investigations were divided into four phases: 1) Habitat Assessment; 2) Acoustical Survey; 3) Concurrent Mist Net & Acoustical Surveys; and 4) Radiotracking Survey. The objective of the acoustic and mist net surveys were to assess the presence, or probable absence, of Indiana bats using summer habitat within the Project areas on Beaver Island. To effectively investigate the Project area, the Corps and the USFWS designed and implemented guidelines to maximize the chances of capturing Indiana bats. A Habitat Assessment and an Acoustic Survey to identify potential habitat for the Indiana bat and northern long-eared bat were conducted in Phase 1. The acoustic survey suggested the presence of both Indiana and northern long eared bats per USFWS' 2015 range-wide Indiana bat summer survey guidelines. See the USFWS' February 29, 2016, concurrence letter in Appendix A, *Correspondence* for more information. Mist net surveys were conducted in summer 2015 to provide more insight on the species composition of this Beaver Island bat community. Overall, 190 bats, representing seven species, were captured within the Project area. The most common species captured was the little brown bat (*Myotis lucifugus)*, big brown bat (*Eptesicus fuscus)* and evening bat (*Nycticeius humeralis*). Refer to Section II.E. for federally-listed species results.

D. Aquatic Resources

Beaver Island contains approximately 178 acres of aquatic habitat. The site offers both lentic (i.e., backwater; 159 acres or 89%) and lotic (i.e., riverine; 19 acres or 11%) general aquatic habitat types. Although the site offers a diverse array of interconnected channels and backwaters, the habitat provided by these resources for aquatic organisms is limiting at times. The following sections describe the typical aquatic community composition and habitat that currently exist at Beaver Island.

1. Backwater Fishery Habitat. The IADNR has conducted fish sampling at several sites in Beaver Island and Pool 14. Fish species sampled in Pool 14 and Beaver Island are similar to most other Mississippi River species. Many of the important recreational and commercial fish species (e.g., bluegill *Lepomis macrochirus*, largemouth bass *Micropterus salmoides*, black and white crappie *Pomoxis spp.*, catfish (Family Ictaluridae), and buffalo species *Ictiobus spp.*) are commonly found in the backwaters and Beaver Slough during different times of the year.

In general, Beaver Island backwater aquatic areas can be described as relatively shallow large river backwaters (Table II-3), which contains some aquatic vegetation. Structure is in the form of large woody debris, which serves as important structure habitat. Substrates typically consist of a silt/sand mixture. Water quality is generally acceptable with intermittent high temperatures in the summer and occasional low dissolved oxygen (DO) levels in the winter.

Spawning habitat for centrarchid fish species (e.g., largemouth bass, bluegill, black and white crappie) does not appear to be limiting within Beaver Island. The apparent successful spawning is most likely due to the relatively stable (i.e., average water level change from June 10 to July 31 is a drop of 2.08 feet) high water during June and July. These prolonged conditions provide the opportunity to utilize the floodplain to seek out low velocity (<3.0 cm/sec), warm (>18.0 °C), and stable substrates near structure (e.g., trees, scrub/shrub, miscellaneous vegetation) to successfully spawn.

Table II-3. Beaver Island Aquatic Habitat Depth Intervals, Acres per Depth Contour, Percent of Total, and Cumulative Percent

Depth Contour	Acres	Total	Cumulative
0 - 1'	85.8	48.2%	48.2%
1 - 2'	41.5	23.3%	71.5%
2 - 3'	23.1	13.0%	84.5%
3 - 4'	18.4	10.3%	94.8%
4 -5'	6.1	3.4%	98.3%
> 5'	3.1	1.8%	100.0%
Total Below WS	178.0	100.0%	--

Reference Water Surface (70% annual duration, 572.15 NAVD88 at RM 513.5)

Post-spawning rearing/foraging habitat for centrarchids in the summer and early fall typically consists of areas with adequate water quality (i.e., water temperatures 24-30°C, >8.0 mg/L DO, and abundant foraging opportunities for maximum growth). The average water temperature during the growing season (July–September) within Beaver Island is approximately 24.8°C. However, due to the shallow nature of the backwaters, midsummer water temperatures intermittently exceed 30.0°C, and DO concentrations dip below 5.0 mg/L.

Later in fall and early winter when the water temperatures begin to drop below 10.0°C centrarchids will initiate movements from foraging areas to overwintering areas. Preferred habitat consists of deep water (>4 feet), low velocity (<1 cm/sec), high DO concentrations (> 5.0 mg/L), and warmer water temperatures (>4.0°C). Ideally, this habitat is directly connected with the aforementioned fall foraging habitat and spawning habitat. The connection of these habitats reduces energy expenditure during times of low metabolic activity. This is especially important for age-0 fish spawned the previous spring. Copeland and Noble (1994) noted yearling largemouth bass movements were limited through the first winter and the second growing season, indicating the need for connected spawning, overwintering, and fall foraging habitat in close proximity.

The existing backwaters are limited with respect to high quality overwintering habitat. Of the available backwater habitat, only about 5% is suitable depth for overwintering, which is located mainly in Blue Bell Lake and sporadically in the other lakes (Table II-3). Even so, much of the existing overwintering area experiences higher flows or low DO (<3 mg/L) in the winter (Appendix D, *Habitat Evaluation, Benefits Quantification and Incremental Analysis*, and Appendix F, *Water Quality)*.

The physical characteristics of the backwaters are suboptimal for year-round habitat. Overwintering habitat is the most limited habitat type and should be restored to increase off-channel habitat (UMRCC Fisheries Plan 2010). However, the area is heavily used during the remainder of the year with successful spawning, rearing, and foraging occurring for a diverse array of fish species, including centrarchids.

2. Riverine Fishery Habitat. Riverine fishery habitat under consideration for this Project includes Albany Slough (19 acres). Albany Slough has an average depth near 9 feet, and flows, temperatures, and water quality measurements similar to the main channel during the course of the year. Albany Slough offers minimal habitat diversity directly, but the Island serves as an important characteristic because it directly facilitates side channel habitat suitable for freshwater mussel colonization. Without the existence of Albany Island, the side channel ceases to function as a

secondary channel and likely converts to main channel border habitat. This would likely have a negative impact on the mussel community currently inhabiting the slough.

3. Mussel Habitat. Mussel surveys have been conducted in Pool 14 since 2008. These studies include surveys at Cordova EHA (last surveyed 2014); 2008 and 2012 surveys at Hanson's Slough; a 2013 survey at Lower Beaver Slough; and a 2013 survey at Upper Beaver Slough. There are three other known beds in the area. Each of the surveys provides insight into the potential mussel community within Beaver Island.

Eight hundred and eighty-six mussels (17 total species) were collected at 12 different sample sites during the August 14, 2014 mussel survey at Albany Slough. Albany Slough appears to harbor around 17 live unionid species, including the federally endangered Higgins eye pearlymussel (*Lampsilis higginsii)*. The most abundant mussel species (60% of the mussels collected) was threeridge (*Amblema plicata*). Plain pocketbook (*Lampsilis cardium*) and wabash pigtoe (*Fusconaia flava*) comprised 18% and 11%, respectively, of the collected individuals.

In an attempt to better understand the freshwater mussel community structure and dynamics within Albany Slough, an additional mussel survey was conducted during the summer of 2015 by staff from the Corps, USFWS, IADNR, USGS, and ILDNR. This was an extensive survey with a series of dive, pollywog, and various timed surveys. In general, results indicate there were low densities of mussels on the head of the island and in the deeper water holes. Present mussels were primarily threeridge followed by various other native common species with no collection of Higgins eye pearlymussel (*Lampsilis higginsii)*. Identified mussel beds were generally on the left descending bank of Albany Slough, the tail end of the island, and near the lower end of Albany Slough. Refer to Section II.E. for federally-listed species results.

4. Aquatic Vegetation. Surveys conducted since 1975 by USFWS document the presence of various species of submergent, emergent, and rooted floating aquatic vegetation (Figure II-3), including sago pondweed (*Potamogeton pectinatus*), water celery (*Vallisneria americana*), and American lotus (*Nelumbo lutea*). While densities have varied over the years due to variability in the environmental conditions, submerged, emergent, and floating-leaved aquatic vegetation exists today in randomly located patches within the Project area.

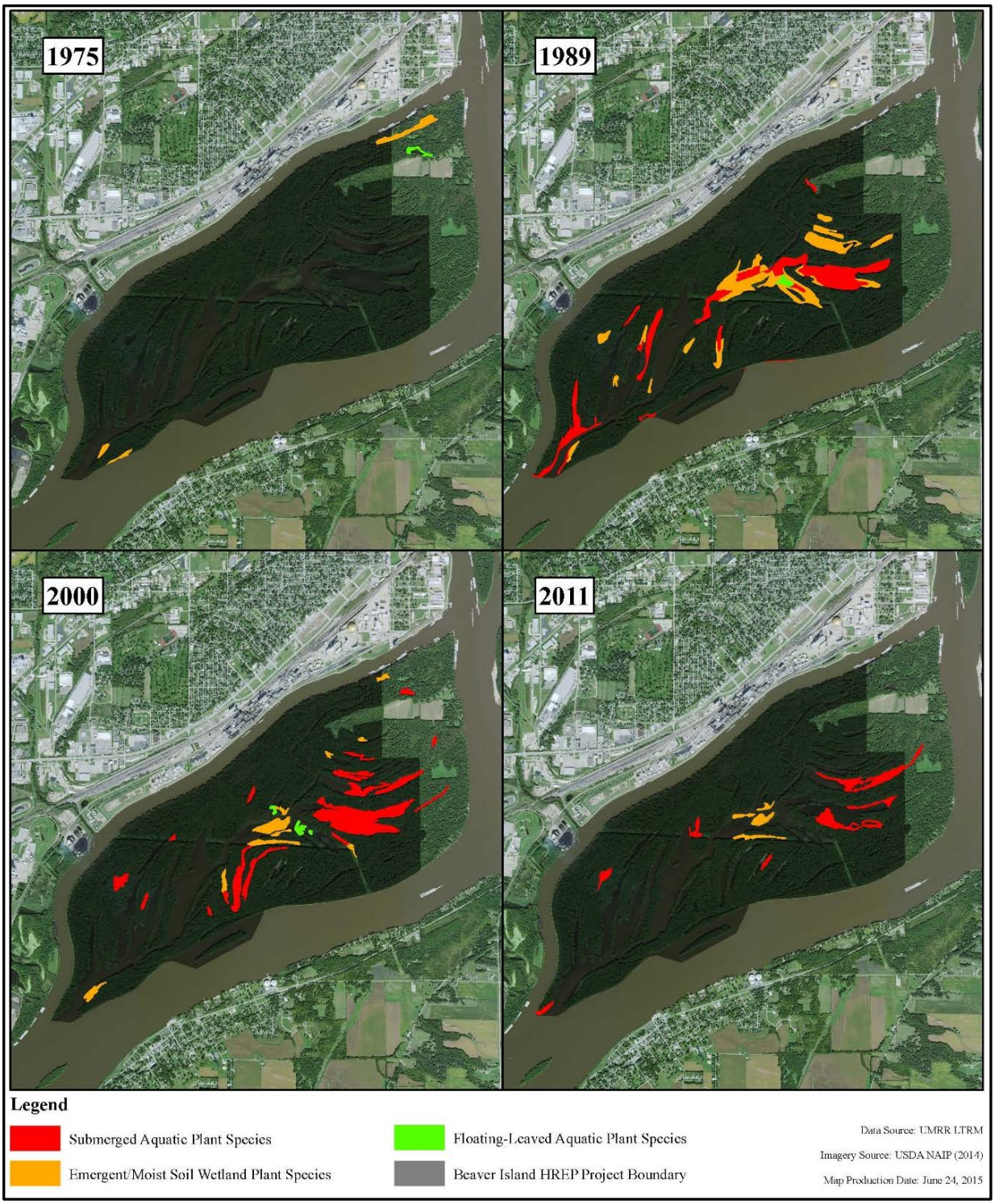

Figure II-3. Beaver Island HREP – Aquatic Vegetation

E. Endangered, Threatened, and Candidate Species

The USFWS has identified the Indiana bat (*Myotis sodalist*); northern long-eared bat (*Myotis septentrionalis*); prairie bush clover (*Lespedeza leptostachya*); western prairie fringed orchid (*Platanthera praeclara*); Higgins eye pearlymussel (*Lampsilis higginsii*)*;* and Iowa Pleistocene snail (*Discus macclintocki*) as federally-endangered or threatened species that have the potential to occur within Clinton County, Iowa.

1. Indiana bat. The Indiana bat's range includes the eastern half of the United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. Indiana bats hibernate during the winter months in limestone caves and abandoned underground mines known as hibernacula. After hibernation, most females depart from the caves and abandoned underground mines during April, while males typically remain longer before migrating to summer habitats. Females migrate to summer habitats where they congregate to bear and raise young in what are known as maternity colonies. A tree/habitat survey conducted by the Corps identified additional alternative roosting habitat throughout the Project's forested areas that could also serve as secondary or primary maternity roosts.

Critical habitat has not been listed in Iowa; however, maternal activity has been recorded at 26 locations in Iowa. After a habitat survey and an acoustic survey using the USFWS' 2015 Range-wide Indiana bat Summer Survey Guidelines determined there was the potential for Indiana and northern long-eared bats to be present in the Project area, a summer mist net survey was conducted in August 2015. No federally-endangered Indiana bats were captured during nine net nights of effort at Beaver Island. Although it is not possible to determine with absolute certainty the absence of Indiana bats, the lack of Indiana bat captures at mist net site locations at Beaver Island suggests their probable absence during the summer reproductive season.

2. Northern long-eared bat. The northern long-eared bat is a federally-threatened bat and is found in the United States from Maine to North Carolina on the Atlantic Coast, westward to eastern Oklahoma and north through the Dakotas, even reaching into eastern Montana and Wyoming. They hibernate during the winter months in caves. After hibernation, they migrate to wooded areas to roost and forage during late spring and summer. During the summer, northern long-eared bats roost singly or in colonies under bark, in cavities or crevices of both live and dead trees.

Critical habitat has not been listed in Iowa. After a habitat assessment and an acoustic survey using the USFWS' 2015 Range-wide Indiana Bat Summer Survey Guidelines determined there was the potential for Indiana and northern long-eared bats to be present in the Project area, a summer mist net survey was conducted in August 2015. Fourteen federally-threatened northern long-eared bats were captured at the site. Three of the northern long-eared bats were fitted with a radio-transmitter and tracked to five individual day roosts, four of which are within the Project area, and one located 25 feet outside the Project boundary.

3. Prairie bush clover. The prairie bush clover is a federally-threatened prairie plant endemic to the tallgrass prairie region of the UMR Valley. Collection history and current distribution indicate the species is most abundant in an area that lies on drift of the Des Moines Lobe of the Wisconsin stage of glaciation, in northern Iowa and southern Minnesota. Habitat in this area typically consists of gentle, usually north-facing slopes, with fine silty loam, fine sandy loam or clay loam. The USFWS lists potential habitat statewide. However, the species has not previously been recorded in the area nor does the Beaver Island floodplain offer suitable habitat for establishment or survival.

4. Western prairie fringed orchid. The western prairie fringed orchid is a federally-threatened terrestrial orchid known to occur at 175 sites in 8 ecoregions, including 41 counties of 6 states and one population in Manitoba (USFWS 1996). Preferred habitat consists of unplowed, calcareous prairies and sedge meadows. Populations are mostly associated with poorly drained to moderately well drained, nearly level to gently sloping soils formed on loamy and clayey glacial till. Approximately 90% of known western prairie fringed orchids in the United States occurs in the Red River Valley of North Dakota and Minnesota.

According to the 1996 USFWS Recovery Plan, extant populations existed at 23 locations in 15 counties in Iowa. Of those 15 counties, Guthrie, Cherokee, and Mills counties contained the maximum number of documented flowering plants. The USFWS lists potential habitat statewide. However, the species has not previously been recorded in the area nor does the Beaver Island floodplain offer suitable habitat for establishment or survival.

5. Higgins eye pearlymussel. The Higgins eye pearlymussel is a federally-endangered freshwater mussel that has been found in parts of the UMR, Iowa River, St. Croix River, Wisconsin River, and Rock River. Higgins eye is characterized as a large river species and is usually found in areas with deep water and moderate currents. They typically inhabit areas with stable substrates varying from sand to boulders, but not firmly packed clay, flocculent silt, organic material, bedrock, concrete, or unstable sand.

The USFWS's recovery plan for Higgins eye pearlymussel (USFWS 2004) focuses on the recovery of the species within Essential Habitat Areas (EHA). In the plan, the USFWS documented 10 EHAs, with an additional 4 EHAs being documented in 2008. There is one EHA in Pool 14. Higgins eye pearlymussel has been found to occur within the Project area with one individual found at Albany Slough during the 2014 survey. The subsequent mussel survey conducted in 2015 found none.

6. Iowa Pleistocene Snail. The endangered Iowa pleistocene snail is found on north-facing slopes of the driftless area in Clayton, Clinton, Dubuque, Fayette, and Jackson Counties, Iowa. It occupies algific (cold producing) talus slopes at the outlet of underground ice caves along limestone bluffs within a narrow regime of soil moisture and temperature.

There is no critical habitat designated. It must not be harmed, harassed or disturbed. However, the species has not previously been recorded in the area nor does the Beaver Island floodplain offer suitable habitat for establishment or survival.

7. State Threatened or Endangered Species. In addition to federally-listed species, the IADNR identified state-threatened or endangered species that have the potential to occur within Clinton County, Iowa (Table II-4).

Table II-4. Iowa State Threatened or Endangered Species

Common Name	Scientific Name	Class
Central Newt (T)	*Notophthalmus viridescens*	Amphibian
Barn Owl (E)	*Tyto alba*	Bird
King Rail (E)	*Rallus elegans*	Bird
Red-shouldered Hawk (E)	*Buteo lineatus*	Bird
Blacknose Shiner (T)	*Notropis heterolepis*	Fish
Bluntnose Darter (E)	*Etheostoma chlorosoma*	Fish
Chestnut Lamprey (T)	*Ichthyomyzon castaneus*	Fish
Freckled Madtom (E)	*Notorus nocturnus*	Fish
Grass Pickerel (T)	*Esox americanus*	Fish
Lake sturgeon (E)	*Acipenser fluvescens*	Fish
Western Sand Darter (T)	*Ammocrypta clara*	Fish
Butterfly (T)	*Ellipsaria lineolata*	Freshwater Mussel
Creeper (T)	*Strophitus undulatus*	Freshwater Mussel
Higgins-eye Pearly Mussel (E)	*Lampsilis higginsii*	Freshwater Mussel
Round Pigtoe (E)	*Pleurobema sintoxia*	Freshwater Mussel
Yellow Sandshell (E)	*Lampsilis teres*	Freshwater Mussel
Byssus Skipper (T)	*Problema byssus*	Insect
Black Huckleberry (T)	*Gaylussacia baccata*	Plant
Dwarf Dandelion (E)	*Krigia virginica*	Plant
Eastern Jointweed (E)	*Polygonella articulata*	Plant
Flax-leaved Aster (T)	*Aster linariifolius*	Plant
Mead's Milkweed (E)	*Asclepias meadii*	Plant
Meadow Beauty (T)	*Rhexia virginica*	Plant
Orange Grass St. John's Wart (E)	*Hypericum gentianoides*	Plant
Poppy Mallow (E)	*Callirhoe triangulata*	Plant
Racemed Milkwort (E)	*Polyhala polygama*	Plant
Pale Green Orchid (E)	*Platanthera flava*	Plant
Black-footed Quillwort (E)	*Isoetes melanopoda*	Plant
Daisy-leaved Moonwort (E)	*Botrychium matricariifolium*	Plant
Royal Fern (T)	*Osmunda regalis*	Plant
Blanding's Turtle (T)	*Emydoidea blandingii*	Reptile
Eastern Massasauga Rattlesnake (E)	*Sistrurus catenatus*	Reptile
Ornate Box Turtle (T)	*Terrapene ornata*	Reptile
Iowa Pleistocene Snail (E)	*Discus macclintocki*	Snail

F. 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. As one of the four major migration flyways in North America, the Mississippi River Flyway, offers ideal conditions for migratory birds. Although there are numerous migratory birds that utilize Beaver Island, the following migratory birds are the most relevant in the area and would be potentially affected by the Project alternatives:

1. Bald Eagle *(Haliaeetus leucocephalus)*. The Bald eagle is protected under the Bald and Golden Eagle Protection Act of 1940 and typically utilizes large trees for roosting and building nests. The bald eagle is a common inhabitant within Beaver Island during the winter months and there are known bald eagle nests.

2. Great Blue Heron *(Ardea Herodias)*. The great blue heron is a large wading bird which typically utilizes the shores of open water and wetlands where it forages for small fish as its primary food source. The species usually breeds in colonies, in trees close to open water or wetlands. A colony is often referred to as a rookery and can be as large as 500 nests. Heron rookeries in the UMR are vulnerable because the availability of suitable nesting habitat is declining. Beaver Island contains suitable habitat for heron foraging, roosting, and nesting. An active heron rookery has been recorded within the vicinity of the Project area and likely has 75 to 100 active nests.

3. Waterfowl. While Beaver Island has not been included in aerial waterfowl surveys due to the hazard of overhead power lines, it has been chosen as a Closed Area due to its importance to waterfowl and the lack of other large backwater areas in Pool 14 for resting and feeding. The seasonal water conditions within the many backwater lakes make it ideal for seed production of wetland plants, which are a primary food source for waterfowl. Area refuges and a nearby rookery continue to attract ducks and other waterfowl during migrations.

4. Neotropical Migratory Birds. Floodplain complexes and the habitat provided are highly important to migratory bird species such as neotropical migrants. The diverse array of habitat types floodplain forests typically provide, tend to support higher abundances of species and individuals. In fact, 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.

Healthy populations of floodplain forest wildlife, including migratory birds, requires adequate habitat. The Beaver Island forest community has become less diverse and the dominance of silver maple has increased since impoundment. The changes in tree species composition, structure, and function have contributed to a reduction in diversity of habitat over time. These changes are likely to continue, and without intervention, Beaver Island will cease to provide migration, dispersal, breeding, nesting, and cover habitat for a wide range of migratory birds.

G. Invasive Species

Common invasive species known to be present in Pool 14 include purple loosestrife *(Lythrum salicaria);* curly-leaf pondweed (*Potamogeton crispus)*; Eurasian watermilfoil (*Myriophyllum spicatum)*; Asian clam *(Corbicula fluminea)*; zebra mussel *(Dreissena polymorpha)*; common carp *(Cyprinus carpio)*; reed canary grass *(Phalaris arundinacea);* silver carp *(Hypophthalmichthys molitrix)*; emerald ash borer *(Agrilus planipennis);* and bighead carp *(H. nobilis).*

Invasive terrestrial plants found during the forest inventory include barnyardgrass *(Echinochloa crus-galli)*; winter creeper *(Euonymus fortune)*; Amur honeysuckle *(Lonicera maackii)*; white mulberry *(Morus alba)*; and reed canary grass *(Phalaris arundinacea).*

H. Subsurface Soil Characterization

The Natural Resources Conservation Service (NRCS) publishes soil surveys for most counties in the United States. Information in a pre-published soil survey indicated that the types of soils that are present in and around Beaver Island generally classify as Fluvent-Ambraw soil series, which is described as an alluvium product in the NRCS classification system. This series is described as frequently flooded with a water table that varies between ground surface and 1 foot deep.

I. Subsurface Explorations

The District conducted a subsurface exploration using 4-inch diameter Iwan style hand-augers in order to characterize the composition and engineering properties of soils present at Beaver Island. Borings were taken at locations shown on Plate 4, (B-101).

On each boring, samples were taken at sufficient intervals to classify all the strata encountered. Representative samples were taken for visual classification and moisture content on enough samples to verify classifications. Boring logs can be found on Plate 5, (B-301).

Borings BI-14-01 through BI-14-03 were taken at the downstream end of Beaver Island. The borings were approximately 14 feet deep from the top of water elevation. Below ground surface, a top layer of approximately 5 feet composed of soft lean clays and fat clays showed gradual change in stiffness with increased depth. Underlying this clay layer, until the bottom of the borings, is medium to fine sand approximately 4-6 feet down from ground elevation. Atterberg limit tests were performed on several of the clay samples gathered throughout the site. Results for liquid limits expressed as an index ranged between 51 and 41, and plastic limits expressed as an index ranged between 22 and 20.

Borings BI-14-04 and BI-14-05 were taken downstream and upstream of Upper/Deep Cut Channel, respectively. BI-14-04 showed similar soils composition to those found on borings BI-14-01 through BI-14-03. BI-14-05 showed similar materials to those found in all the other borings, although the thickness of the top clay layer was significantly thinner than the one found on all the other borings. The difference in layer thickness can be directly correlated to higher flow velocity that would not allow the fine sediment to deposit as observed in the other borings.

J. Water Quality

Baseline water quality monitoring was initiated at Beaver Island by the District on December 16, 2008 at sites W-M513.4P and W-M513.5R (Figure II-4; Plate 31, O-101; and Appendix F, *Water Quality*) and continued through September 9, 2015, with eight samples collected during the summer months and three samples during the winter months each full year. Table II-5 is a summary of this discrete, or grab sample, data. In addition to grab samples, multi-parameter water quality monitoring instruments, or sondes, were used to collect more frequent data. Site W-M513.5R is located on an interior channel that traverses most of the length of the island, entering from Beaver Slough near the upper end of the island and exiting into the Mississippi River at the downstream end of the island. This location was chosen to provide data on water flowing into the backwater lakes in the lower portion of Beaver Island. Site W-M513.4P is located in Blue Bell Lake, a backwater “finger” that branches from the interior channel near the lower part of the island. This location was chosen to establish representative pre-Project overwintering habitat conditions because Blue Bell Lake was identified by the Sponsors as the most likely location to restore overwintering habitat. Aquatic vegetation has been observed in the area near site W-M513.4P, but not near site W-M513.5R.

Figure II-4. Water Quality Monitoring Locations

Grab sample results indicate site W-M513.4P had a lower median summer velocity (2.34 cm/sec) than site W-M513.5R (9.90 cm/sec). When only winter measurements are considered, median velocities were 0.41 cm/sec and 2.64 cm/sec at the respective sites. Dissolved Oxygen (DO) concentrations ranged from 0.90 mg/L to 31.95 mg/L, with a summer median of 6.76 mg/L at site W-M513.4P. While at site W-M513.5R, the DO concentration summer median was 6.06 mg/L and the range was narrower, with a minimum of 3.05 mg/L and a maximum of 19.70 mg/L. Eleven DO concentrations were low (less than the target level of 5 mg/L) at site W-M513.4P, with nine occurring during the summer months and two during the winter. At site W-M513.5R, eleven DO concentrations were less than 5 mg/L and all occurred during the summer months. The majority of low DO concentrations at both sites occurred during the summer of 2010, when water levels remained high for most of June through August. During this period, algal numbers were depleted as indicated by the low chlorophyll a concentrations, and the associated reduction in photosynthesis resulted in low DO concentrations. Apparently the flow during this high water period was sufficient to preclude the establishment of significant algal populations. Water temperatures ranged from 0.1 to 30.0°C at site W-M513.4P and -0.1 to 29.2°C at site W-M513.5R. The winter median water temperatures at the respective sites were 1.9°C and 0.3°C.

Continuous water quality monitors were often deployed at the Beaver Island sampling sites during grab sample collection trips. They were typically positioned 1 to 2 feet above the river bottom and were programmed to collect data every 2 hours for a period of about two weeks during the summer and six weeks during the winter. Extended periods of continuous low DO (concentrations less than 5

mg/l) occurred during the summer months at site W-M513.4P from July 15 to 23, 2010, most of June 2011, July 12 to 28, 2011, July 30 to August 9, 2011, and most of June 2015. There were fewer instances of extended low DO concentrations during the summer months at site W-M513.5R: July 3 to 12, 2012 and August 25 to 29, 2012. DO concentrations during the winter at both sites were often supersaturated, but there were occasions when extended periods of continuous low DO were recorded at site W-M513.4P, including the following: January 17 to 24, 2009, January 23 to February 3, 2011, February 4 to 18, 2011 and several days during January and February 2014. The March 6-10, 2014 was the only time DO concentrations below 5 mg/L were observed during the winter months at site W-M513.5R. Snow-covered ice was present during all extended low DO excursions at both sites. Both low DO and supersaturated conditions can be harmful to the fishery.

Similar to selected interior channels within the Huron Island HREP in Pool 18, the main interior channel of Beaver Island also exhibited significant bed load movement during periods of high flow. This became evident when a continuous water quality monitor at site W-M513.5R was buried under sand over a two week deployment. The monitor was deployed on June 8, 2010 when the water depth was 1.1 m. By the following sampling trip on June 22, 2010, the river had risen and the water depth was 2.1 m. Although the signal of the monitor's transmitter could be detected, the instrument could not be retrieved because it had been covered by several inches of sand.

Table II-5. Water Quality Discrete Data Summary

Site	Water Depth (m)	Velocity (cm/sec)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)
W-M513.4P Summer									
Min.	0.510	0.00	19.2	0.90	7.20	18.8	2.0	1.0	1.2
Max.	3.685	32.21	30.0	14.73	8.74	199.0	57.1	62.0	71.0
Avg.	1.481	4.90	24.1	6.70	-	47.9	17.5	24.4	18.3
Median	1.256	2.34	24.0	6.76	7.98	40.4	13.8	23.3	12.0
W-M513.4P Winter									
Min.	0.600	0.10	0.1	3.05	6.83	-	1.9	-	-
Max.	1.960	1.86	9.1	31.95	9.50	-	44.0	-	-
Avg.	0.908	0.54	2.3	15.67	-	-	9.9	-	-
Median	0.760	0.41	1.9	15.69	7.97	-	6.8	-	-
W-M513.5R Summer									
Min.	0.478	0.26	1.0	3.05	7.16	15.0	6.3	9.0	1.3
Max.	3.930	70.36	29.2	10.15	9.02	102.0	66.2	66.0	35.0
Avg.	1.819	16.01	23.5	6.21	-	38.2	22.7	31.2	9.4
Median	1.600	9.90	23.8	6.06	7.82	33.8	18.7	29.1	6.5
W-M513.5R Winter									
Min.	0.850	0.23	-0.1	10.68	6.95	-	3.8	-	-
Max.	2.350	16.77	7.4	19.70	9.00	-	55.2	-	-
Avg.	1.297	3.78	0.9	14.68	-	-	11.1	-	-
Median	1.170	2.64	0.3	14.16	7.80	-	6.1	-	-

K. Hydrology and Hydraulics

Beaver Island is located in the upper third of Pool 14, approximately 22 miles upstream of Lock and Dam (LD) 14 and 7 miles downstream of LD 13. The Mississippi River borders the eastern edge of the island and the Beaver Slough side channel flows along the western boundary. ADM's Clinton plant occupies much of the real estate along Beaver Slough and as a result there are significant fleeting and loading/unloading activities within Beaver Slough.

LD 14 is located near LeClaire, Iowa and was placed into operation in June 1939 to provide navigable channel depths by maintaining a water surface elevation of 571.2 feet NAVD88 (flat pool) or higher. The annual river stage hydrograph is affected by river regulation such that low river stages are maintained higher by the dam during low discharge periods. Pool 14 is regulated using a dam control point, therefore the degree of influence of the impounding dam decreases as you move upstream of the dam where there is increasing fluctuation in river stage (Figure II-5).

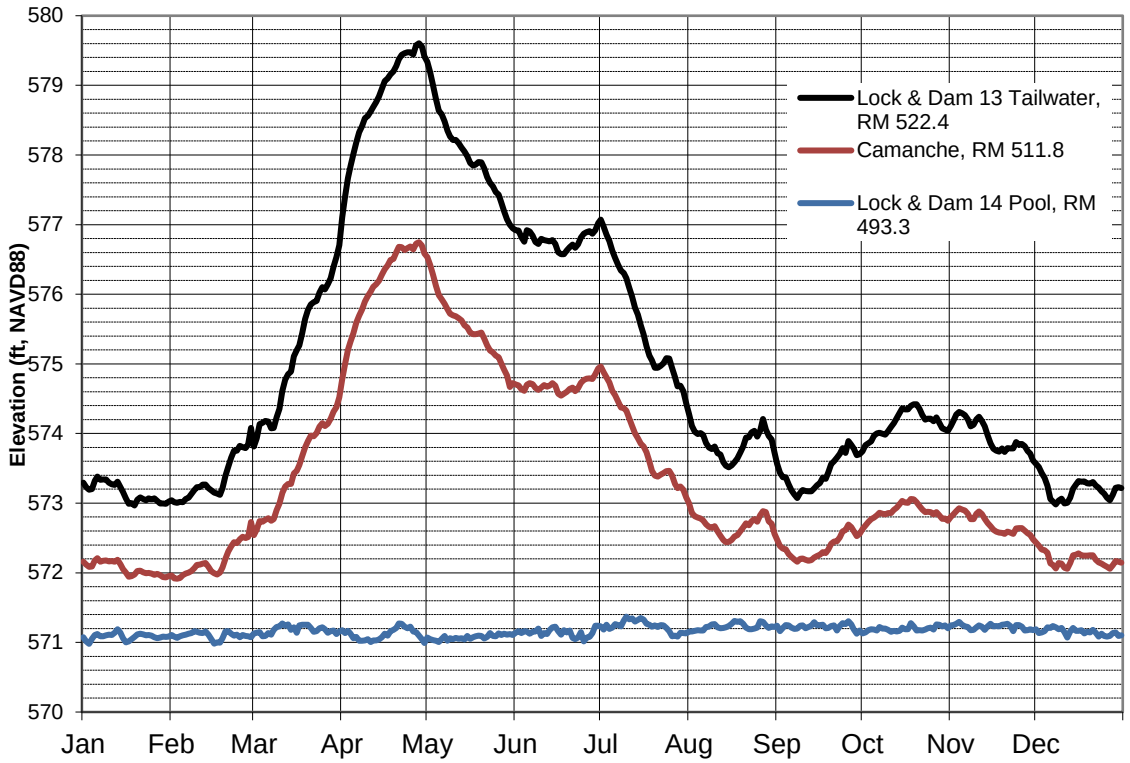

Figure II-5: Average Annual Stage Hydrographs – Upper, Middle, and Lower Portions of Pool 14 1984-2013

The USGS Clinton gage, co-located with the Corps' Camanche gage, is approximately one mile downstream of the island (RM 511.8) and drains an area of 85,600 square miles. Average annual discharge at Clinton/Camanche gage is 56,400 (cfs; period of record 1984-2013). The long-term average annual elevation hydrograph (Figure II-6) illustrates a spring to early summer flood followed by mid to late summer low flows. There is generally a slight pulse through the fall followed by low and more stable flows through the winter.

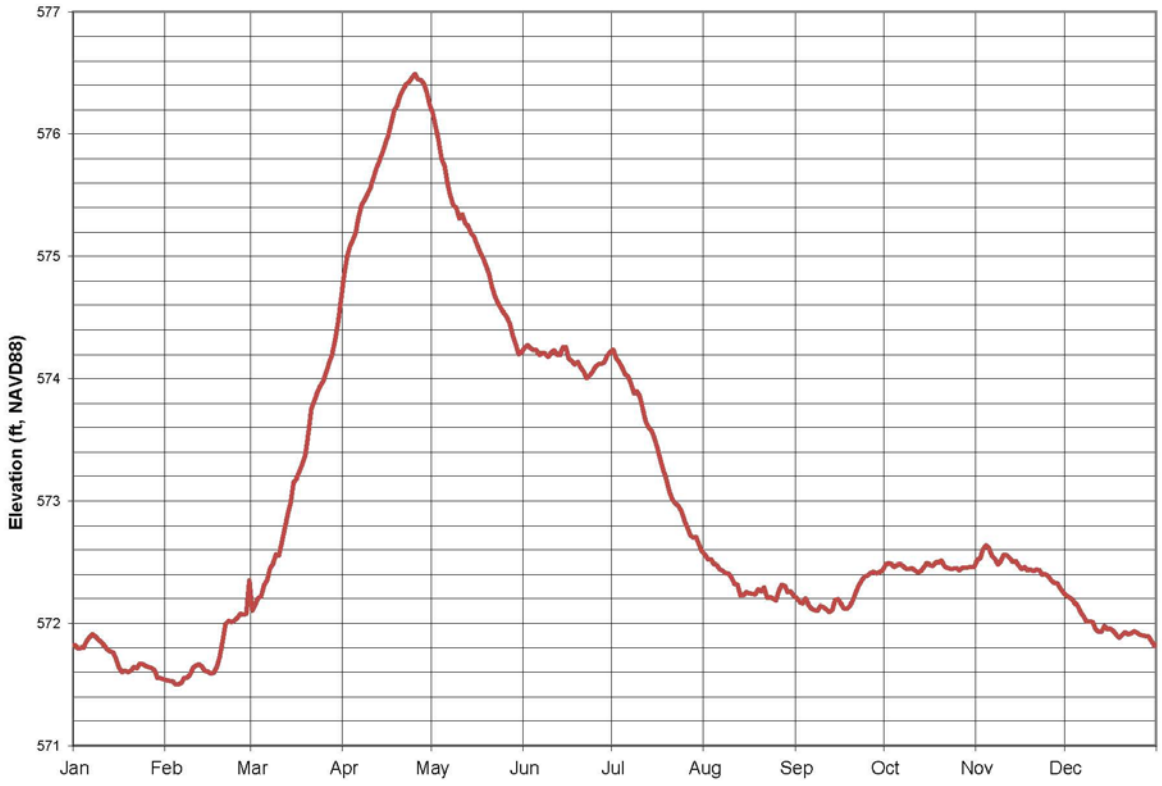

Figure II-6: Average Annual Elevation Hydrograph at the Camanche Gage – 1940-2013

A comparison of annual-elevation duration curves for the most recent 30-year period with the prior 30-year period for the Clinton/Camanche gage is shown in Figure II-7. The annual elevation-duration curve for the current 30-year period (1984-2013) indicates a median river elevation of 573.4 feet and 572.9 feet for the prior 30-year period (1954-1983). This comparison indicates river stages have increased over the last 30 years.

Additional hydrology and hydraulics information can be found in Appendix H.

High water events at the Camanche gage have occurred in 1965, 2001, 1993, 2011 and 1997 (listed in order of decreasing magnitude). The highest flood on record occurred in April 1965 with a river elevation of 587.06 NAVD88.

The Beaver Island interior is comprised of a network of channels and long and narrow backwater lakes. These backwater features include Upper Lake, Lower Lake, Sand Burr Lake, Blue Bell Lake, Stewart Lake, Crappie Slough and many others. Some of these channels convey water throughout the year and others are ephemeral. Albany Island is a small island located near the lower left-descending bank of Beaver Island. During 50% chance exceedance flood conditions, approximately 98% of the Beaver Island complex is inundated (based on adjusted LiDAR data).

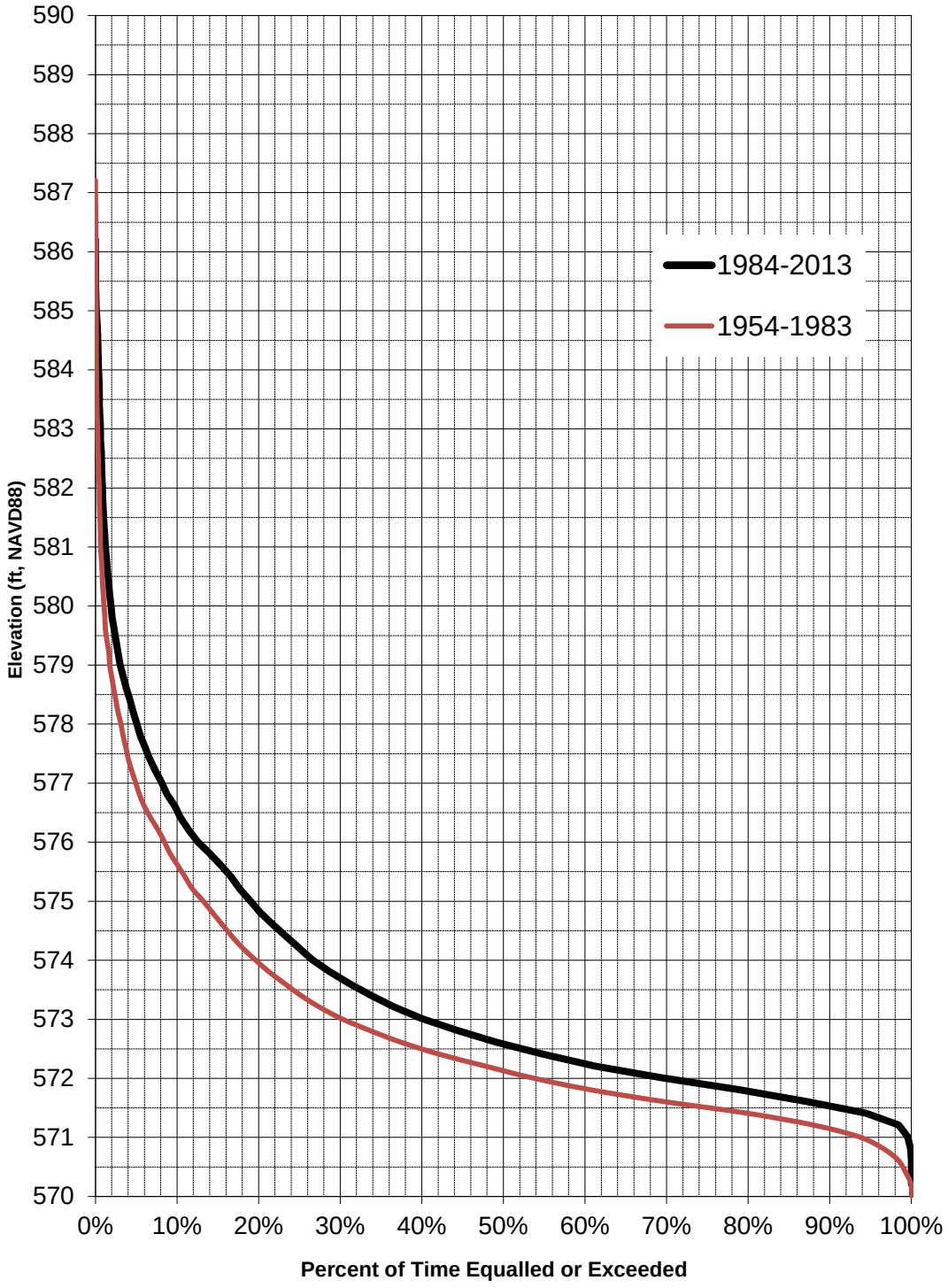

Figure II-7: Comparison of Annual Elevation-Duration Curves for Different Time Periods

Several seasonal duration curves were computed based on the periods critical to habitat targeted for restoration at Beaver Island. Low water conditions which threaten DO concentrations and fish habitat occur during the winter (November through February) and summer (July through August) months. As shown in Figure II-8, the period between November and February represents the more critical conditions for fish. During the overwintering months, a water surface elevation of 572 feet NAVD88 is exceeded 60% of the time at the Camanche gage (70% of the time during the entire year). Due to the location of the Project in the upper portion of pool, it is influenced more by the tail water effect at LD13 rather than the Pool at LD14. Therefore, the 70% exceedance value, rather than flat pool, was chosen to represent typical low water and the reference water surface elevation to distinguish floodplain (above water) from aquatic (below water) habitat.

A duration analysis was also completed for the growing season defined as April 15th through October 15th. A comparison of the median growing season stage for the current 30-year period and the median growing season stage for the prior 30-year period indicates and increase in median stage of over 0.5 foot. As initially occurred when the locks and dams were constructed, longer periods of increased water levels continue to contribute to decreases in species and age diversity among the floodplain forest community.

L. Sediment Deposition

The Wapsipinicon River is the largest tributary to Pool 14 and is located on the Iowa side, approximately 8 miles downstream of the Project. Maintenance dredging within Pool 14 occurs as needed to address shoaling issues impacting navigation. However, channel maintenance activities in Pool 14 are not nearly as frequent as those in other Pools, especially those with significant tributaries. Although there is no major tributary both within Pool 14 and upstream of the Project, sediment from the 85,600 square mile upstream drainage area provide ample sources for sediment delivery. Figure II-9 illustrates the historical dredge cuts near Beaver Island.

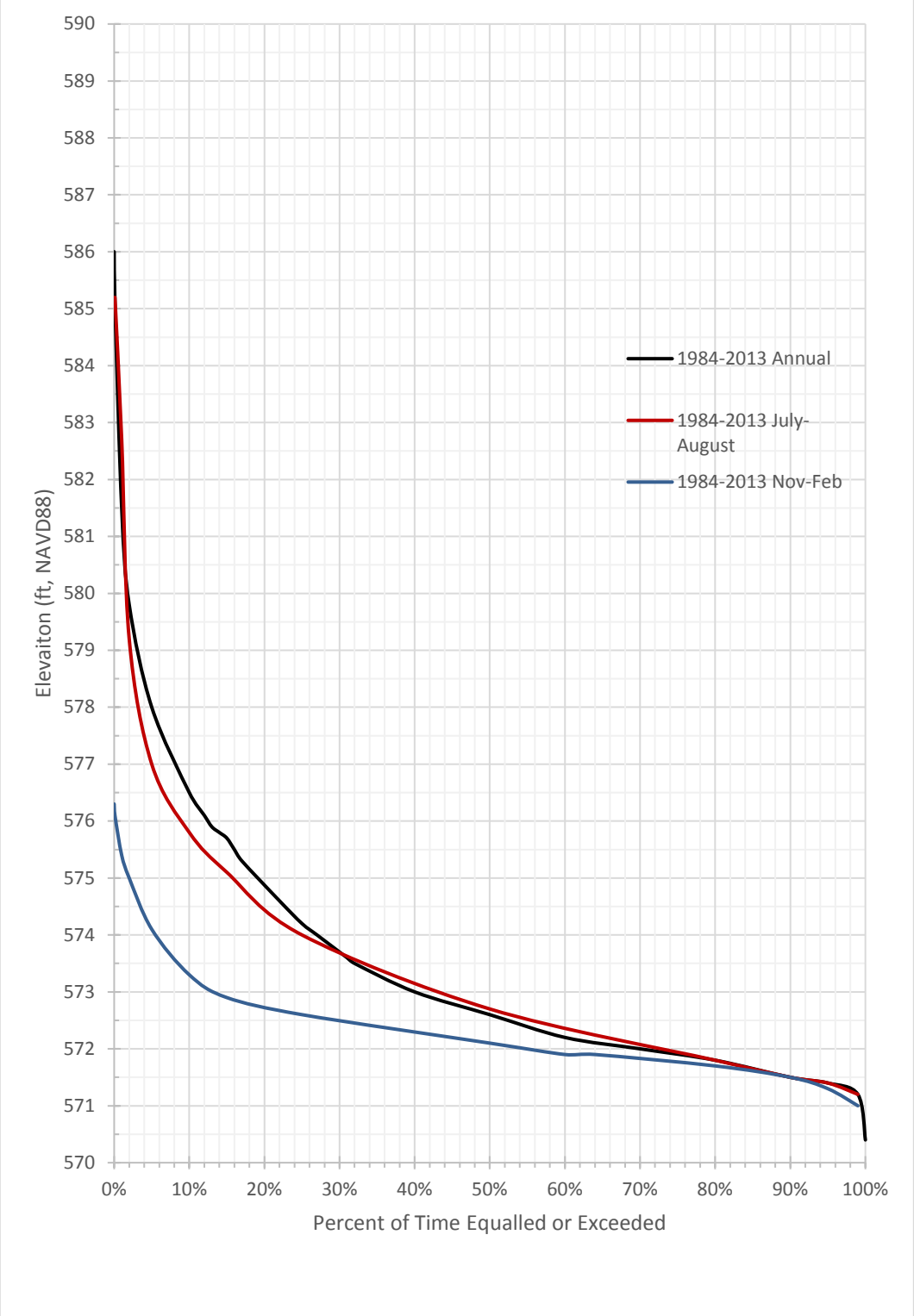

Figure II-8. Comparison of Seasonal and Annual Elevation-Duration Curves for 1984-2013

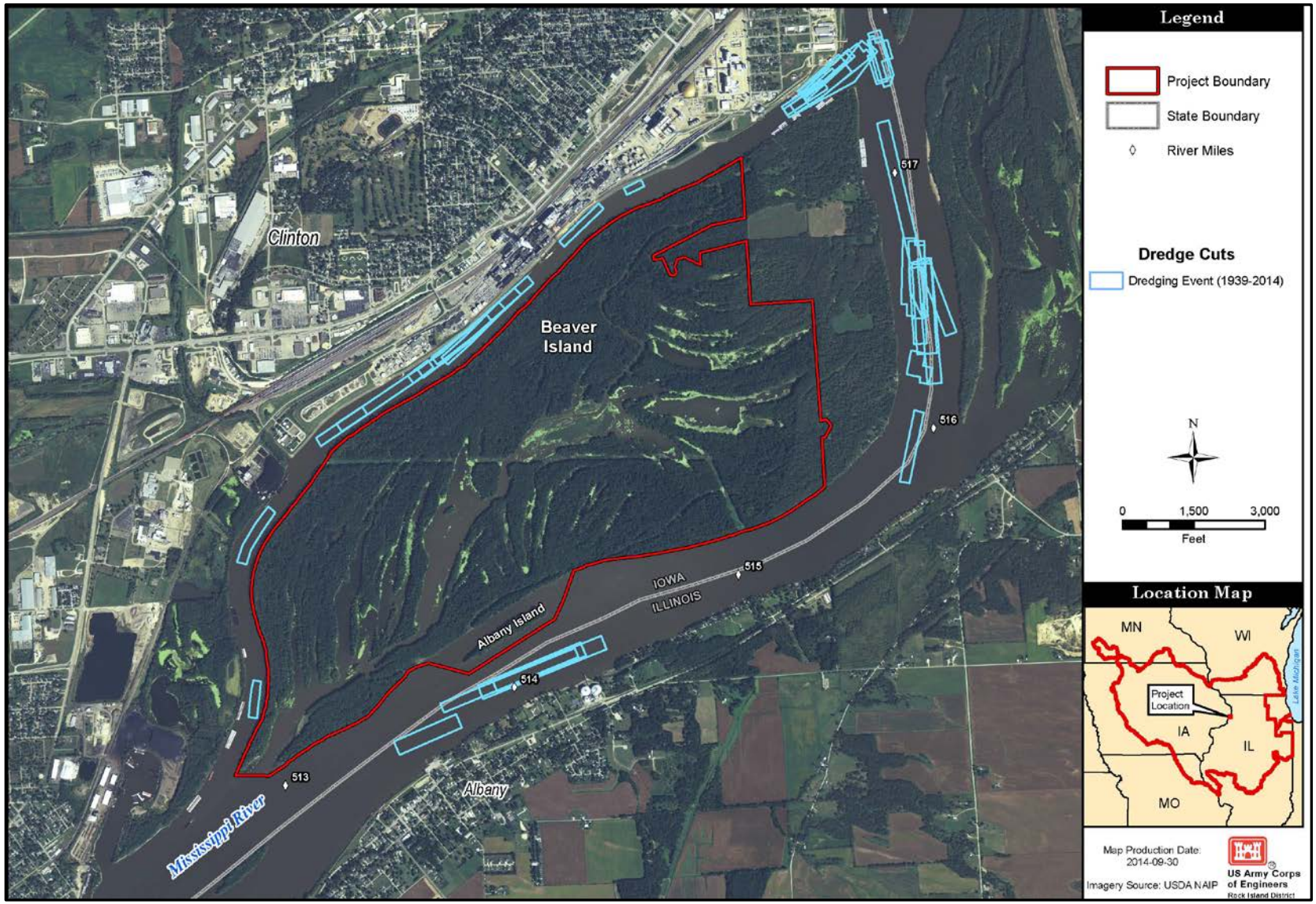

Figure II-9. Historical Dredge Cuts near Beaver Island

Temporal and spatial variability is inherent in the numerous processes that drive sediment deposition, thereby sediment deposition rates are also dynamic. Some of the watershed features that impact backwater sediment deposition rates include geology and soils, land use and other rainfall runoff characteristics of the contributing watershed, in addition to spatial and temporal variability in natural impoundments such as beaver dams. To date, backwater sediment deposition studies within the UMR have focused on Pools 4-10 and Pool 13 (see Appendix H, *Hydrology and Hydraulics* reference list). Results from these studies vary from as much as 4.0 cm/year (Pools 4-10) and as little as 0.2 cm/year (Pool 7). A sediment deposition rate of 0.8 cm/year was reported for Navigation Pool 13 by Rogala, et. al. (Appendix H, *Hydrology and Hydraulics* reference list). Seven backwater sites within Pool 14 were monitored for sediment deposition from 1984 through 2000 by former IADNR biologist, Bill Aspelmeir (Appendix H). Two of these sites were located in Beaver Island; one at the lower end of Upper Lake (Station 5), and the other in the middle of Lower Cut (Station 6). Annual measurements along a transect at each site were collected from 1984-1989 and again in 1994 and 2000. During this field study period, the 1993 flood, the third largest flood on record at the Camanche Gage, occurred, and in 1986 the 12th largest flood on record occurred. Rates range from -0.8 in/year (erosion) to 1.9 in/year of deposition, however the overall trend is toward deposition. The average sediment deposition rate at Stations 5 and 6 based on the study period are 0.8 in/year (2.0 cm/year) and 0.5 in/year (1.3 cm/year), respectively. As a result of the variability in reported values and the inherent variability in sediment deposition rates, an average annual sediment deposition rate of 1 cm/year was assumed for the Beaver Island Project.

M. Historic and Cultural Resources

The Corps reviewed the report, *An Investigation of Submerged Historic Properties in the Upper Mississippi River and Illinois Waterway* (October 1997), prepared by American Resources Group, Ltd. (Contract No. DACW25-93-D-0012, Delivery Order No. 37). No underwater historic properties are documented within the proposed construction locations. The Corps' Geographic Information System archeological file database was queried for both offshore and shoreline locations and no previously recorded submerged historic properties were identified on or near Beaver Island.

Based on the nature of the Project, the Corps contracted Bear Creek Archaeology, Inc. (BCA) of Cresco, Iowa to conduct an archaeological and geomorphological evaluation of Beaver Island. The resulting report is entitled *Phase I Archeological and Geomorphological Survey for the Beaver Island Complex Habitat Rehabilitation and Enhancement Project, Camanche and Clinton Townships, Clinton County, Iowa*, dated December 2014. Messrs. Lowell Blikre and David W. Benn of BCA prepared the report for the Corps Contract W912EK-12-D-0001, Work Order #0012.

In regards to geomorphology, BCA determined that the peripheral islands are very young and have virtually no archeological potential. The margins and southern quadrant of Beaver Island are proto-historic and historic in age and are deemed to have "very low" archeological potential for historic sites. The southern margin and northern interior of Beaver Island are likely to be Late Holocene in age. Much of this landscape is seasonally wet and covered by relatively thick post-settlement alluvium. Its archeological potential is "low to none". Only the central zone of Beaver Island (around the lakes), particularly areas with oak-hickory forest, appears to be old enough and sufficiently well drained to have been occupied by Late Archaic (possibly) and Woodland period peoples. However, based on past experience with floodplain archeology in the center of the UMR Valley, the archeological potential of this zone is deemed to be "low". Only the high ground, particularly the natural levees and crevasse splays, are more likely to have been occupied by prehistoric people if they were visiting the mid-valley floodplain environment surrounding the lakes.

BCA pre-field research identified four portions of Beaver Island that had been surveyed previously and that all of these surveys were outside of the current area of potential effect (APE). The BCA research identified five previously-recorded sites on Beaver Island and 14 additional sites within a 1 mile radius of the APE. None of the sites were recorded within the current APE although BCA reviewed historic maps and aerial photographs of the Project area and identified one potential historic site within the general Project area that had not been previously recorded.

The BCA intensive archaeological survey recorded three newly identified sites, two of which are within the Project area. A multiple occupation bivouac, located near the center of Beaver Island, is interpreted to be a Late Woodland habitation site that possibly contains a Middle Woodland component. Archeological features are likely at this location and this site is recommended as potentially eligible for nomination to the National Register of Historic Places (NRHP). BCA recommends that this site be avoided or, if avoidance is not possible, a Phase II investigation be accomplished. A single occupation bivouac, located near the center of Beaver Island, is interpreted to be a prehistoric encampment that possibly contains Late Archaic and Middle-Late Woodland components. Archeological features are likely at this location and this site is recommended as potentially eligible for nomination to NRHP. BCA recommends that this site be avoided or, if avoidance is not possible, a Phase II investigation be accomplished.

N. Socioeconomic Resources

The Beaver Island HREP is dominated by an undeveloped forested area and has little residential populations within the Project area. The Project is located in Pool 14 on the Mississippi River, which flows through Clinton and Scott counties, Iowa as well as Rock Island and Whiteside counties, Illinois. The land in these four counties is used primarily for agriculture, but there is also significant industrial development, especially in the City of Clinton as shown on Figure II-10 and Table II-6.

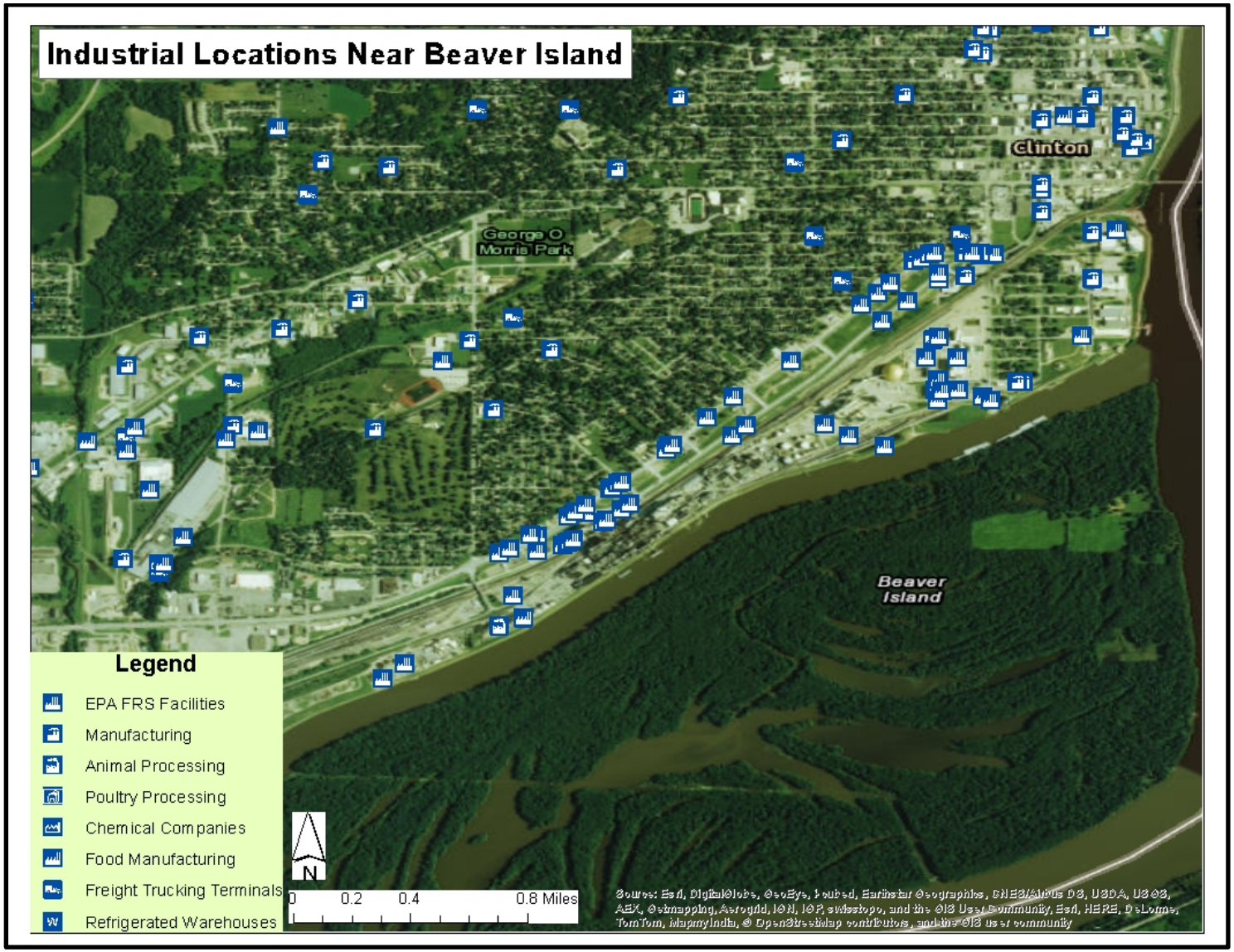

Figure II-10. Industrial Locations near Beaver Island

Table II-6. Mississippi River Pool 14 Business and Industry Distribution by County

Mississippi River Pool 14 Business Activities and Distribution of Industry						
	Number of Establishments					
Major Industry	**Scott County IA**	**Clinton County IA**	**Rock Island IL**	**Whiteside County IL**	**Total**	**% of Total**
Agriculture, Forestry, Fishing and Hunting	5	8	3	4	**20**	0.2%
Mining, Quarrying, and Oil and Gas Extraction	6	2	6	2	**16**	0.2%
Utilities	10	4	9	3	**26**	0.3%
Construction	452	114	229	129	**924**	9.2%
Manufacturing	175	54	154	86	**469**	4.6%
Wholesale Trade	314	50	174	76	**614**	6.1%
Retail Trade	631	190	469	189	**1,479**	14.6%
Transportation and Warehousing	126	70	102	52	**350**	3.5%
Information	65	23	46	19	**153**	1.5%
Finance and Insurance	303	88	216	99	**706**	7.0%
Real Estate and Rental and Leasing	182	37	111	38	**368**	3.6%
Professional, Scientific, and Technical Services	404	59	287	76	**826**	8.2%
Management of Companies and Enterprises	34	2	25	6	**67**	0.7%
Administrative and Support and Waste Management and Remediation Services	244	57	143	41	**485**	4.8%
Educational Services	45	7	37	9	**98**	1.0%
Health Care and Social Assistance	496	132	426	96	**1,150**	11.4%
Arts, Entertainment, and Recreation	74	24	48	18	**164**	1.6%
Accommodation and Food Services	423	112	370	123	**1,028**	10.2%
Other Services (except Public Administration)	417	147	406	177	**1,147**	11.4%
Industries not classified	2	1	2	1	**6**	0.1%
Total	**4,408**	**1,181**	**3,263**	**1,244**	**10,096**	
% of Total	43.7%	11.7%	32.3%	12.3%		

Source: http://censtats.census.gov/cgi-bin/cbpnaic/cbpsect.pl

Table II-7 shows cumulative acreage totals for Clinton, Scott, Rock Island, and Whiteside Counties classified by land and water resource descriptions. This information was retrieved from the 2014 USDA National Agricultural Statistics Service Cropland Data Layer.

Table II-7. Land and Water Resource Acreages for Pool 14 Counties

Class Name	Acres
Corn	595,278
Soybeans	309,997
Grassland/Pasture	156,779
Deciduous Forest	129,864
Developed/Open Space	83,070
Developed/Low Intensity	59,647
Open Water	42,434
Woody Wetlands	41,533
Developed/Medium Intensity	27,338
Alfalfa	13,030
Developed/High Intensity	11,781
Herbaceous Wetlands	7,028

Existing socio-economic information for Iowa and Illinois counties near Beaver Island is as follows:

Iowa Counties: With an average population density of 361 people per each of its 459 square miles (2010), Scott County, Iowa experienced an 8.0% increase in total population from 158,668 to 171,387 people during the years 2000 to 2014 (2014 estimated). The median household income is estimated at $52,735, with 13.1% of persons living below the poverty level (2009-2013). Income per capita is $28,948 (2013). Of persons over 25 years of age, 92.3% have a high school education or higher and 31.6% have a bachelor's degree or higher (2009-2013).

With an average population density of 71 people per each of its 695 square miles (2010), Clinton County, Iowa experienced a 4.2% decrease in total population from 50,149 to 48,051 people during the years 2000 to 2014 (2014 estimated). The median household income is estimated at $49,559, with 14% of persons living below the poverty level (2009-2013). Income per capita is $25,966 (2013). Of persons over 25 years of age, 90% have a high school education or higher and 17.7% have a Bachelor's degree or higher (2009-2013).

Illinois Counties: With an average population density of 345 people per each of its 427 square miles (2010), Rock Island County, Illinois experienced a 2.2% decrease in total population from 149,374 to 146,063 people during the years 2000 to 2014 (2014 estimated). The median household income is estimated at $48,702, with 13.3% of persons living below the poverty level (2009-2013). Income per capita is $26,455 (2013). Of persons over 25 years of age, 87.4% have a high school education or higher and 21.8% have a Bachelor's degree or higher (2009-2013).

With an average population density of 85 people per each of its 684 square miles (2010), Whiteside County, Illinois experienced a 6.2% decrease in total population from 60,653 to 56,876 people during the years 2000 to 2014 (2014 estimated). The median household income is estimated at $47,667, with 12% of persons living below the poverty level (2009-2013). Income per capita is $24,525 (2013). Of persons over 25 years of age, 87.4% have a high school education or higher and 16.2% have a Bachelor's degree or higher (2009-2013).

Along with non-monetary ecosystem restoration benefits that are measured in terms of increased habitat units per targeted species, potential economic benefits of habitat restoration also exist. These benefits can include an enhanced quality of life for humans, making it a more attractive location for business and new residential development. In addition, recreational activities tend to increase in

relation to cleaner, more inhabitable water. Increased recreation then creates an economic multiplier, or ripple effect for tourism growth in affected areas. Affected areas of successful ecosystem restoration projects will almost certainly extend far beyond the boundaries of the Project area itself.

O. Hazardous, Toxic, and Radioactive Waste

Phase I and Phase II Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessments (ESA) for the Beaver Island HREP were conducted. The Phase I and Phase II ESAs were completed in accordance with Engineering Regulation (ER) 1165-2-132, *HTRW Guidance for Civil Works Projects*; ER 405-1-12, R*eal Estate Handbook*; ASTM Practice E 1527-13, and ASTM Practice E 1903-11.

The Phase I ESA revealed evidence of a Recognized Environmental Condition (REC) that could potentially affect the Project area. The REC consists of the historic and extant presence of industrial and commercial activity immediately adjacent to the Project area, as well as a documented release of hydraulic oil into Beaver Slough.

This REC had the potential to impact sediments within the Project area. As such, HTRW soil sampling was completed in March 2014 in select areas where sediments could be potentially disturbed during HREP construction or operation. Five borings were installed to depths of 8 to 12 feet below the sediment surface. Soil samples were collected from each boring and laboratory analyzed for pH, Volatile Organic Compounds, Semi-Volatile Organic Compounds, heavy metals, and Polychlorinated Biphenyls. The laboratory analytical results were compared to the IADNR Soil Standards (Chapter 137 Land Recycling Program) and the U.S. Environmental Protection Agency (USEPA) Region 9 Soil Screening Levels. No chemicals of concern were detected that were above the standards.

Based on the Phase 1 ESA and subsequent Phase II HTRW investigation, no further HTRW assessment is recommended. In addition, no restrictions are required on the proposed HREP measures (Appendix E, *Hazardous, Toxic, and Radioactive Waste*).

III. PROBLEMS AND OPPORTUNITIES

A. Problems and Opportunities Identification

Human activity over the past two centuries within the UMR basin, floodplain, and channel has altered the hydrology, topography, and biotic communities historically present. These alterations have reduced the diversity and quality of aquatic habitat and reduced the acreage and diversity of the native floodplain.

Problem. Loss of Diverse Aquatic Habitat. Backwater fisheries habitat is an important component of the Mississippi River ecosystem. This type of habitat has declined in most of the UMRS with the leveling effects of sediment deposition in off-channel areas. The regular occurrence of maintenance dredging in Pool 14, exemplifies the sediment deposition problem occurring in this reach. Benthic organisms such as mussels play a significant role in aquatic ecosystems. North America has the highest diversity of freshwater mussels in the world. The highest mussel richness is found in the Mississippi ecoregion. Currently more than half of the 78 known species are in some form of Federal or state listing. An existing mussel bed near Albany Island is endangered by ongoing erosion of Albany Island, which over time will increase flow and sedimentation levels.

Opportunity. Restoration of backwater areas would improve habitat conditions for a large variety of backwater and channel fish species and mussels. There is an opportunity to increase overwintering habitat, improve spawning habitat, and increase nursery/rearing habitat to produce year round habitat within the Project. Year-round habitat would include a diversity of water velocities (including <1 cm/sec during winter), adequate water depths (> 4 feet), aquatic vegetation, desirable dissolved oxygen concentrations from 5 mg/L to supersaturation (based on water temperature, pressure, and dissolved oxygen concentration), and a diversity of substrates and structure. Protecting Albany Island from erosional forces would maintain and improve the mussel habitat present in Albany slough

Problem. Loss of Acreage and Diversity of Native Floodplain Forest. The entire UMRS has undergone dramatic changes in the extent, composition, and structure of its floodplain forests over the last two centuries. The report *Ecological Status and Trends of the Upper Mississippi River System,* found that what was once a diverse forest composed of mixed silver maple, willow, cottonwood, oak-hickory, swamp cypress, shrub, and plantation communities is now nearly 80% mixed silver maple. Lack of mast-tree regeneration, reduction of species diversity, and increased tree mortality can be directly attributed to the increase in flood frequency and duration over time. These losses in habitat value limit the present and future ability of the Project area to attract and sustain a diverse community of resident and migratory wildlife species.

Opportunity. There is an opportunity to restore and enhance the age, composition and structure of the current Beaver Island floodplain forest and to enhance the diversity of the floodplain forest habitat. Floodplain forests are essential life support systems to a tremendous array of wildlife species. The variety of floodplain forest types and the associated plant and tree communities historically found on Beaver Island provide necessary habitat for a large number of animal species.

B. Future Without Project Conditions/No Action Alternative. Under the National Environmental Policy Act (NEPA), the No Action Alternative is necessary to provide a reference point, enabling a comparison of environmental effects of the action alternatives. Due to either avoidance or no existing resources present, cultural, HTRW, socioeconomics, and man-made resources were all determined as

not having foreseeable impacts both with and without project. The PDT determined hydrology and hydraulics, aquatic habitat, and floodplain habitat as resources that would be significantly impacted with the No Action Alternative. In other words, without intervention these resources will continue to degrade, emphasizing the importance of the project.

1. Hydrology and Hydraulics. As illustrated in Figure II-7, river stages have increased. As the stage duration at Camanche, Iowa, increases, so does the duration of island inundating flows. The Hydrologic Engineering Center's Ecosystem Functions Model (HEC-EFM) was used to identify topographic elevations necessary to support a diverse floodplain forest community provided the current hydrologic regime. The results of this analysis, as described in Appendix H, indicate that many areas should be increased in elevation by several feet in order to improve and sustain a diverse forest community. Without these Project measures we would expect inundation durations associated with tree mortality to continue to increase and result in a greater loss of floodplain forest diversity.

Without action, sediment deposition within the Beaver Island backwater lakes is expected to continue. If sediment deposition rates as high as 1 cm/year, continue over the 50-year period of analysis, deposition of as much as 1.6 feet of sediment or greater may occur within the backwater areas.

2. Aquatic Habitat. If the Beaver Island HREP was subjected to an average sediment deposition rate of 1 cm/year over the next 50 years (1.6 feet total), backwater habitat would be reduced by about 60%. It is unlikely the loss would be linear as most sediment deposition occurs during flooding events. Nonetheless, over time backwater habitat would be reduced from roughly 178 acres to a little over 70 acres. It is anticipated the existing interior flowing channels will continue to exist, but may shift location. Remaining lentic habitat will consist of isolated interior shallow pools with fish access only during high water events. Beaver Island HREP numbers are comparable to predictions made for Pool 14 during the Cumulative Effects Study (West Consultants Inc. 2000) (Table III-1). The study also projected an overall loss of backwater aquatic habitat, but minimal loss of flowing channels.

Table III-1. Cumulative Effects Study: Predicted Future Conditions for Pool 14 Aquatic Habitats (WEST Consultants, Inc. 2000)

		Acres of Aquatic Habitat by Strata					
	Year	**Main Channel**	**Secondary**	**Contiguous Backwater**	**Isolated Backwater**	**Island Area**	**Island Perimeter**
Pool 14	1989	6,597	1,396	1195	254	3,408	432,550
	2050	6,597	1,396	908	195	3,408	295,495
	% Change	**0%**	**0%**	**-25%**	**-23%**	**0%**	**-32%**

It is probable that Beaver Island will continue to provide spawning habitat based off of future floodplain conditions. Rearing and foraging habitat currently provided by the interior backwaters will be substantially reduced as remaining pool habitat will have impaired water quality or restricted access during average flows. Consequently, summer habitat will either shift to another backwater complex or other flowing channels, if available, in Pool 14. Finally, overwintering habitat will continue to be of low quality within the interior backwaters of the Project.

Without intervention, Albany Island will continue to erode and be reduced to near zero island habitat within 50 years. Albany Slough would cease to function as spawning, resting, and foraging habitat for a variety of riverine species. Any current flow refuge offered to migratory fish would be reduced to zero. Flow gradients created by the islands and sought after by foraging fish would be eliminated.

Water velocity and substrate changes resulting from a shift from secondary channel to main channel border would likely result in negative impacts to current mussel communities.

3. Floodplain Habitat. Influencing factors at Beaver Island have resulted in a lack of topographic diversity due to increased water levels and limited forest regeneration due to increased water inundation and duration. As such, the forest is dominated by over-mature even-aged silver maple stands, with limited regeneration, and decreasing numbers of nut producing trees. Current topography shows a significant portion of the Project area is low in elevation and below the threshold for producing a sustainable nut producing tree population. It is highly unlikely nut producing trees will regenerate without intervention in the next 50 years.

Based on the current age structure, it is anticipated that a large percentage of the current forest will experience mortality over the next 50 years. Without a new cohort of trees in the understory, canopy openings are filled with non-desirable species. Essentially, the forest slowly converts to a habitat replaced by moist soil vegetation and reed canary grass, which has far less habitat value to floodplain wildlife.

Achievement of a healthy age distribution and species diversity of floodplain trees increases the numbers of nut producing trees and provides the conditions (i.e., increased elevation) to restore a sustainable diverse forest. This is very important to neotropical migratory birds and other floodplain wildlife. A conversion of diverse forest to shrub-scrub habitat or silver maple monoculture would alter the structure of the wildlife community. Areas converting to shrub-scrub would no longer support a diverse migratory bird community as forest fragmentation is detrimental to migration and breeding. Species preferring the habitat structure provided by silver maples will increase and those requiring the structure and/or mast provided by cottonwood, elm, and oak will likely decline.

C. Resource Significance

Due to the challenges associated with comparing non-monetized benefits, the concept of output significance plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem outputs will help determine whether the proposed investment is worth its cost and whether a particular alternative should be recommended. Statements of significance provide qualitative information to help decision makers evaluate whether the value of the resources of any given restoration alternative are worth the costs incurred to produce them. The Water Resources Council's Principles and Guidelines (1983) ER 1105-2-100 define significance in terms of institutional, public, and technical recognition (Table III-2).

Institutional Recognition: 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 statements 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.

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.

Technical Recognition: Technical recognition means that the resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment 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 (e.g., ecosystem, landscape, or ecoregion) 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, critical habitat, 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 ecosystems 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 Trends* measures the relationship among 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 other significant natural habitats.
- *Critical Habitat* is habitat that is essential for the conservation, survival, or recovery of one or more species.
- *Limiting Habitat* is the measure of resources present supporting significant species.
- *Biodiversity* is a measure of the variety of distinct species and the genetic variability within them.

Table III-2. Beaver Island Resource Significance

		Sources of Significance		
Resource	**Location**	**Institutional Recognition**	**Public Recognition**	**Technical Recognition**
Aquatic Habitat (including backwater)	Beaver Island is part of the UMR National Wildlife and Fish Refuge.	Fish and Wildlife Conservation Act of 1980 Clean Water Act UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2006) National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy UMR Wildlife and Fish Refuge Act of 1924 Fish and Wildlife Coordination Act, as amended (16 U.S.C. § 661) National Wildlife Refuge System Administrative Act of 1966 National Wildlife Refuge System Improvement Act of 1997	In 1986, Congress designated the UMRS as both a nationally-significant ecosystem and a nationally-significant navigation system. The National Research Council's Committee on Restoration of Aquatic Ecosystems has targeted the UMR and the IL River for restoration as 2 of only 3 large river-floodplain ecosystems so designated. 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. The FWIC, a committee of state and Federal natural resource specialists who work on Pools 11-22, has identified backwater complexes in Pool 14 as priority areas in need of habitat restoration. 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. The River was a "special mention" on the 2011 list. The public recognizes the backwaters and side channels of Pool 14 as a locally and regionally important recreational fishery.	***Representativeness:*** Many of the important recreational and commercial fish species (e.g., bluegill, largemouth bass, black and white crappie, catfish, and buffalo species) are commonly found in the backwaters of Beaver Slough during different times of the year. ***Scarcity/Limiting Habitat*:** Beaver Island contains approximately 178 acres of aquatic habitat. The site offers both lentic (i.e., backwater; 159 acres or 89%) and lotic (i.e., riverine; 19 acres or 11%) general aquatic habitat types. The existing backwaters are limited with respect to high quality overwintering habitat. Of the available backwater habitat, only about 5% is suitable depth for overwintering. Even so, much of the existing overwintering area experiences higher flows or low DO (<3 mg/L) in the winter.

Table III-2. Beaver Island Resource Significance

		Sources of Significance		
Resource	**Location**	**Institutional Recognition**	**Public Recognition**	**Technical Recognition**
Threatened & Endangered Species	Beaver Island is part of the UMR National Wildlife and Fish Refuge	Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661) Endangered Species Act (ESA) of 1973, as amended UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2006) National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy USFWS's recovery plan for Higgins eye (USFWS 2004) National Wildlife Refuge System Administrative Act of 1966 National Wildlife Refuge System Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924	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; prairie bush clover; western prairie fringed orchid; Higgins eye pearlymussel; and Iowa Pleistocene snail as federally-endangered or threatened species that have the potential to occur within Clinton County, IA. 14 federally-threatened northern long-eared bats were captured during a survey at Beaver Island. Three of the northern long-eared bats were fitted with a radio-transmitter and tracked to 5 individual day roosts, 4 of which are within the Project area, and one located 25 ft outside the Project boundary ***Scarcity:*** There is 1 EHA listed in the Higgins eye recovery plan in Pool 14. The federally-endangered Higgins eye pearlymussel has been found in the Project area, with 1 found at Albany Slough during the 2014 survey.

Table III-2. Beaver Island Resource Significance

		Sources of Significance		
Resource	**Location**	**Institutional Recognition**	**Public Recognition**	**Technical Recognition**
Migratory Birds	Beaver Island is part of the UMR National Wildlife and Fish 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 Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661) National Wildlife Refuge System Administrative Act of 1966 National Wildlife Refuge System Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924 UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2006)	Migratory birds provide the public with recreational opportunities, such as bird watching and hunting.	***Representativeness:*** Numerous migratory birds utilize Beaver 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 Beaver Island forest community have contributed to a reduction in diversity of habitat over time. These changes are likely to continue, and without intervention, Beaver Island will cease to provide migration, dispersal, breeding, nesting, and cover habitat for a wide range of migratory birds.

Table III-2. Beaver Island Resource Significance

		Sources of Significance		
Resource	**Location**	**Institutional Recognition**	**Public Recognition**	**Technical Recognition**
Floodplain Forests	Beaver Island is part of the UMR National Wildlife and Fish Refuge	Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661) ESA of 1973, as amended UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2006). National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy National Wildlife Refuge System Administrative Act of 1966 National Wildlife Refuge System Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924	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:*** Beaver Island contains approximately 1,500 acres of floodplain habitat. ***Status and Trend:*** The majority of the island is located at or below an elevation of 576 ft, which is an elevation shown to be the threshold for optimal survival, growth, and sustainability of mast trees (i.e., nut producing trees) (DeJager et al. 2012; Guyon et al. 2012). The areas with mast trees present were on average over 88 years (ranged 1874 to 1964) old and contained little production in the understory. The largest concern is without intervention, the Project area is likely to experience forest fragmentation and an influx of invasive species, essentially transitioning from forest to grassland over time (Guyon et al. 2012). Consequently, neotropical and other migratory birds, Indiana bats, and the other floodplain species that rely on the forest resources will be severely impacted. ***Limiting Habitat:*** During a 2015 forest inventory, mast tree species recorded totaled 10 different species in the overstory including red oak and black walnut. Those species are not normally found in the floodplain in this region due to flood intolerance.

Table III-2. Beaver Island Resource Significance

		Sources of Significance		
Resource	**Location**	**Institutional Recognition**	**Public Recognition**	**Technical Recognition**
Mussels	Beaver Island is part of the UMR National Wildlife and Fish Refuge	Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661) ESA of 1973, as amended UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2006). National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy National Wildlife Refuge System Administrative Act of 1966 National Wildlife Refuge System Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924	Freshwater mussels are of unique ecological value as natural biological filters, food for fish and wildlife, and indicators of good water quality. In the United States, some species are commercially harvested for their shells and pearls.	***Representativeness:*** 886 mussels (17 species) were collected at 12 different sample sites during the Aug 14, 2014 mussel survey at Albany Slough. The most abundant mussel species (60% of the mussels collected) was threeridge. Plain pocketbook and wabash pigtoe comprised 18% and 11% of the collected individuals. ***Scarcity:*** Albany Slough appears to harbor around 17 live unionid species, including the federally-endangered Higgins eye pearlymussel. ***Status and Trend:*** Without Albany Island, the side channel ceases to function as a secondary channel and likely converts to main channel border habitat, likely having a negative impact on the mussel community currently inhabiting the slough.

The Water Resources Council's Principles and Guidelines (1983) define significance in terms of institutional, public, and technical recognition. Backwater habitats on the UMR are a significant resource. In 1986, Congress designated the UMRS as both a nationally significant ecosystem and a nationally significant navigation system. The National Research Council's Committee on Restoration of Aquatic Ecosystems has targeted the UMR and the Illinois River for restoration as two of only three large river-floodplain ecosystems so designated. The Upper Mississippi River Basin Association advocates for restoration of habitat on the Upper Mississippi River. In addition, the UMRCC, made up of UMR resource professionals, is also a strong advocate for habitat restoration on the river. The UMRCC recognized the importance of the floodplain forest to the fish and wildlife of the UMR in the report, *Upper Mississippi and Illinois River Floodplain Forests* (Urich et al., 2002). The report describes the habitat significance of the forest, describes the changes in the floodplain forests, and recommends management actions to restore the species, age, and structural diversity of the forest. Knutson et al. (1996) described the importance of floodplain forest in the conservation and management of neotropical migratory birds. The UMR floodplain forest is dominated by flood tolerant species such as silver maple, cottonwood, and green ash.

Beaver Island is part of the Upper Mississippi River National Wildlife and Fish Refuge. Refuge objectives, detailed in Section III.F., include maintaining and enhancing the habitat of fish and other aquatic life on the UMR (USFWS CCP 2006).

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. Regional groups also recognize the importance of backwater habitats and floodplain forests. The public recognizes the backwaters and side channels of Pool 14 as a locally and regionally important recreational fishery.

The Fish and Wildlife Interagency Committee (FWIC), a committee of state and federal natural resource specialists that work on Pools 11-22, has developed Environmental Pool Plans to address navigation and restoration needs. The FWIC has identified backwater complexes in Pool 14 as priority areas in need of habitat restoration. These areas were identified as priority areas for restoration as part of the UMR-Illinois Waterway System Navigation Study (DeHaan et al. 2003).

Fisheries biologists recognize the importance of off-channel deep water habitat to overwintering and year-round habitat to fish. Fisheries biologists have identified overwintering habitat as a limiting factor for centrarchid populations (Bodensteiner and Lewis, 1992 and 1994, Gent et al. 1995, Sheehan et al. 2000a and 2000b) and are continuing research on winter habitat selection of centrarchid fishes (Pitlo 2003, Steuck 2010).

D. Upper Mississippi River System Ecosystem Restoration Objectives

Formal planning for the Upper Mississippi River System (UMRS) ecosystem management and restoration has been an ongoing process that was institutionalized in the 1970s with a Comprehensive Master Plan completed by the Upper Mississippi River Basin Commission in 1982. The Master Plan proposed an outline for the Environmental Management Plan (EMP) (now UMRR) which was authorized in WRDA 1986. UMRR has been a National leader in ecosystem restoration planning and implementation for 30 years. UMRR partners have participated in several project planning cycles to develop regional ecosystem restoration needs and priorities. Their prior experience and strong interagency relationships provided the foundation to develop the ecosystem restoration component of

the Navigation and Ecosystem Sustainability Program (NESP) which was authorized in WRDA 2007. Program partners understand the interrelated information needs of multiple navigation and ecosystem restoration programs, so Reach Planning was conducted to identify ecosystem objectives and subareas where they can be achieved in a program-neutral fashion. Reach Planning relied on participants from River Management Team workgroups including the Fish and Wildlife Work Group in the Upper Impounded Reach; the FWIC in the Lower Impounded Reach; the Illinois River Work Group on the Illinois River; and the River Resource Action Team in the Unimpounded Reach (also the Lower Impounded Reach and the Illinois River)..

The *Upper Mississippi River System – Ecosystem Restoration Objectives 2009* 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 technical basis for investment decisions through 2013 and as a backdrop for the formulation of specific restoration projects and their adaptive management (AM) components.

The reach planning process leads to the identification of high priority areas for restoration of natural river processes (as required by Section 8004 of WRDA 2007). The reach planning process also provides context for formulating project measures, defining performance measures, and designing monitoring plans.

The Reach Planning framework emphasized system-wide environmental goals, implementation guidance to achieve objectives, considerations of scale and connectivity, and then identified a stepwise process for setting ecosystem restoration objectives that included: identifying unique characteristics, historic, existing, and future conditions, stressors, objectives, performance criteria, and indicators. Goals and objectives for condition of the river ecosystem are central to river management, and are linked to other elements of the framework.

1. **Over-Arching Ecosystem Goal:** ***To conserve, restore, and maintain the ecological structure and function of the UMRS to achieve the vision.***

2. **Ecosystem Goals**
    - Manage for a more natural hydrologic regime
    - Manage for functions that shape diverse and dynamic channels and floodplain
    - Manage for natural materials transport and processing functions
    - Manage for a diverse and dynamic pattern of habitats to support native biota
    - Manage for viable populations of native species within diverse plant and animal communities

3. **Lower Impounded Floodplain Reach.** The Beaver Island Project area is within the Lower Impounded Floodplain reach. Objectives for the reach include:
    - A more natural stage hydrograph
    - Naturalize the hydrologic regime of tributaries
    - Increased water clarity
    - Reduced nutrient loading from tributaries to rivers

- Reduced sediment loading and sediment resuspension in backwaters
- Increased storage and conveyance of flood water on the floodplain
- Restored backwater areas
- Restored bathymetric diversity, and flow variability in secondary channels, sand bars, shoals, and mudflats
- Restored habitat connectivity
- Restored riparian habitat
- Restored lower tributary valleys
- Restored floodplain topographic diversity
- Restored diversity and extent of native communities throughout their range in the UMRS
- Diverse and abundant native aquatic vegetation communities
- Reduced adverse effects of invasive species

E. Environmental Pool Plans

The FWIC of the River Resources Coordinating Team created Pool Plans in September of 2002 which established common habitat goals and objectives for the UMR. The following resource problems for Pool 14 and proposed actions specific to Beaver Island are taken directly from the report *Environmental Pool Plans, Corps of Engineers, Rock Island District, Mississippi River, Pools 11-22.*

1. Resource Problems

- Fine sediments are accumulating at accelerated rates within backwaters and other floodplain sites due to high suspended sediment concentrations and the reduced sediment transport capability of the navigation project.
- Habitats critical to migratory birds must be maintained, especially aquatic food resources and woodlands
- Coarse sediments, or bed load sediments, accumulate in side channels where they fill valuable habitats and restrict flows.
- An elevated water table favors moisture tolerant forest species and limits potential for species diversity.
- Watershed discharges into Pool 14 contribute to significant water quality and habitat problems, which impact natural resources. Issues include accelerated sediment deposition, and associated nutrient and contaminate delivery and urban and industrial discharges.
- Locks and Dams 13 and 14 restrain fish passage between pools.
- Information is needed to better assess and manage Pool 14 mussels, especially the Higgins eye population.
- The current Pool water management regime, especially avoidance of seasonal low water, removes much potential for periodic regeneration of aquatic habitats.

2. Proposed Actions Specific to Beaver Island

- Restore shallow aquatic habitat in the upper reaches of rapidly accreting wetlands. Consider pothole blasting technique.
- Restore over-wintering habitat for centrarchids with dredging.
- Increase island elevation with dredged material to introduce and sustain mixed bottomland tree species.
- Reduce accelerated sediment accumulation in backwater lakes by diverting high flows with a low deflection structure.

F. Upper Mississippi River National Wildlife and Fish Refuge Goals

Fish and wildlife management goals and objectives for the area fall under those defined more broadly for the Upper Mississippi River National Wildlife and Fish Refuge and those designated specifically in the Comprehensive Conservation Plan (USFWS 2006). Broader objectives also come from the National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy. The management goals and objectives of the Upper Mississippi River National Wildlife and Fish Refuge which apply most directly to the study area include:

1. Environmental Health Goal: Improve the environmental health of the Refuge by working with others.

- First and foremost maintain existing levels of biological integrity, diversity, and environmental health at the refuge scale.
- Secondarily, restore lost or severely degraded elements of integrity, diversity, environmental health at the refuge scale and other appropriate landscape scales where it is feasible and support achievement of refuge purpose(s) and System mission.
- USFWS favors management that restores or mimics natural ecosystem processes or functions to achieve refuge purpose(s).
- Working with others and through a more aggressive refuge program, seek a continuous improvement in the quality of water flowing through and onto the refuge in terms of parameters measured by the LTRM; DO, major plant nutrients, suspended material, turbidity, sediment deposition, and contaminants.
- Increase efforts to control invasive plants and animals through active partnerships with States and other service programs and federal agencies, and increase public awareness and prevention.
- Improve water quality and reduce and/or address sediment deposition.
- Complete $150 million worth of habitat restoration and enhancement projects or $10 million per year compared to $2.7 million per year on Refuge from the EMP.

2. Wildlife and Habitat Goal: Habitat management will support diverse and abundant native fish, wildlife, and plants.

- By 2021, in cooperation with various agencies and states, implement at least 30% of the refuge-priority Environmental Pool Plan actions and strategies in Pools 4 through 14.

- Adopt and use the following guiding principles when designing or providing input to design and construction of habitat enhancement projects:
    - Management practices will restore or mimic natural ecosystem processes or functions to promote a diversity of habitat and minimize operation and maintenance costs. Mimicking natural process in an altered environment often includes active management and/or actions.
    - Maintenance and operation costs of projects will be weighed carefully because annual budgets are not guaranteed.
    - Terrestrial habitat on constructed islands and other areas needs to best fit the natural processes occurring on the river, which in many cases will allow for natural succession to occur.
    - If project measures in Refuge Closed Areas serve to attract the public during the waterfowl season, spatial and temporal restrictions of uses may be required to reduce human disturbance of wildlife.
    - The aesthetics of projects in context of visual impacts to the landscape should be considered in project design.
- Develop and implement monitoring and management plans for threatened and endangered species, fish, mussels, turtles, furbearers, and forest species.
- Increase emphasis on fishery and mussel management in cooperation with the states and Corps of Engineers.

3. Wildlife-Dependent Recreation Goal: Manage programs and facilities to ensure abundant and sustainable hunting, fishing, wildlife observation, wildlife photography, interpretation, and environmental education opportunities for a broad cross-section of the public.

- General success in maintaining or restoring biological integrity, diversity, and environmental health will produce higher quality opportunities for wildlife-dependent public use.
- Provide a balanced approach between the needs of the waterfowl and the public.
    - Provide migrating waterfowl a more balanced and effective network of feeding and resting areas.
    - Minimize disturbances to feeding and resting waterfowl in closed areas.
    - Provide waterfowl hunters with more equitable hunting opportunities over the length of the refuge.
- Enhance fishing opportunities on suitable areas of the refuge habitat, access, and facilities improvements.
- Maintain abundant hunting and fishing opportunities, and increase opportunities for wildlife observation, photography, interpretation and environmental education.

G. Project Goals and Objectives

Based on the identified problems affecting Beaver Island's significant natural resources and considering the management goals of the cooperating agencies, the Project goals are to restore and protect off-channel aquatic and wetland habitat and restore floodplain forest habitat. The objectives are as follows:

- Increase year-round aquatic habitat diversity, as measured by acres and native fish use of spawning, rearing and overwintering habitat

- Increase structure and function of side channel habitat, as measured by native freshwater mussel use

- Diversify floodplain forest habitat on Beaver Island, as measured in acres of elevated topography and number of hard mast tree species present in Project area

H. Planning Constraints

The following constraints were considered in plan formulation:

- **Navigation.** Ensure measures do not negatively impact the 9-foot navigation channel.
- **Environmental Laws and Regulations.** Construct measures consistent with Federal, state, and local laws. Compliance and coordination under National Environmental Policy Act (NEPA) emphasizes the importance of environmental impacts to be minimized and avoided, as much as possible. Therefore, the following constraints are considered when analyzing alternatives:
    - Minimize floodplain forest impacts
    - Minimize endangered species impacts
    - Minimize migratory bird impacts (rookery)
    - Maintain hydraulic connectivity to allow for improved water quality for fish
    - Avoid cultural resources, if possible
- **Flood Heights.** Restoration measures should not increase flood heights or adversely affect private property or infrastructure.
- **Aesthetics.** Measures should be designed to minimize negative impacts to aesthetics.

IV. POTENTIAL PROJECT MEASURES

This section discusses potential enhancement measures that will meet the goals and objectives outlined in Section III, *Problems and Opportunities* (Table IV-1). For planning purposes, the period of analysis was established as 50 years. These potential enhancement measures were initially screened based on their contribution to the Project goals and objectives, engineering considerations, and local restrictions or constraints. Several measures were identified in the early planning stages. Several of these were partially developed, then were determined not feasible or did not meet the Project objectives, and as such were not subject to further evaluation (Plate 9, C-104, *Project Enhancement Measures Not Evaluated*). Measures that will be evaluated further are found on Plate 8, C-103, *Project Enhancement Measures Evaluated*. Design criteria and typical photographs are provided in Appendix M, *Engineering Design*.

Table IV-1. Beaver Island Goals, Objectives, and Potential Enhancement Measures

Goals	Objectives	Potential Enhancement Measures
Restore and Protect Off-Channel Aquatic and Wetland Habitat	Increase year-round aquatic habitat diversity, as measured by acres and native fish use of spawning, rearing and overwintering habitat Increase structure and function of side channel habitat, as measured by native freshwater mussel use	Excavate backwater areas to ensure a depth and velocity appropriate for year round fish use Construct water control structures and/or river training structures to protect existing islands and provide appropriate velocities for fisheries and mussels. Install rock substrate at the appropriate depth and location for freshwater mussel use
Restore Floodplain Forest Habitat	Diversify floodplain forest habitat on Beaver Island, as measured in acres of elevated topography and number of hard mast tree species present in Project area	Increase elevation of existing topography to obtain optimum heights for tree survivability Plant native bottomland forest species in sufficient density to diversify tree species present in Project area

A. Aquatic and Topographic Diversity

1. Aquatic Diversity Measures. Excavation has been proposed as a potential measure to provide suitable year-round aquatic habitat for fish, which includes critical overwintering habitat for centrarchid fish species. Excavation will also provide material to increase topographic diversity within the floodplain forest. Mechanical excavation or dredging would be required for these aquatic diversity sites.

a. Lower Cut Aquatic Diversity. Lower Cut would be excavated to provide aquatic diversity through the direct act of dredging and to provide sufficient material for floodplain forest topographic diversity. The entire width of this cut was considered to be excavated in the early planning stages; however, sufficient benefits were observed with a narrower channel width. This site would provide access into the Beaver Island interior as well as the numerous side lakes or channels.

The cut was situated to ensure it will tie into deeper water in the main channel of the river, and placed in deeper water locations. A deep hole will be constructed within this dredge cut, approximately 100 feet in length by 60 feet in width and an additional 4 feet deep. Material excavated from this site will be transported to a topographic diversity site. See Table IV-2 for further details. This measure was retained for further evaluation.

Table IV-2: Lower Cut Aquatic Diversity

Item	Quantity	Unit
Length	5,101	FT
Acres Below 4 feet	11.37	AC
Quantity Excavated	110,189	CY
Bottom Width	100 feet (0 to 6+50), 60 feet (6+50 to end)	FT
Average Bottom Elevation	563.20 (deep hole 559.20)	NAVD88

b. Stewart Lake Aquatic Diversity. Stewart Lake is the furthest downstream inlet lake. The lake would likely be the first location fish enter, and possibly the last location fish exit during overwintering periods. Material excavated from this site would be transported to topographic diversity sites (likely Stewart Lake and Lower Cut-South). See Table IV-3 for further details. This measure was retained for further evaluation.

Table IV-3: Stewart Lake Aquatic Diversity

Item	Quantity	Unit
Length	1,695	FT
Acres Below 4 feet	3.6	AC
Quantity Excavated	47,100	CY
Bottom Width	60	FT
Average Bottom Elevation	563.20	NAVD88

c. Small Lake Aquatic Diversity. This lake was a potential measure which would have had the entire lake excavated to a depth of 8 feet below flat pool. See Table IV-4 for further details. This measure was retained for further evaluation.

Table IV-4: Small Lake Aquatic Diversity

Item	Quantity	Unit
Length	718	FT
Acres Below 4 feet	2.2	AC
Quantity Excavated	34,600	CY
Bottom Width	100	FT
Average Bottom Elevation	563.20	NAVD88

d. Blue Bell Lake Aquatic Diversity. Blue Bell Lake was selected to have varying widths of channel bottoms. Unlike the other proposed lake dredging, this lake currently provides some overwintering opportunities that is important to maintain for returning fish. A deep hole would be constructed within this dredge cut, approximately 100 feet in length by 60 feet in width and an additional 4 feet deep. Material excavated from this site would be transported to topographic diversity sites (likely Blue Bell-East and Blue Bell-West). See Table IV-5 for further details. This measure was retained for further evaluation.

Table IV-5: Blue Bell Lake Aquatic Diversity

Item	Quantity	Unit
Length	1,708	FT
Acres Below 4 feet	5.5	AC
Quantity Excavated	70,089	CY
Bottom Width	150 feet from Sta 0+00 to 10+00 and 18+00 to end, 60 feet Sta 10+00 to 18+00	FT
Average Bottom Elevation	563.20 (deep hole 559.20)	NAVD88

e. Sand Burr Lake Aquatic Diversity. Sand Burr Lake was selected to have varying widths of channel bottoms, with the wider location used to hold fish in the later winter months when oxygen levels are depleted. A deep hole would be constructed within this dredge cut, approximately 100 feet in length by 60 feet in width and an additional 4 feet deep. Material excavated from this site would be transported to a topographic diversity site (likely Sand Burr, Blue Bell-East, and Lower Cut-South). Dredging this lake also provides a connection to existing valuable wetland habitat in the adjacent Hulzinger Lake. See Table IV-6 for further details. This measure was retained for further evaluation.

Table IV-6: Sand Burr Lake Aquatic Diversity

Item	Quantity	Unit
Length	2,466	FT
Acres Below 4 feet	6.8	AC
Quantity Excavated	88,190	CY
Bottom Width	60 feet Sta 0+00 to 17+00, 150 feet Sta 17+00 to end	FT
Average Bottom Elevation	563.20 (deep hole 559.20)	NAVD88

f. Lower Lake Aquatic Diversity. Lower Lake would be excavated. Initially the entire lake was considered, then the cut was reduced to a 60 foot bottom width at a depth of 8 feet below flat pool. The cut was placed in the deepest part of the lake and would have connected the upper lake and lower cuts. See Table IV-7 for further details. This measure was retained for further evaluation.

Table IV-7: Lower Lake Aquatic Diversity

Item	Quantity	Unit
Length	3,046	FT
Acres Below 4 feet	6.4	AC
Quantity Excavated	66,700	CY
Bottom Width	60	FT
Average Bottom Elevation	563.20	NAVD88

g. Upper Lake Aquatic Diversity. Originally, the entire lake was considered to be excavated, but the lake has filled in significantly and excavation in this area would be too substantial. Upper Lake was considered to be excavated, at a width of 60 feet, however only 6 feet below flat pool. The material would be side cast. See Table IV-8 for further details. This measure was retained for further evaluation.

Table IV-8: Upper Lake Aquatic Diversity

Item	Quantity	Unit
Length	3,500	FT
Acres Below 4 feet	6.1	AC
Quantity Excavated	64,100	CY
Bottom Width	60	FT
Average Bottom Elevation	565.20	NAVD88

h. Deep Cut/Upper Cut Aquatic Diversity. Deep Cut/Upper Cut would be excavated with a narrower bottom width to accommodate the existing channel footprint. The bottom elevation would be 6 feet below flat pool to reduce the amount of material excavated from this site. See Table IV-9 for further details. This measure was retained for further evaluation.

Table IV-9: Deep Cut/Upper Cut Aquatic Diversity

Item	Quantity	Unit
Length	7,112	FT
Acres Below 4 feet	49.5	AC
Quantity Excavated	80,900	CY
Bottom Width	30	FT
Average Bottom Elevation	565.20	NAVD88

i. Beaver Slough to Stewart Lake Cut. A new cut would be created. Excavation (bottom) width would be 50 feet with a depth of 8 feet below flat pool. The cut would provide aquatic diversity through the direct act of dredging and provide sufficient material for floodplain forest topographic diversity. This would also provide increased flows into the interior complex by creating a direct connection with Beaver Slough. The mouth of the cut in Beaver Slough was moved away from a shoaling area noted from surveys, and ensured any added velocities were at the downstream end of the Project, thereby protecting overwintering fish from excessive velocities in the winter.

The cut has been considered to attach to Stewart Lake, but the velocities into Stewart Lake were too high for overwintering fisheries habitat, and the increase in sediment from Beaver Slough into Stewart Lake could cause this area to fill in too quickly. The cut was moved to downstream of Stewart Lake into Lower Cut. Based on the length of the cut and the relatively flat slope of the proposed channel, the cut would have filled in too quickly with sediment. During the analysis, a heron rookery relocated in the general location of the proposed cut. Based on these reasons, this measure was not retained for further evaluation.

j. Lower Cut (between Albany Slough and Lower Dredge Cut). A deeper cut would be excavated (about 1,000 LF). Excavation (bottom) width would be 50 feet with a depth of 8 feet below flat pool. The cut would provide aquatic diversity through the direct act of dredging and provide sufficient material for floodplain forest topographic diversity. This would also provide increased flows into the interior complex by creating a direct connection with the main channel. This measure was eliminated due to potential impacts to mussel habitat on the navigation side of the island and because of higher flows on the interior of the island during overwintering months. This measure was not retained for further evaluation.

k. Crappie Slough Cut. A deeper cut would be excavated (about 3,000 LF) between Crappie Slough and Lower Cut. Excavation (bottom) width would be 50 feet with a depth of 8 feet below flat pool. The cut would provide aquatic diversity through the direct act of dredging and provide sufficient material for floodplain forest topographic diversity. This would also provide increased flows into the interior complex by creating a direct connection with the main channel. This measure was eliminated due to potential impacts to mussel habitat on the navigation side of the island and because of higher flows on the interior of the island during overwintering months. This measure was not retained for further evaluation.

2. Topographic Diversity Measures. Planting native bottomland forest species on the raised placement areas associated with excavation for aquatic diversity has been proposed as a potential measure to diversify the forested areas on Beaver Island. All topographic diversity sites will require the existing trees (if present) to be cleared and removed off site or used for fish structure in the excavated channels. Material excavated from the channels will be placed to construct the site to an optimum elevation for tree survival. Initial design elevations were determined based upon inundation duration tolerance criteria specific to the desired tree species, based upon input from the Project forester and hydraulic engineer. The upper limit of tree planting was identified based on the 25-percent exceedance probability for the minimally tolerant tree species criteria and the lower limit of tree planting was identified based on the 25-percent exceedance probability for the moderately tolerant tree species criteria. Following the climate change analysis, the tree planting elevations as determined above were further increased to provide greater resiliency throughout the 50-year period of analysis. The final design elevation was evaluated to ensure there were no impacts to the floodplain. Details of these various analyses are described in Appendix H, *Hydrology and Hydraulics*. Material will come from channels within the Beaver Island complex. The sites will either be sloped to drain, or will have +/- 1 foot elevation changes to create swales across the wider sites. Once shaping is complete, temporary seeding may be employed if permanent seeding cannot occur immediately.

Topographic diversity sites will be divided into ½ acre plots, which will be planted with one size of tree [#3, #5, or #15 root pruned method (RPM) trees]. This planting approach allows for more efficient monitoring and evaluation should future questions arise about the effectiveness, efficiency and performance of the planted trees. Tree species to be planted are shown in Table IV-10. Three sizes of trees offers a more realistic representation of the optimal structure of the bottomland hardwood forest, which then provides a more resilient and sustainable functioning floodplain ecosystem. Forested wetland shrubs will be interplanted with the forested wetland trees (Table IV-11). The understory seed mixture will be planted below the shrubs and trees (Table IV-12). A buffer mix that includes seeds and willow stakes will be planted on the slopes approaching the planting areas to reduce herbivory of the tree plantings (Table IV-13).

Table IV-10: Forested Wetland Trees

#3 RPM (108 trees per acre)	
River Birch	*Betula nigra*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Common Hackberry	*Celtis occidentalis*
Common Persimmon	*Diospyros virginiana*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
American Sycamore	*Platanus occidentalis*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Overcup Oak	*Quercus lyrata*
#5 RPM (48 trees per acre)	
River Birch	*Betula nigra*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Common Hackberry	*Celtis occidentalis*
Common Persimmon	*Diospyros virginiana*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
American Sycamore	*Platanus occidentalis*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Overcup Oak	*Quercus lyrata*
#15 RPM (27 trees per acre)	
River Birch	*Betula nigra*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Common Hackberry	*Celtis occidentalis*
Common Persimmon	*Diospyros virginiana*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
American Sycamore	*Platanus occidentalis*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Overcup Oak	*Quercus lyrata*
MISCELLANEOUS	
TREE WRAPS (#3/#5 Trees)	
TREE WRAPS (#15 Trees)	

Table IV-11: Forested Wetland Shrubs

Common Name	Scientific Name
Common Buttonbush	*Cephalanthus occidentalis*
Red-Osier Dogwood	*Cornus stolonifera*
Silky Dogwood	*Cornus amomum*
American Elderberry	*Sambucus canadensis*
Northern Spicebush	*Lindera benzoin*
American Bladdernut	*Staphylea trifolia*

Table IV-12: Understory Seed Mixture

125,000 seeds per acre	
Common Name	**Scientific Name**
Virginia Wild Rye	*Elymus virginicus*
Canada Wild Rye	*Elymus canadensis*
Partridge Pea	*Chamaechrista fasciculata*
Buttonbush	*Cephalanthus occidentalis*
Rice Cut Grass	*Leersia oryzoides*
Cardinal Flower	*Lobelia cardinalis*
Sneezeweed	*Helenium autumnale*
Swamp Milkweed	*Asclepias incarnata*

Table IV-13: Buffer Area

Common Name	Scientific Name
Black Willow	*Salix nigra*
Cottonwood	*Populus deltoids*
River Birch	*Betula nigra*
Buttonbush	*Cephalanthus occidentalis*

a. Lower Cut Topographic Diversity (North and South Bank). The topographic diversity site on the north bank would help prevent overland flow during flood conditions from entering the channel from Beaver Slough. This is a lower quality forest which would be cleared then constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and surrounded by buffer species.

The topographic diversity site on the south bank was selected as one of the lower quality forest stands on the island. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and surrounded by buffer species. Refer to Table IV-14 for further details. Both North and South Bank topographic diversity sites were retained for further evaluation.

Table IV-14: Lower Cut Topographic Diversity

Item	Quantity	Unit
Length – North Bank	696	FT
Length – South Bank	4,417	FT
Approximate Tree Clearing	19	AC
Topographic Diversity	30.50	AC
Quantity Capacity	184,300	CY
Average Width – North Bank	200	FT
Average Width – South Bank	200	FT
Average Top Elevation	579.80	NAVD88

b. Stewart Lake Topographic Diversity (East and West Bank). These sites would be located adjacent to Stewart Lake on the east and west sides. The sites were placed in areas of lower forest diversity, but adjacent to higher diversity areas. This site would be cleared then constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees,

understory species, forested wetland shrubs, and surrounded by buffer species. Refer to Table IV-15 for further details. Both East and West topographic diversity sites were retained for further evaluation.

Table IV-15: Stewart Lake Topographic Diversity

Item	Quantity	Unit
Length – West Bank	1,297	FT
Length – East Bank	508	FT
Approximate Tree Clearing	11	AC
Topographic Diversity	11	AC
Quantity Capacity	82,300	CY
Average Width	East 150, West 300	FT
Average Top Elevation	579.80	NAVD88

c. Small Lake Topographic Diversity. This site was located between Blue Bell Lake and Small Lake. Refer to Table IV-16 for further details. The site was placed in areas of lower forest diversity, but adjacent to higher diversity areas. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and surrounded by buffer species. This measure was retained for further evaluation.

Table IV-16: Small Lake Topographic Diversity

Item	Quantity	Unit
Length	422	FT
Approximate Tree Clearing	3	AC
Topographic Diversity	3	AC
Quantity Capacity	14,000	CY
Average Width	150	FT
Average Top Elevation	579.80	NAVD88

d. Blue Bell Lake Topographic Diversity (East and West Bank). The west site is located between Small Lake and Blue Bell Lake. The site has a lower quality forest which would be cleared, then built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and surrounded by buffer species.

The east site is located between Blue Bell Lake and Sand Burr Lake. The site follows existing contours and is in a lower quality forest. The site would be adjacent to a higher quality forest which may help future regeneration in the area in addition to Project plantings. The site would be cleared, then built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and surrounded by buffer species. Refer to Table IV-17 for further details. Both East and West Bank topographic diversity sites were retained for further evaluation.

Table IV-17: Blue Bell Lake Topographic Diversity

Item	Quantity	Unit
Length – West Bank	1,208	FT
Length – East Bank	575	FT
Approximate Tree Clearing	11	AC
Topographic Diversity	11	AC
Quantity Capacity	75,000	CY
Average Width – West Bank	200	FT
Average Width – East Bank	150	FT
Average Top Elevation	579.80	NAVD88

e. Sand Burr Lake Topographic Diversity (East and West Bank). These sites would be located adjacent to Sand Burr Lake on the east and west banks. The site would follow existing topography. The site would be cleared, then built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species. Refer to Table IV-18 for further details. Both East and West Bank topographic diversity sites were retained for further evaluation.

Table IV-18: Sand Burr Lake Topographic Diversity

Item	Quantity	Unit
Length	1,446 feet east side, 554 feet west side	FT
Approximate Tree Clearing	6	AC
Topographic Diversity	12	AC
Quantity Capacity	96,500	CY
Average Width (East and West)	200	FT
Average Top Elevation	579.80	NAVD88

f. Lower Lake Topographic Diversity. The Lower Lake site is located on the west side of the Lower Lake cut. Material would be placed in shallow lake depths and follow existing topography. The site would be built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and surrounded by buffer species. Refer to Table IV-19 for further details. This measure was retained for further evaluation.

Table IV-19: Lower Lake Topographic Diversity

Item	Quantity	Unit
Length	3,108	FT
Approximate Tree Clearing	3	AC
Topographic Diversity	19	AC
Quantity Capacity	148,400	CY
Average Width	200	FT
Average Top Elevation	579.80	NAVD88

g. Upper Lake Topographic Diversity. The Upper Lake site would be adjacent to the cut. Placement would be in very shallow water (lake is occasionally dry during summer drought conditions). The site would be built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and

surrounded by buffer species. Refer to Table IV-20 for further details. This measure was retained for further evaluation.

Table IV-20: Upper Lake Topographic Diversity

Item	Quantity	Unit
Length	3,311	FT
Approximate Tree Clearing	5	AC
Topographic Diversity	21	AC
Quantity Capacity	135,330	CY
Average Width	200	FT
Average Top Elevation	579.80	NAVD88

h. Deep Cut/Upper Cut Topographic Diversity. The site would be within the existing tree line and be a narrow site located on both sides of the channel. The site would be built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and surrounded by buffer species. Refer to Table IV-21 for further details. This measure was retained for further evaluation.

Table IV-21: Deep Cut/Upper Cut Topographic Diversity

Item	Quantity	Unit
Length	14,223	FT
Approximate Tree Clearing	5	AC
Topographic Diversity	13	AC
Quantity Capacity	111,952	CY
Average Width	30	FT
Average Top Elevation	579.80	NAVD88

B. River Training Structures

1. River Training (Rock Closure) Structures. Closure structures have been proposed as a potential measure to improve aquatic habitat diversity by deflecting sediment and reducing flows. Closure structures were identified for consideration at several sites.

a. Beaver Island Closure Structure. The closure structure is located at the upstream end of Upper Cut/Deep Cut and is adjacent to Beaver Slough. The main purpose of the structure is to reduce sediment deposition into the site. The structure would be constructed to match the top of bank along the edge of Beaver Island, thereby preventing flows as high as bank full (~el. 579.5) from delivering sediment into the backwater complex. This reduction in flow also has an ancillary benefit to overwintering fish. While the closure structure will not protect the interior water channels from island overtopping events, it will reduce bed material load and wash load delivery and deposition in the backwater complex from this source. Trees would be cleared at the tie in ends of the structure and the structure would be constructed with riprap. Refer to Table IV-22 for further details.

Table IV-22: Beaver Island Closure Structure

Item	Quantity	Unit
Length (bank to bank)	252	FT
Upstream Slope	2	H:1V
Downstream Slope	3	H:1V
Approximate Tree Clearing	0.3	AC
Estimated Quantity	18,200	TN
Top Width	10	FT
Average Top Elevation	575.80	NAVD88

While there are numerous inlets into the Beaver Island complex at different river levels, this structure was identified by visual observations by the Project sponsors as a primary source of sediment over time. Photograph IV-I provides a visual example of sediment entering Upper Lake from the Deep Cut/Upper Cut channel (as seen on the lower right hand side of the photograph). This introduction of sediment is resulting in deposition from upstream to downstream, with Upper Lake now converted from aquatic to floodplain habitat. At the public meetings and according to the Project sponsors, this Upper Lake had sufficient depths in the past to support recreational boating, such as water skiing. At this time, the lake has filled in with enough sediment that wetland vegetation covers the site and willows are beginning to be established. A survey in this location identified benchmarks that had previously been above surface level, but were in fact several feet below existing ground elevation due to the large amount of sedimentation in this area.

Photograph IV-1: View in June 2015, Looking Downstream at Upper Cut/Deep Cut Entering Upper Lake and the Introduction of Sediment

b. River Training (Rock Closure Structure – Albany Island). This measure includes the construction of a rock closure structure between Albany Island and Beaver Island. Construction of the closure structure would result in lower flows for fish resting habitat during overwintering conditions and could manipulate flows to improve mussel habitat. This structure would be constructed to 4 feet above flat pool, would have a top width of 10 feet, 2H:1V upstream slopes and 3H:1V downstream

slopes. The length would be approximately 350 feet (from bank to bank). This measure was not selected for further analyses as constructing the structure could impact downstream mussel habitat.

c. River Training (Rock Closure) Structure – Beaver Island (Lower Lake). This measure includes the construction of a rock closure structure at the downstream end of Lower Lake where the channel narrows. Construction of the closure structure would result in lower flows for fish resting habitat during overwintering conditions and could manipulate flows to improve mussel habitat. This structure would be constructed to 4 feet above flat pool, would have a top width of 10 feet, 2H:1V upstream slopes and 3H:1V downstream slopes. The length would be approximately 300 feet (from bank to bank). This measure was not selected for further analyses as the cut off in this location was not deemed necessary for any habitat types.

d. Lower Cut Deflection Berm. A Lower Cut deflection berm was considered at the downstream end of Beaver Island to reduce recirculation into the Lower Cut Aquatic Diversity Site. Based on further analysis (refer to Appendix H, *Hydrology and Hydraulics*), this berm had no effect on water circulation. This measure was not retained for further evaluation.

2. Water Control Structures. Water control structures have been proposed to increase aquatic habitat diversity by maintaining water depths and reducing sedimentation.

a. Beaver Slough Cut Water Control Structure. This measure would include a screw gate or similar structure that would connect Beaver Slough to the proposed Beaver Slough Cut during winter conditions or during high flow conditions. If oxygen levels dropped, the structure could be opened to allow for oxygenation of the backwater area. Increased flows when the structure is opened may allow the channel to self-scour and maintain its depth better over time. This would only be constructed if the Beaver Slough Cut was excavated. The water control structure would need to be wider than the proposed "cut" which is estimated to be 50 feet at the bottom with 4H:1V side slopes. This measure will not be retained for further evaluation because the Beaver Slough Cut was removed from further consideration.

b. Crappie Slough Cut Water Control Structure. This measure would include a screw gate or similar structure that would connect the main channel to the proposed Crappie Slough Cut during winter conditions or during high flow conditions. If oxygen levels dropped, the structure could be opened to allow for oxygenation of the backwater area. Increased flows when the structure is opened may allow the channel to self-scour and maintain its depth better over time. This would only be constructed if the Crappie Slough Cut was excavated. The water control structure would need to be wider than the proposed "cut" which is estimated to be 50 feet at the bottom with 4H:1V side slopes. This measure will not be retained for further evaluation because the Crappie Slough Cut was removed from further consideration.

c. Lower Lake Cut Water Control Structure. This measure would include a screw gate or similar structure that would connect the main channel to the proposed Lower Lake Cut during winter conditions or during high flow conditions. If oxygen levels dropped, the structure could be opened to allow for oxygenation of the backwater area. Increased flows when the structure is opened may allow the channel to self-scour and maintain its depth better over time. This would only be constructed if Lower Lake Cut was excavated. The water control structure would need to be wider than the proposed "cut" which is estimated to be 50 feet at the bottom with 4H:1V side slopes. This measure will not be retained for further evaluation because the Lower Lake Cut was removed from further consideration.

3. Bank Protection. Bank protection has been proposed to control erosion of the islands, which would increase the structure and function of side channel habitat. Generally, bank protection is material placed in the form of vanes, chevrons, or a rock layer placed on the bank (bank stabilization). Bank protection was identified for consideration at three sites.

a. Chevron (Albany Island). This measure would protect Albany Island from further erosion, thereby protecting the adjacent mussel beds. Further details are provided in Table IV-23 and in Appendix H, *Hydrology and Hydraulics*. This measure was retained for further evaluation.

Table IV-23: Albany Island Chevron

Item	Quantity	Unit
Length	682	FT
Upstream Slope	2	H:1V
Downstream Slope	2	H:1V
Approximate Tree Clearing	0	AC
Estimated Quantity	10,600	TN
Top Width	6	FT
Average Top Elevation	578.5	NAVD88

b. Albany Island Bankline Protection (Head End). Stone protection would be added to the upstream end of Albany Island, covering approximately 900 linear feet. This would tie into bankline protection on the Albany Slough side of the island. This measure was retained for further evaluation. Refer to Table IV-24 for further details.

Table IV-24: Albany Island Bankline Protection – Head End

Item	Quantity	Unit
Length	900	FT
Slope	3	H:1V
Approximate Tree Clearing	2	AC
Riprap Thickness	2	FT
Estimated Quantity Riprap	4,900	TN
Bedding Thickness	1	FT
Estimated Quantity- Bedding	2,700	TN
Average Top Elevation	580 (top of bank)	NAVD88

c. Albany Island Bankline Protection -Albany Slough and Navigation Channel Banks. Both banklines would be protected with stone placement along actively eroding locations at the upstream interior end of the island and the downstream navigation side of the island. Refer to Table IV-25 for further details. This measure was retained for further evaluation.

Table IV-25: Albany Island Bankline Protection-Albany Slough and Navigation Channel Banks

Item	Quantity	Unit
Length (Upstream)	300	FT
Length (Downstream)	1,000	FT
Slope	3	H:1V
Approximate Tree Clearing (Upstream)	2	AC
Approximate Tree Clearing (Downstream)	2	AC
Riprap Thickness	2	FT
Estimated Quantity Riprap	1,700 (U/S)+9,000 (D/S)	TN
Bedding Thickness	1	FT
Estimated Quantity- Bedding	900 (U/S) + 4,900 (D/S)	TN
Average Top Elevation	580 (top of bank)	NAVD88

C. Constructed Soil Units

Constructed soil units were proposed as a measure to increase the abundance of isolated seasonally flooded wetlands, which would restore wildlife habitat for migratory waterfowl, reptiles, amphibians, and other wildlife.

1. Seasonally Flooded Perched Wetlands. Adjacent to the topographic diversity sites in non-diverse locations, a perched wetland could be constructed to provide wetland habitat for an extended time period. However, perching the wetland does not meet the objectives set forth by this study and will not be retained for further evaluation.

2. Ephemeral or Depressional Wetland. Ephemeral wetlands or potholes could be constructed by excavating existing soil to create wet areas. This option consists of creating ephemeral wetlands to provide secluded open water for reptiles, amphibians, and other animals (the topographic diversity sites would provide refuge from recurring flood events).

a. Upper Wetland/Herptile Site. This measure includes excavating about 1 acre to a depth of 3 feet below flat pool. Excavated material would be side cast and slopes flattened to promote wetland plant growth. Top heights of the placed material would be between 3 to 8 feet above existing ground to protect the wetland from minor river elevation changes. Adjacent diverse forest areas would have limited impacts as clearing would be avoided other than that required to access the site with construction equipment. During a site visit to the Project area by the USFWS in April 2015, many existing suitable ephemeral wetlands were identified (see correspondence in Appendix A). As a result of this investigation, this measure was not retained for further evaluation.

b. Lower Wetland/Herptile Site. This measure includes excavating about 1.5 acres to a depth of 3 feet below flat pool. Excavated material would be side cast and slopes flattened to promote wetland growth. Top heights of the placed material would be between 3 to 8 feet above existing ground to protect the wetland from minor river elevation changes. Adjacent diverse forest areas would have limited impacts as clearing would be avoided other than that required to access the site with construction equipment. During a site visit to the Project area by the USFWS in April 2015, many existing suitable ephemeral wetlands were identified (see correspondence in Appendix A). As a result of this investigation, this measure was not retained for further evaluation.

c. Grass Slough Wetland/Herptile Site. This measure includes excavating up to 23 acres to a depth of 4 feet below flat pool. Excavated material would be side cast and slopes flattened to promote wetland growth. Top heights of the placed material would be up to 8 feet above existing ground to protect the wetland from minor river elevation changes. During a site visit to the Project area by the USFWS in April 2015, many existing suitable ephemeral wetlands were identified (see correspondence in Appendix A). As a result of this investigation, this measure was not retained for further evaluation.

d. Buffalo Hole Wetland/Herptile Site. This measure includes excavating up to 11 acres to a depth of 4 feet below flat pool. Excavated material would be side cast and slopes flattened to promote wetland growth. Top heights of the placed material would be up to 8 feet above existing ground to protect the wetland from minor river elevation changes. During a site visit to the Project area by the USFWS in April 2015, many existing suitable ephemeral wetlands were identified (see correspondence in Appendix A). As a result of this investigation, this measure was not retained for further evaluation.

D. Mussel Habitat

The addition of substrate was considered at various locations to increase structure and function of side channel habitat that would in turn enhance and maintain existing mussel habitat.

1. Albany Slough. This area is located between Albany Island and Beaver Island. The addition of substrate (e.g. river washed stone) across this slough was considered, however flows and anticipated sediment deposition in this slough were not amenable to mussel habitat. Protection of Albany Island will protect this habitat from further degradation through other measures. This measure was not retained for further evaluation.

2. Beaver Island. This area is located within the backwaters of Beaver Island, downstream of Lower Lake and extending to the confluence with Blue Bell Lake. This measure will not be retained for further evaluation because the primary mussel habitat is located in Albany Slough.

3. Albany Island Bankline Protection. River stone sized to optimize mussel habitat will be added along the base of the Albany Island rock protection on the Albany Slough side. Refer to Table IV-26 for further details. This measure will be retained for further analysis.

Table IV-26: Albany Island Mussel Substrate

Item	Quantity	Unit
Length (Upstream)	300	FT
River stone Thickness	1	FT
Estimated Quantity	900	TN

E. Non-Structural Methods

Non-structural methods have been proposed to help meet the Project objectives. While there are other non-structural methods discussed in this report, they were better suited in other categories.

1. Best Management Practice (BMPs). BMPs are defined by the USEPA 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 Corps authority, the District recommends it be evaluated further by other responsible persons or organization rather than in this report.

2. 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 measures available to aid in the restoration of the environment. Education measures related to Beaver Island includes, but is not limited to, information on non-point source pollution, point source pollution, agricultural practices, invasive species, threatened and endangered species, floodplain, and wetlands. Education and Outreach programs are established through local, state and Federal agencies as well as other public forums. Several education programs have been implemented by the USDA and the USEPA regarding BMPs and other agriculture practices. The IADNR has a list of summer classes, training programs, grants, conservation education programs, as well as stream and watershed management workshops. The USFWS has several migratory bird initiatives to include international migratory bird day festivals, partners in flight, and junior duck stamp program. Corps 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. The Corps realizes 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 measures will not be evaluated further for the purposes of this study.

3. Timber Stand Improvement. This measure is a combination of crop tree release, girdling, and planting trees within existing timber stands. Crop tree release would clear old trees and benefit desirable understory by decreasing competition. Girdling produces snag and cavity trees for roosting bats and colony nesting birds. The forest inventory will be summarized using the Forest Management Geodatabase to help further define the desired future conditions. The stands and overall complex summary will be analyzed in reference to the desired stand conditions and goals and objectives in the Upper Mississippi River Systemic Forest Stewardship Plan (UMRSFSP). An emphasis will be placed on maintaining and improving existing tree diversity, improving structural diversity for long-term forest health, and maintaining a diversity of wildlife habitat. It is anticipated that up to 350 acres of dispersed Timber Stand Improvement may be required to help meet UMRSFSP objectives. One area currently planned for thinning and tree planting is dominated by large silver maples with some small amount of diverse understory. This area is higher in elevation and the majority of the site was farmed when the property was acquired by the Federal government for the 9-foot navigation project. Crop tree release would include a combination of girdling and felling of immediate competing trees to allow for small canopy openings with dead standing trees for additional wildlife habitat while improving conditions for each desired crop tree. This measure will be retained for further analysis.

F. Quantity Calculations

Acres and/or distances were measured using Google Earth or surveyed data. Average depths and/or elevations were obtained by LiDAR (IADNR) and bathymetry (Corps). These quantities were ***not*** based on recently surveyed information, or using 3D modeling software such as Bentley MicroStation or InRoads. Further estimates will be required as the PDT proceeds with its analysis.

V. DEVELOPMENT AND EVALUATION OF ALTERNATIVES

Feasible measures identified and described in Section IV, *Potential Project Measures,* were carried forward as the preliminary measures for development of alternatives. These were further evaluated to determine necessary refinement, dependencies, and ecologically relevant combinations by the PDT, the Sponsors, and coordinating agency partners for moving forward with alternative development.

The PDT determined topographic diversity is reliant on its adjacent lake dredging in order to gain the material necessary for construction. These cases were combined into single measures, along with the tree planting required to complete the topographic diversity objective. Next, the PDT and agency partners determined that all Albany Island stabilization measures (i.e., chevron protection, rip-rap protection) required Albany Slough and navigation channel bank stabilization in order to be effective (Plate 8, C-103).

These refinements resulted in the following feasible Project measures and descriptions. Plate 8, C-103, *Project Enhancement Measures Evaluated* depicts the location of each measure.

- **Lower Cut:** This measure includes the Lower Cut Aquatic Diversity excavation, and the Lower Cut Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Stewart Lake:** This measure includes the Stewart Lake Aquatic Diversity excavation, and the Stewart Lake Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Small Lake:** This measure includes the Small Lake Aquatic Diversity excavation, and the Small Lake Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Blue Bell Lake:** This measure includes the Blue Bell Aquatic Diversity excavation, and the Blue Bell Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Sand Burr Lake:** This measure includes the Sand Burr Aquatic Diversity excavation, and the Sand Burr Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Lower Lake:** This measure includes the Lower Lake Aquatic Diversity excavation, and the Lower Lake Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Upper Lake:** This measure includes the Upper Lake Aquatic Diversity excavation, and the Upper Lake Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Upper Cut:** This measure includes the Deep Cut/Upper Cut Aquatic Diversity excavation, and the Deep Cut/Upper Cut Topographic Diversity development (clearing, placement, shaping, and planting #3, #5, and #15 RPM trees and shrubs).
- **Closure Structure:** This measure includes the Beaver Island rock closure structure material and clearing.

- **Chevron:** This measure includes the Albany Island Chevron and the Albany Island Bankline Stabilization (upstream and downstream ends of the island).
- **Riprap:** This measure includes the Albany Island Bankline Stabilization (head end) and the Albany Island Bankline Stabilization (Albany Slough and Navigation Channel Banks).
- **Mussel Substrate:** This measure includes the strategic placement of appropriate mussel and host fish substrate in Albany Slough.
- **Timber Stand Improvement (TSI):** This measure includes a mix of interspersed tree plantings, tree girdling, and crop tree releases at various locations on over 350 acres of Beaver Island.

As the team progressed toward a focused array of alternatives for evaluation, the PDT identified the following additional considerations and rules for combining measures:

- The closure structure measure is necessary with any proposed aquatic diversity excavation to aid in the reduction of sediment into the backwater system;
- Mussel substrate is only an effective measure when Albany Island is being protected, either through the construction of the chevron or riprap-head end measures;
- TSI measure was added to all alternatives;
- In an effort to take advantage of existing opportunities, gain synergies between lakes, and improve connectivity of the backwater system, only ecological relevant and scientifically sound combinations of backwater dredging measures (i.e., dredging lakes and cuts) would be combinable.

After a lengthy process involving preliminary analysis, identification of compatibility, dependencies, and input from our resource agencies, the team identified the following list of measures to be formulated into alternatives (Table V-1).

Table V-1: Combined Aquatic Diversity Measures

A2	All Lakes w/closure
C2	Lower Cut, Stewart, Small, Blue Bell, Sand Burr Lakes w/closure
D2	Lower Cut, Stewart, Small Lakes w/closure
E2	Lower Cut, Blue Bell, Sand Burr Lakes w/closure
F2	Lower Cut, Stewart, Blue Bell, Sand Burr Lakes w/closure
G2	Lower Cut, Stewart, Small, Blue Bell, Sand Burr, Lower Lakes w/closure
H2	Lower Cut, Blue Bell, Sand Burr, Lower Lakes w/closure
I2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lakes w/closure
J2	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Upper Cuts and Upper Lakes w/closure
K2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Upper Cuts and Upper Lakes w/closure
L1	Albany Island Chevron Protection
L2	Albany Island Chevron Protection w/ mussel substrate
L3	Albany Island Riprap Head-end
L4	Albany Island Riprap Head-end Protection w/ mussel substrate

A. Formulation of Project Alternatives

After all potential features were identified (Table V-1) the IWR Planning Suite software (IWR-Plan) was used to facilitate development of alternative combinations of the measures. Input into the software included preliminary construction costs based on previous projects of a similar scope (i.e. parametric costs), and an initial estimation of habitat outputs. This resulted in over 100 possible alternatives, which was further reduced through an iterative process. Non-cost effective plans were removed from further consideration. Of the remaining alternatives, a base plan was identified as a stand-alone project with the combination of measures needed to achieve a minimum level of restoration (D2L3; Table V-2). The PDT then identified the maximum restoration plan which contained the maximum amount of habitat restoration and produced the maximum restoration output (K2L2; Table V-2). Finally, the PDT identified the remaining 16 with-Project alternatives based on factors such as ease of construction, management objectives, and ecological relevance including habitat connectivity and synergy with existing habitat. This approach resulted in our focused array of 19 alternatives including the no-action (Table V-2).

B. Evaluation of Focused Array of Project Alternatives

1. Habitat Benefits. The initial habitat benefit evaluation was further refined and additional detail applied to the focused array of alternatives to finalize the environmental benefits. This assessment includes a summary of the existing biological conditions used in the evaluation, as well as a forecast for future conditions under the No Action Alternative and each potential Project measure. The evaluation was conducted by a multi-agency team that included representatives from the USFWS, IADNR, and Corps. Aquatic benefits were quantified through the use of the Habitat Evaluation Procedures (HEP; USFWS 1980a). Floodplain benefits were quantified through the use of the HEC-Ecosystem Functions Model.

a. 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 wildlife species. The HEP is based on the assumption that habitat for selected wildlife species can be described by a Habitat Suitability Index (HSI). This index value (from 0.0 to 1.0) 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 (50 years). Habitat Units are calculated for select target years and annualized [using the Institute for Water Resources (IWR) Planning Suite II tool annualizer] over the period of analysis to derive net Average Annual Habitat Units (AAHUs). Net AAHUs are used as the output measurement to compare the measures and alternatives for the proposed Project.

The HEP procedures were used to evaluate the effects of the proposed Project measures on aquatic habitat quantity and quality. The bluegill HSI model (Certified for Regional Use per EC 1105-2-412) was used to assess backwater aquatic habitat because bluegills require backwater habitat for all or most of their life cycle and are often limited in the availability of high quality overwintering habitat. The walleye HSI model (Approved for Regional Use per EC 1105-2-412) was used to assess the riverine components because it is rheophilic or oriented to flow, and captures the benefits from an increase in forage, water clarity, and spawning habitat afforded by the measures. Additionally, walleye is a popular host fish species for numerous freshwater mussels that inhabit the Project area.

Assessment of existing Project area conditions, projected future conditions without the Project, and expected impacts of proposed Project measures was completed. A detailed description of the habitat analysis is provided in Appendix D, *Habitat Evaluation, Benefits Quantification and Incremental Analysis*.

b. HEC-Ecosystem Functions Model. The Corps-Certified (per EC 1105-2-412) Hydrologic Engineering Center Ecosystem Functions Model (HEC-EFM) was used to quantify the habitat benefits associated with increases in topographic diversity and bottomland forest restoration. The model estimates the potential forest community benefit from changing the relative surface area within specific flood zones. The area in each flood zone is compared among several reference conditions to assess physical changes affecting plant communities. In this case, the historic condition is represented by pre-dam hydrology (<1935) and the present by the hydrology that has been in place since the 1970s. Alternative restoration states include the area and height of topographic diversity. Topographic diversity is important because different plant communities occur within specific flood zones, and lack of physical diversity can lead to low plant community diversity as has been seen in large rivers nation-wide.

The theory behind this analysis is firmly entrenched in plant community ecology; plants are adapted to a specific moisture tolerance. Many plant species drown when inundated for too long. Forest species are grouped into one of three different groups based upon their tolerance (maximum, moderate, and minimum) to sustained inundation. Each tolerance category is assigned a number of days which refers to the maximum duration the group can withstand inundation, beyond which mortality sets in. A forest benefit metric is calculated by integrating the acres subject to flooding with the number of trees likely to occur within specific flood zones relevant to the survival and distribution of trees (DeJager et al. 2012; Appendix D, Figure D-1). The underlying premise of the quality score is that as the site tracks in the direction of the pre-dam conditions, habitat quality increases for numerous floodplain animals and neotropical migrant bird species. Timber stands improve in diversity, evenness, age, and growth, providing a more balanced forest structure. In order to determine the ideal conditions at the site, the pre-dam hydrologic condition was established, utilizing HEC-EFM, as the reference condition against which the existing condition and Project alternatives are compared.

Changes occur over time as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the period of analysis (50 years). HUs are calculated for the Pre-dam, Existing, Future with, and Future Without-Project conditions. HUs were calculated for each target year (pre-dam, existing, 25, 50) and annualized (using IWR Planning Suite's NER Annualizer) over the period of analysis (50 years) to derive AAHUs. AAHUs are used as the output measurement to compare the measures and alternatives for the proposed Project. A summary of the habitat analysis is provided in Table V-2. See Appendix D for a detailed description of the Alternatives' Environmental Outputs.

2. Cost Estimate for Measures. Table V-2 shows the estimated cost of Project alternatives as of completion of the habitat analysis (IWR Planning Suite). Cost estimates were prepared using May 2016 price levels. Annualized costs include construction costs, contingency costs, adaptive management costs and OMRR&R costs. Project measures are on Federal lands; consequently, there are no lands and damages or relocation costs. Total Project costs were annualized based on the Fiscal Year 2016 discount rate of 3.125% and a 50-year period of analysis. A more detailed breakdown of costs based on further design refinement for the Recommended Plan is outlined in Section VIII, *Cost Estimates.* The costs in Section VIII will not match the costs used in this habitat analysis.

C. Comparison of Focused Array of Project Alternatives

IWR-Plan was used to complete a cost effective and incremental cost analysis for the 19 alternatives (including the no action) using the average annual habitat units and annualized costs included in Table V-2 and described in Section V.C. This analysis identifies the subset of cost-effective plans that are superior financial investments, called "best buys," through analysis of the preliminary incremental costs. Best buys are the plans that are the most efficient at producing the output variable. In this case, best buys provide the greatest increase in AAHUs for the least increase in preliminary cost. The first best buy is the most efficient plan, producing output at the lowest incremental cost per unit. If a higher level of output is desired than that provided by the first best buy, the second best buy is the most efficient plan for producing additional output, and so on.

Table V-3 and Figure V-1 show the resulting alternatives differentiated by cost effectiveness. From this list of 19 alternatives, 4 Best Buy Plans (including No Action) were determined (Table V-4 and Figure V-2).

Table V-2. Environmental Output and Costs of Focused Array of Alternatives
(May 2016 Price Level – 50 year period of analysis using 3.125% discount rate)

Symbol	Measures	Over-wintering (Net AAHUs)	Floodplain Forest (Net AAHUs)	Island Prot./Mussel Substrate (Net AAHUs)	Total Gross AAHUs	Net AAHUs	Construction Costs w/ Contingency ($)	Annualized Costs ($)	Annualized Operation Costs ($)	Annualized Maintenance Costs ($)	Annualized Adaptive Mgmt Costs ($)	Interest During Construction ($)	Total Annualized Costs ($)
0	No Action Plan	0	0	0	70.1	0	0	0	0	0	0	0	0
D2L3	Lower Cut, Stewart, Small, Riprap, Closure	105	51	6.5	232.6	162.5	10,741,000	447,655	1,084	11,537	20,448	15,802	496,526
D2L4	Lower Cut, Stewart, Small, Riprap w/substrate, Closure	105	51	7.4	233.5	163.4	10,821,000	450,990	1,084	11,537	20,448	15,201	499,260
D2L1	Lower Cut, Stewart, Small, Chevron, Closure	105	51	16.1	242.2	172.1	11,154,000	464,868	1,084	11,537	20,448	15,678	513,615
D2L2	Lower Cut, Stewart, Small, Chevron w/substrate, Closure	105	51	23.2	249.3	179.2	11,234,000	468,202	1,084	11,537	20,448	17,191	518,462
E2L1	Lower Cut, Blue Bell, Sand Burr, Chevron, Closure	121	59	16.1	266.2	196.1	15,513,000	646,539	1,084	12,600	20,448	41,027	721,698
F2L1	Lower Cut, Stewart, Blue Bell, Sand Burr, Closure, Chevron	115	72	16.1	273.2	203.1	17,414,000	725,768	1,245	15,259	14,475	48,149	804,896
E2L2	Lower Cut, Blue Bell, Sand Burr, Chevron w/substrate, Closure	121	59	23.2	273.3	203.2	15,593,000	649,873	1,084	12,600	14,475	41,226	719,258
F2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Closure, Chevron w/substrate	115	72	23.2	280.3	210.2	17,495,000	729,144	1,245	15,259	15,745	48,348	809,741
H2L1	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron	126	75	16.1	287.2	217.1	17,952,000	748,190	1,245	16,588	15,745	49,622	831,390
H2L2	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron w/substrate	126	75	23.2	294.3	224.2	18,033,000	751,566	1,245	16,588	17,228	49,861	836,488
I2L3	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Riprap	129	89	6.5	294.6	224.5	19,659,000	819,333	1,406	19,246	19,064	68,683	927,732
H2L3	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Riprap w/substrate	126	75	6.5	277.6	207.5	19,741,000	822.751	1,406	19,246	19,064	70,553	933,020
G2L1	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron	131	86	16.1	303.2	233.1	20,080,000	836,879	1,406	19,246	17,228	70,155	944,914
G2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron w/substrate	131	86	23.2	310.3	240.2	20,162,000	840,297	1,406	19,246	19,064	70,434	950,447
J2L1	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron	135	101	16.1	322.2	252.1	23,724,000	988,751	1,568	20,044	19,615	87,306	1,117,284
J2L2	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron w/substrate	135	101	23.2	329.3	259.2	23,806,000	992,169	1,568	20,044	19,064	87,584	1,120,429
K2L1	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron	137	109	16.1	332.2	262.1	25,494,000	1,062,520	1,729	22,702	21,451	93,792	1,202,194
K2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron w/substrate	137	109	23.2	339.3	269.2	25,576,000	1,065,938	1,729	22,702	19,615	94,110	1,204,094

Table V-3. Focused Array of Alternatives Differentiated by Cost Effectiveness

Alt. Number	Alternative	Annualized Cost ($)	Output (AAHU)	Average Cost ($)	Cost Effective
0	No Action Plan	0	0	0	Best Buy
D2L3	Lower Cut, Stewart, Small, Riprap, Closure	496,526	162.5	3,056	Yes
D2L4	Lower Cut, Stewart, Small, Riprap w/substrate, Closure	499,260	163.4	3,055	Yes
D2L1	Lower Cut, Stewart, Small, Chevron, Closure	513,615	172.1	2,984	Yes
D2L2	Lower Cut, Stewart, Small, Chevron w/substrate, Closure	518,462	179.2	2,893	Best Buy
E2L1	Lower Cut, Blue Bell, Sand Burr, Chevron, Closure	721,698	196.1	3,680	No
F2L1	Lower Cut, Stewart, Blue Bell, Sand Burr, Closure, Chevron	804,896	203.1	3,963	No
E2L2	Lower Cut, Blue Bell, Sand Burr, Chevron w/substrate, Closure	719,258	203.2	3,540	Yes
F2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Closure, Chevron w/substrate	809,741	210.2	3,852	Yes
H2L1	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron	831,390	217.1	3,830	Yes
H2L2	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron w/substrate	836,488	224.2	3,731	Yes
I2L3	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Riprap	927,732	224.5	4,132	Yes
H2L3	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Riprap w/substrate	933,020	207.5	4,496	Yes
G2L1	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron	944,914	233.1	4,054	Yes
G2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron w/substrate	950,447	240.2	3,957	Best Buy
J2L1	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron	1,117,284	252.1	4,432	Yes
J2L2	Lower Cut, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron w/substrate	1,120,429	259.2	4,323	Yes
K2L1	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron	1,202,194	262.1	4,587	Yes
K2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron w/substrate	1,204,094	269.2	4,473	Best Buy

Table V-4. "Best Buy" Combinations

Symbol	Alternative	Outputs (HU)	Annualized Cost ($)	Average Cost ($)	Incremental Cost ($)	Incremental Output (HU)	Incremental Cost/Output ($/HU)
0	No Action Plan	0	0	0	0	0	0
D2L2	Lower Cut, Stewart, Small, Chevron w/substrate, Closure	179.2	518,462	2,893	518,462	179.2	2,893
G2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron w/substrate	240.2	950,447	3,957	431,985	61.0	7,082
K2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron w/substrate	269.2	1,204,094	4,473	253,647	29.0	8,746

Table V-5. "Best Buy" Combinations with Recommended Plan

Symbol	Alternative	Outputs (HU)	Annualized Cost ($)	Average Cost ($)	Incremental Cost ($)	Incremental Output (HU)	Incremental Cost/Output ($/HU)
0	No Action Plan	0	0	0	0	0	0
D2L2	Lower Cut, Stewart, Small, Chevron w/substrate, Closure	179.2	518,462	2,893	518,462	179.20	2,893
Rec.Plan Cost Eff. F2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Closure, Chevron w/substrate	210.2	809,741	3,852	291,279	31.00	9,396
G2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Closure, Chevron w/substrate	240.2	950,447	3,957	140,706	30.00	4,690
K2L2	Lower Cut, Stewart, Blue Bell, Sand Burr, Lower Lake, Upper Lake, Upper Cut, Closure, Chevron w/substrate	269.2	1,204,094	4,473	253,647	29.00	8,746

Costs were prepared using May 2016 price levels and are based on a 50-year period of analysis, 3.125% interest rate

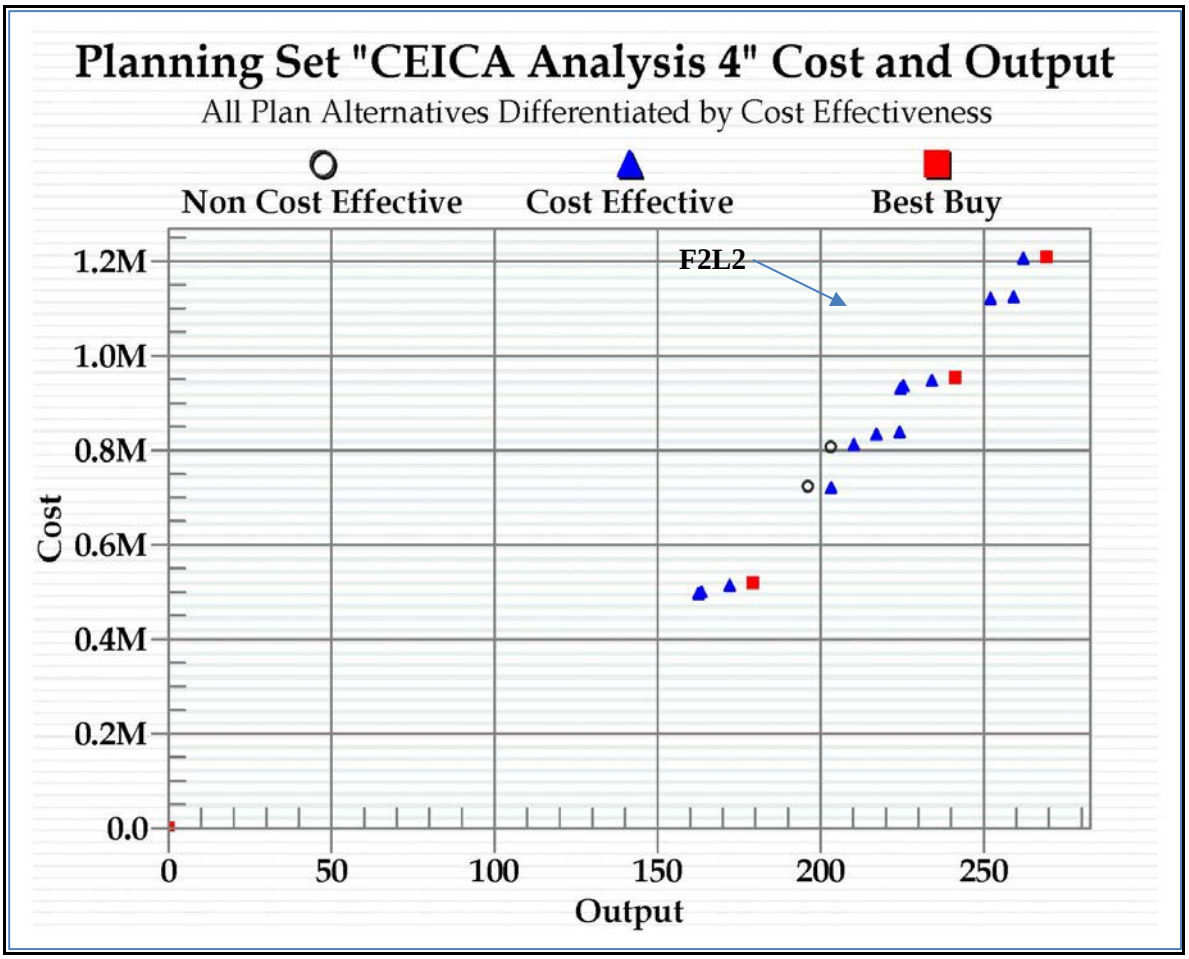

Figure V-1. Focused Array of Alternatives Differentiated by Cost Effectiveness

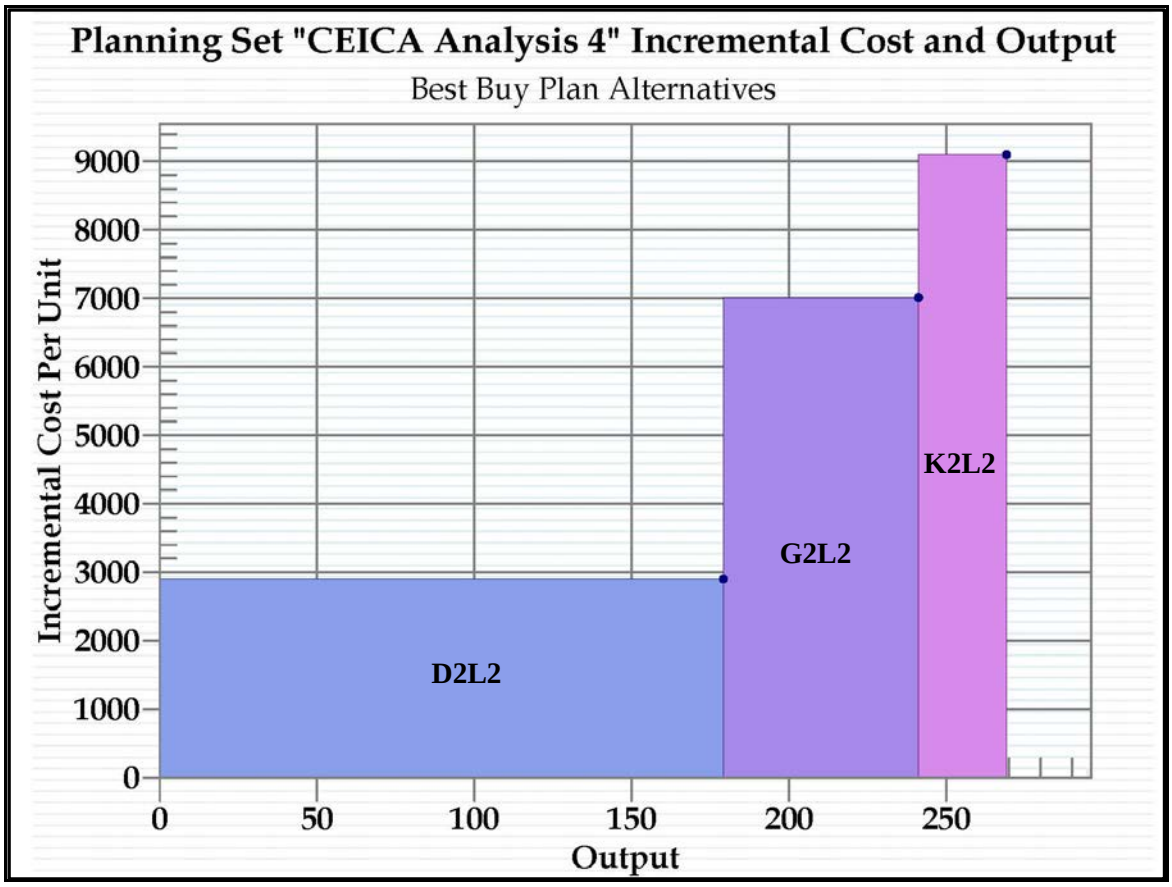

Figure V-2. Beaver Island "Best Buy" Plans

D. Selection of the Recommended Plan. Federal planning for water resources development was conducted in accordance with the Principles and Guidelines (P&G) adopted by the U.S. Water Resources Council.

> *"For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. This plan shall be identified as the National Ecosystem Restoration (NER) Plan."*

Review of the four formulation criteria suggested by the P&G (completeness, effectiveness, efficiency, and acceptability, defined below) and resource significance (institutional, public, and technical) were used to aide in the selection of the Recommended Plan.

- ***Completeness.*** Completeness is the extent to which an alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. That could require relating the plan to other types of public or private plans if the other plans are crucial to achieving the contributions to the objective.

- ***Effectiveness***. All the plans in the final array provide some contribution to the Project objectives. Effectiveness is defined as a measure of the extent to which a plan achieves its objectives.

- ***Efficiency.*** All the plans in the final array provide net benefits. Efficiency is a measure of the plan's cost-effectiveness expressed in net benefits.

- ***Acceptability.*** All the plans in the final array must be in accordance with Federal law and policy. Acceptability is defined in terms of acceptance of the plan by the non-Federal sponsor and the concerned public. After completing the alternative formulation briefing, the Recommended Plan is presented to stakeholders to determine its acceptability.
- ***Institutional Recognition***: The importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups.
- ***Public Recognition***: 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.
- ***Technical Recognition***: The resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. 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.

The PDT reviewed the Best Buy Plans (Table V-4 and Figure V-2) and determined that the cost to implement the first iteration of Best Buy Plans above the No Action Plan, Alternative D2L2, was worth the incremental investment above the No Action Plan because it provides an acceptable level of restoration for an acceptable cost. It provides 179.2 habitat units over the No Action Plan at an incremental cost per unit of output ($/HU) of $2,893.

The next Best Buy Plan, Alternative G2L2 (240.2 AAHUs; $7,082 $/HU), differs from Alternative D2L2 by adding dredging at Blue Bell, Sand Burr, and Lower Lakes and dropping dredging at Small Lake. The PDT determined that although there would be additional benefits, Alternative G2L2 would not be considered further because placing material excavated from Lower Lake would require a higher amount of clearing of a diverse forested area as shown on Figure II-2 or shift material placement to all aquatic areas, which the PDT considered as having higher impacts when compared to other potential cost effective plans.

The last Best Buy Plan, Alternative K2L2 (269.2 AAHUs; $8,746 $/HU), differs from Alternative D2L2 by adding dredging at Blue Bell, Sand Burr, Lower, and Upper Lakes and Upper Cuts plus dropping dredging at Small Lake. The PDT determined that although there would be additional benefits, Alternative K2L2 would not be considered further because placing material excavated from Lower Lake would require a higher amount of clearing of a diverse forested area as shown on Figure II-2 or shift material placement to all aquatic areas, which the PDT considered as having higher impacts when compared to other potential cost effective plans. Excavating Upper Lake would result in a large volume of excavated material because the overwhelming majority of the lake is at flat pool or higher, which the PDT considered too expensive for the habitat units gained. After further investigation of the proposed excavation at the Upper Cuts, it was determined that this excavation was

not operationally feasible because the narrow, twisting channel restricts use of barge mounted equipment and using land-based equipment would result in a higher amount of tree clearing when compared to other potential cost effective plans.

Blue Bell and Sand Burr Lakes that were a part of both best buy Alternatives G2L2 and K2L2 are worthy of additional discussion regarding inclusion in the Recommended Plan. The PDT proposes that the cost effective Alternative F2L2 (210.2 AAHUs; $9,396 $/HU) is a better selection than the best buy alternatives in that it includes Blue Bell Lake, which currently provides overwintering habitat and is important to maintain for fish to continue to return to year after year (Figure V-1 and Table V-3). The swapping of Sand Burr for Small Lake is worth it because more deep water habitat is restored and it provides a connection to the valuable wetland habitat already existing in adjacent Hulzinger Lake.

The other cost effective alternatives between best buy Alternatives D2L2 and K2L2 fall short of the Project objectives and the Sponsors' needs because Stewart Lake is not included in Alternatives E2L2, H2L1, and H2L2 and/or Lower Lake is included in each cost effective alternative except E2L2. Stewart Lake is important because its proximity to the main channel would maintain a hydraulic connection, providing adequate DO levels to overwintering fish during severe winters or other low DO events. Excavating Lower Lake would result in a higher amount of diverse forest clearing or aquatic placement, as described previously. As a result of this discussion and review of the four formulation criteria, the PDT concludes that **Alternative F2L2 is the Recommended Plan and the NER Plan** since it reasonably maximizes ecosystem restoration benefits at an acceptable incremental cost. Refer to Tables V-5 and V-6 to demonstrate how the Recommended Plan compares to other plans based on the P&G criteria and Resource Significance of the Outputs.

The Recommended Plan is important to Beaver Island and offers a unique opportunity to restore and enhance fish and wildlife resources in this section of Pool 14. The enhancement of Beaver Island offered by the Recommended Plan is preferred among the other plans, specifically because of the improvements to the recognized significant resources (institutional, public, and technical).

The institutional importance of the Beaver Island HREP is primarily demonstrated as it meets the goals and objectives of the Upper Mississippi River National Wildlife and Fish Refuge, which was established by Congress in 1924 to provide a refuge and breeding ground for migratory birds, fish, other wildlife, and plants. Other features of the Recommended Plan, as in the protection and enhancement of mussel habitat in Albany Slough and the enhancement of bat habitat by TSI actions, achieve the goals and objectives set forth in the Endangered Species Act of 1973, as amended. Additional habitat gains will result for floodplain forest quality through increasing hardwood forest stand species diversity, age, and structure. This will also provide long-term benefits to resident migratory bird and other species relying on hardwood mast trees as a source of food and shelter, implementing the goals and objects set forth in The Migratory Bird Treaty Act of 1918, the EO 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds, the Bald and Golden Eagle Protection Act of 1940, and the Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661).

The public importance of the Beaver Island HREP is primarily demonstrated by the multi-agency coordination effort in maintaining a high quality UMR ecosystem while avoiding adverse impacts. Beaver Island represents the largest and single most important habitat restoration Project in Pool 14 to restore degraded environmental conditions within the backwater and floodplain forest habitats that will benefit migratory birds, fish, other wildlife, and plants. This Project addresses the public's and natural resource specialists' needs and preferences in local habitat restoration and recreation.

The technical importance of the Beaver Island HREP is primarily demonstrated by improving overwintering conditions for a variety of species, thus increasing the representativeness of the area. Expansion of the aquatic limiting habitat by excavation in Lower Cut, Stewart Lake, Blue Bell Lake, and Sand Burr Lake to improve overwintering fish habitat and aquatic diversity will increase backwater depths with the resulting improvement in water quality and fish habitat structures. This should promote and improve seasonal refugia with resulting benefits to the warm-water fisheries communities. A rock closure structure is also included to protect the excavated areas from excessive sediment deposition and ensure low flow conditions during fish overwintering periods. Expansion of the forested limiting habitat will be conducted by using the excavated material to increase the topographic diversity on Beaver Island. The topographic diversity areas would be planted with a mix of mast-producing trees and other understory species to improve the biodiversity of the floodplain forest. The enhancement of the floodplain forest by these and other TSI actions will improve the scarcity of the listed bat species in the area. In addition, the construction of a rock chevron on Albany Island's head end in conjunction with bank stabilization, and the addition of rocky substrate for mussels should promote and improve the scarcity of the listed mussel species habitat quality. These improvements would extend beyond each individual site and expected to benefit the entire fish and wildlife communities within adjacent areas, therefore improving connectivity.

Table V-6. Recommended Plan Justification as Compared With Other Alternatives

Alternative	CE/ICA	Completeness (not all alternatives have mussels included)	# Lakes Excavated (Robustness and Connectivity)	Limiting Habitat Gained (overwintering and forest total net	Diverse Forest Clearing (acres)	Aquatic Placement (acres)
D2L3	CE	-	3	156	52	0
D2L4	CE	+	3	156	52	0
D2L1	CE	-	3	156	50	0
D2L2	Best Buy	+	3	156	50	0
E2L2	CE	+	3	180	72	3
F2L2 (TSP)	**CE**	**+**	**4**	**187**	**76**	**3**
H2L1	CE	-	4	201	75	19
H2L2	CE	+	4	201	75	19
I2L3	CE	-	5	218	81	19
H2L3	CE	-	5	201	81	19
G2L1	CE	-	5	217	79	19
G2L2	Best Buy	+	5	217	79	19
J2L1	CE	-	6	236	87	43
J2L2	CE	+	6	236	87	43
K2L1	CE	-	7	246	89	43
K2L2	Best Buy	+	7	246	89	43

Assumptions:
Robustness is defined as number of lakes excavated to connect overwintering habitat
lakes more than 3 considered ideal
AAHU gain 180 and more considered ideal
Forest Clearing over 80 ac considered undesirable
Aquatic Placement over 10 ac considered undesirable

E. Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made regarding the reliability of estimated benefits and the costs of alternative plans. Risk is defined as the probability or likelihood for an outcome. Uncertainty refers to the likelihood that an outcome results from a lack of knowledge about critical elements or processes that then contributes to risk or natural variability in the same elements or processes.

The team worked to manage risk in developing measures. It developed measures by expanding on and referencing successful similar work completed by previous HREPs and the Design Handbook. The team used that experience from previous projects to identify possible risks and decrease uncertainty in plan formulation. No measures in the Recommended Plan are believed to be burdened by significant risk or uncertainty regarding the eventual success of the proposed measures. Significant risk would be avoided by proper design, appropriate selection, and correct seasonal timing of 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 uncertain outcomes in all Recommended Plan components.

Success of floodplain forest plantings was identified as having a minor level of risk. The team lowered the risk by determining the optimal elevation for successful growth through hydraulic analysis and planting a variety of species with varying circumference size on areas of higher elevation. This design will not only increase survivability, but also lead to a better understanding of tree survivability in the Mississippi River floodplain.

It is expected that overwintering and summer habitat in the dredged backwaters will not be limited by dissolved oxygen or flow as a result of the closing structure construction. However, this expectation remains uncertain. If monitoring demonstrates a need for decreased flow, increased dissolved oxygen, or a combination of the two, an adaptive management measure to modify the closing structure will be implemented.

It is expected that implementation of the chevron structure will not significantly alter hydraulic forces within Albany Slough side channel and will continue to provide stabilization of Albany Island. If monitoring demonstrates a significant impact to mussels within Albany Slough or continued erosion of Albany Island a modification of the structure will be required. A hydraulic model determined there were no floodplain impacts from placing rock for bank stabilization.

Sea level rise is not expected to impact the Recommended Plan since the Project is located several hundred feet above mean sea level. However, a potential risk and uncertainty associated with climate change is an increase in sediment deposition from increased aggradation and flooding.

VI. RECOMMENDED PLAN: DESCRIPTION WITH DESIGN, CONSTRUCTION, AND OPERATION AND MAINTENANCE CONSIDERATIONS

This section discusses the Recommended Plan, which will meet the Project goals and objectives. This plan was developed following the incremental cost analysis, and was refined with more design details. The Recommended Plan for habitat rehabilitation and enhancement of Beaver Island is shown on Figure ES-1 and Plate 7, C-102, and described as follows:

- Increasing aquatic diversity in the Beaver Island backwater, specifically in Lower Cut, Stewart Lake, Blue Bell Lake, Sand Burr Lake, as well as two unnamed connections through excavation and additions of fisheries structures to address the Project objective of providing suitable year-round aquatic habitat for fish use, spawning, rearing, and overwintering. While details such as fisheries structures are typically developed during the design stage due to the low cost and risk of these structures, the IADNR fisheries specialists requested that information they have available be included in the report to ensure that these details are included in the final design.
- Restoring forest diversity in select areas of Beaver Island by increasing existing elevations and planting trees, shrubs, understory plants, and buffer species to address the Project objective of diversifying floodplain forest habitat.
- Maintaining aquatic diversity in the Beaver Island backwater by constructing a closure structure at the upstream end of Upper Cut, which will help reduce sediment influx into the complex to address the Project objective of providing suitable year-round aquatic habitat for fish use, spawning, rearing, and overwintering.
- Constructing a chevron, bankline protection, and adding substrate to preserve and enhance Albany Island and Albany Slough for aquatic and mussel habitat to address the Project objective of increasing structure and function of side channel habitat for use by native freshwater mussels.

A. Aquatic and Topographic Diversity

The aquatic and topographic diversity measures are listed as separate measures because different habitat types are being developed. However, these measures are intertwined as material used from excavation of the aquatic diversity areas will be used to enhance the topographic diversity measures.

1. Aquatic Diversity Measures. Excavation has been proposed as a potential measure to provide suitable year-round habitat for fish, which includes critical overwintering habitat for centrarchid fish species. Excavation will also provide material to increase topographic diversity within the floodplain forest. Mechanical excavation or dredging would be required for these aquatic diversity sites (Plate 19, C-301). Appendix M, *Engineering Design*, lists design constraints or considerations; some of these considerations are as follows:

- Preferred Minimum width: 60 foot bottom when allowed by existing topography (or full channel width if less than 60 feet).
- Channel slopes 4H:1V
- Allowable overwintering flow: as close to 0 as possible.
- Connect cuts to deep water.

- Place cuts in areas fish use.
- Make cuts deep enough that they do not freeze (habitat benefits for water > 4 feet).
- Make cuts deep enough that they do not fill in during the 50-year period of analysis (expect 1.6 feet of sediment deposition in 50 years).
    - Overwintering depth 6 feet plus 2 additional feet for sediment deposition.
    - Connection depth 4 feet plus 2 additional feet for sediment deposition.
    - Deep hole depth 8 feet plus 2 additional feet for sediment deposition.

Aquatic diversity was considered using a mechanical dredge. While a mechanical dredging would necessitate adjacent placement or handling excavated material multiple times, it does not require a large settling basin as would be required for a hydraulic dredging confined material placement site and would be more readily available for use as a topographic diversity site. A floating excavator, barge mounted crane or barge mounted excavator could be used. For areas with a larger bottom width for the excavation area or a further reach for placement of dredged material, a barge mounted crane with a bucket of sufficient size would likely be used. All areas proposed for dredging or excavation are surrounded by trees which overhang the pool, so tree clearing would be required prior to side casting the material. Refer to Appendix M, *Engineering Design*, for photographs of various dredges which may be used.

a. Lower Cut Aquatic Diversity. The dredge cut would be excavated to provide aquatic diversity through the direct act of dredging and to provide sufficient material for floodplain forest topographic diversity. This site will provide access into the Beaver Island interior as well as the numerous side lakes or channels. The cut was situated to ensure it will tie into deeper water in the main channel of the river, and placed in deeper water locations. A deep hole will be constructed within this cut, approximately 100 feet in length by 60 feet in width and an additional 4 feet deep. Fishery structures such as woody debris or rock piles will be added to this area to provide a more diverse habitat. Material excavated from this site will be transported to a topographic diversity site (such as Lower Cut North or South). This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- Narrower channel widths (bank to bank) on the upstream end reduced channel widths from 60 feet to 50 feet wide.
- Overall length was reduced because there was no longer a need to connect with Lower Lake after it was eliminated by the ICA.

Refer to Table VI-1 and Plates 10, C-105 and 11, C-106 for further details.

Table VI-1. Lower Cut Aquatic Diversity

Item	Quantity	Unit
Length	3,800	FT
Acres Dredged	14.6	AC
Acres Below 4 feet	13	AC
Quantity Excavated	124,590	CY
Bottom Width	150 feet (Sta 0+00 to 25+50), 50 feet (Sta 25+50 to end)	FT
Average Bottom Elevation	563.20 (deep hole 559.20)	NAVD88

b. Stewart Lake Aquatic Diversity. Stewart Lake is the furthest downstream lake. The lake will likely be the first location fish enter, and possibly the last location fish exit during overwintering periods. The cut will extend about halfway up Stewart Lake and encompass most of the lake width. Further excavation north into the lake is not recommended due to federally threatened bats utilizing the forest on the lake's upstream end and its proximity to an occupied heron rookery. Fishery structures such as woody debris or rock piles will be added to this area to provide a more diverse habitat. Material excavated from this site will be transported to topographic diversity sites (likely Stewart Lake and Lower Cut-South). This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- The overall length was reduced to limit potential impacts to identified northern long-eared bat roost trees and a heron rookery.

Refer to Table VI-2 and Plate 12, C-107 for further details.

Table VI-2. Stewart Lake Aquatic Diversity

Item	Quantity	Unit
Length	800	FT
Acres Dredged	2.2	AC
Acres Below 4 feet	1.7	AC
Quantity Excavated	21,700	CY
Bottom Width	60	FT
Average Bottom Elevation	563.20	NAVD88

c. Blue Bell Lake Aquatic Diversity. The Blue Bell Lake cut was selected to have varying channel bottom widths, with the wider location on the lower end to hold fish in the later winter months when oxygen levels are depleted. Unlike the other proposed lake dredging, this lake currently provides some overwintering opportunities that is important to maintain for returning fish. A deep hole will be constructed within this cut, approximately 100 feet in length by 60 feet in width and an additional 4 feet deep. Fishery structures such as woody debris or rock piles would be added to this area to provide a more diverse habitat. Material excavated from this site would be transported to topographic diversity sites (likely Blue Bell-East and Blue Bell-West). This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- The overall widths were changed to better match existing contours.

Refer to Table VI-3 and Plate 13, C-108 for further details.

Table VI-3. Blue Bell Lake Aquatic Diversity

Item	Quantity	Unit
Length	1,708	FT
Acres Dredged	6.2	AC
Acres Below 4 feet	5.3	AC
Quantity Excavated	59,390	CY
Bottom Width	150 feet from Sta 2+00 to 10+00, 60 feet in all other locations	FT
Average Bottom Elevation	563.20 (deep hole 559.20)	NAVD88

e. Sand Burr Lake Aquatic Diversity. The Sand Burr Lake cut was selected to have varying widths of channel bottoms, with the wider location on the upper end used to hold fish in the later winter months when oxygen levels are depleted. A deep hole would be constructed within this cut, approximately 100 feet in length by 60 feet in width and an additional 4 feet deep. Fishery structures such as woody debris or rock piles will be added to this area to provide a more diverse habitat. Excavating this lake also provides a connection to existing valuable wetland habitat in the adjacent Hulzinger Lake. Material excavated from this site would be transported to a topographic diversity site (likely Sand Burr, Blue Bell-East, and Lower Cut-South).

Refer to Table VI-4 and Plate 15, C-110 for further details.

Table VI-4. Sand Burr Lake Aquatic Diversity

Item	Quantity	Unit
Length	2,466	FT
Acres Dredged	8.4	AC
Acres Below 4 feet	6.8	AC
Quantity Excavated	88,190	CY
Bottom Width	60 feet from Sta 0+00 to 17+00, 150 feet from Sta 17+00 to end	FT
Average Bottom Elevation	563.20 (deep hole 559.20)	NAVD88

f. Blue Bell Lake to Sand Burr Lake Aquatic Diversity. This cut would be excavated to ensure that fish could pass between Blue Bell Lake and Sand Burr Lake cuts, providing additional access and egress locations during overwintering and oversummering conditions. Material excavated from this site will be transported to a topographic diversity site (likely Lower Cut-South). This site was added during development of the Recommended Plan as access concerns were raised with the initial layout of sites.

Refer to Table VI-5 and Plate 14, C-109 for further details.

Table VI-5. Blue Bell Lake to Sand Burr Lake Aquatic Diversity

Item	Quantity	Unit
Length	361	FT
Acres Dredged	0.7	AC
Acres Below 4 feet	0.5	AC
Quantity Excavated	5,400	CY
Bottom Width	30	FT
Average Bottom Elevation	563.20	NAVD88

g. Sand Burr Lake to Hulzinger Lake Aquatic Diversity. This cut would be excavated to ensure that fish could pass between the existing deep water in Hulzinger Lake and the Sand Burr Lake cut, providing additional access and egress locations during overwintering and oversummering conditions. Material excavated from this site will be transported to a topographic diversity site (likely Sand Burr and Lower Cut-South). This site was added during development of the Recommended Plan as access concerns were raised with the initial layout of sites.

Refer to Table VI-6 and Plate 16, C-111 for further details.

Table VI-6. Sand Burr Lake to Hulzinger Lake Aquatic Diversity

Item	Quantity	Unit
Length	298	FT
Acres Dredged	0.7	AC
Acres Below 4 feet	0.4	AC
Quantity Excavated	6,300	CY
Bottom Width	30	FT
Average Bottom Elevation	563.20	NAVD88

2. Topographic Diversity Design Criteria. Topographic diversity sites were originally laid out as sites adjacent to the aquatic diversity sites. During development of the Recommended Plan, additional design considerations such as bat habitat, diverse and non-diverse forest locations, heron rookeries, and existing contours were incorporated into the Recommended Plan design. Other design considerations are outlined in Appendix M, *Engineering Design*, and as found below:

- Avoid existing diverse forest locations, and in some cases, avoid specific trees
- Place in areas with lower quality forest and lower elevations
- Maximize heights for planting survivability
- No tree clearing during the federally endangered Indiana bat and northern long-eared bat maternity season of April 1 to September 30
- Do not impact the floodplain
- Minimize footprint of proposed measures
- Consider flat slopes for erosion control
- Provide sufficient placement capacity for dredge cuts
- Ensure sites can be constructed using typical construction equipment

Optimum elevations for tree survival were developed using forestry and hydraulics information. A result of this analysis is provided in Appendix H, *Hydrology and Hydraulics*, and is outlined in Table VI-7. Appendix H also provides a climate change analysis. Table VI-8 outlines water surface elevations near RM 514.

Table VI-7. Topographic Diversity Berm Elevations

Design Criteria	Elevation w/o Climate Change (NAVD88)	Elevation w/ Climate Change (NAVD88)
EFM 25% Exceedance Probability for **Minimally** Tolerant Species (**25** days inundation duration during growing season 4/15 to 10/15)	577.9 (578.7 MSL1912)	579.8 (580.6 MSL1912)
EFM 25% Exceedance Probability for **Moderately** Tolerant Species (**35** days inundation duration during growing season 4/15 to 10/15)	576.7 (577.6 MSL1912)	578.3 (579.2 MSL1912)

Table VI-8. Water Surface Elevations at River Mile 514

Item	Elevation (NAVD88)
Flat Pool	571.2
Aquatic habitat benefits	<572.2
Floodplain habitat benefits	>572.2
50% chance exceedance of flood (2 yr)	578.66
20% chance exceedance of flood (5 yr)	581.36
10% chance exceedance of flood (10 yr)	583.30

All topographic diversity sites will require the existing trees (if present) to be cleared before material will be placed to construct the site to an optimum elevation for tree survival (refer to Plate 23, L-101, *Clearing Plan* for locations and Plate 19, C-301 for typical placement method). No tree clearing will be conducted during the federally endangered Indiana bat and northern long-eared bat maternity season of April 1 to September 30. Cleared trees shall be removed from site or utilized as habitat measures on site. Material will come from excavated channels within Beaver Island. The sites will either be sloped to drain, or will have +/- 1 foot elevation changes to create swales across the wider sites.

Once shaping is complete, temporary seeding may be employed if permanent seeding cannot be planted immediately. Each topographic diversity location will be divided into ½ acre plots that will be planted with different tree sizes.

Tree species to be planted are shown in Table VI-9. Tree wraps or other measures to prevent herbivory will be provided. Forested wetland shrubs will be interplanted with the forested wetland trees (Table VI-10). An understory seed mixture will be planted underneath the shrubs and trees (Table VI-11). A buffer mix to include seeds and stakes will be planted on the slopes approaching the planting areas (Table VI-12).

Topographic diversity sites are shown on Plate 7, C-102, *Recommended Plan*. Each site is further detailed in this section. Additional information on the plantings are shown on Plates 24 through 30, (L-102 through L-603). Timber Stand Improvement (TSI) activities will be implemented on approximately 350 acres of Beaver Island and would clear old trees to benefit desirable understory species by decreasing competition (Plate 7, C-102). Timber Stand Improvement activities may result in positive long-term benefits to federally-listed bat species by providing additional habitat and/or potential roost trees, providing foraging habitat, and increasing solar exposure to occupied roost trees adjacent to clearing areas. Timber Stand Improvement may include the following activities:

- Crop tree release
- Girdling
- Tree plantings

Table VI-9: Forested Wetland Trees

#3 RPM (108 trees per acre)	
River Birch	*Betula nigra*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Common Hackberry	*Celtis occidentalis*
Common Persimmon	*Diospyros virginiana*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
American Sycamore	*Platanus occidentalis*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Overcup Oak	*Quercus lyrata*
#5 RPM (48 trees per acre)	
River Birch	*Betula nigra*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Common Hackberry	*Celtis occidentalis*
Common Persimmon	*Diospyros virginiana*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
American Sycamore	*Platanus occidentalis*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Overcup Oak	*Quercus lyrata*
#15 RPM (27 trees per acre)	
River Birch	*Betula nigra*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Common Hackberry	*Celtis occidentalis*
Common Persimmon	*Diospyros virginiana*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
American Sycamore	*Platanus occidentalis*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Overcup Oak	*Quercus lyrata*
MISCELLANEOUS	
TREE WRAPS (#3/#5 Trees)	
TREE WRAPS (#15 Trees)	

Table VI-10. Forested Wetland Shrubs

Common Name	Scientific Name
Common Buttonbush	*Cephalanthus occidentalis*
Red-Osier Dogwood	*Cornus stolonifera*
Silky Dogwood	*Cornus amomum*
American Elderberry	*Sambucus canadensis*
Northern Spicebush	*Lindera benzoin*
American Bladdernut	*Staphylea trifolia*

Table VI-11. Understory Seed Mixture

125,000 seeds per acre	
Common Name	**Scientific Name**
Virginia Wild Rye	*Elymus virginicus*
Canada Wild Rye	*Elymus canadensis*
Partridge Pea	*Chamaechrista fasciculata*
Buttonbush	*Cephalanthus occidentalis*
Rice Cut Grass	*Leersia oryzoides*
Cardinal Flower	*Lobelia cardinalis*
Sneezeweed	*Helenium autumnale*
Swamp Milkweed	*Asclepias incarnata*

Table VI-12. Buffer Area

Common Name	Scientific Name
Black Willow	*Salix nigra*
Cottonwood	*Populus deltoids*
River Birch	*Betula nigra*
Buttonbush	*Cephalanthus occidentalis*

a. Lower Cut Topographic Diversity (North and South Bank). The topographic diversity site on the north bank will help prevent overland flow during flood conditions from entering the channel from Beaver Slough. This is a lower quality forest which would be cleared then constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species

The topographic diversity site on the south bank is one of the lower quality forest stands on the island. The wide footprint of this site will allow for variations in plantings, and minor variations in elevation height (+/- 1 foot) to provide small swales on top of the placement sites. This site would be cleared then constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species.

This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- The north placement site was lengthened to adjoin the boundaries of the Stewart Lake site in order to provide a contiguous forest improvement location.
- The south placement site was shortened such that the site was accessible via water from the Lower Cut excavation.
- The south placement site was made wider than the majority of other forest enhancement measures. This lower quality forest can be significantly improved by increasing the overall height.

Refer to Table VI-13 and Plates 10, C-105 and 11, C-106 for further details.

Table VI-13. Lower Cut Topographic Diversity

Item	Quantity	Unit
Length – North Bank	1,950	FT
Length – South Bank	2,750	FT
Approximate Tree Clearing	43	AC
Topographic Diversity	42	AC
Quantity Capacity	155,800	CY
Average Width – North Bank	90-245	FT
Average Width – South Bank	229-500	FT
Average Top Elevation	579.80	NAVD88

b. Stewart Lake Topographic Diversity. This site is located adjacent to Stewart Lake on the west bank. The site was placed in an area of lower forest diversity, but adjacent to higher diversity areas. The site was situated to reduce potential impacts to Indiana bats, northern long-eared bats, and a heron rookery. Most of the material at this location will likely come from the Stewart Lake cut. This site would be cleared then constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species. This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- The site on the east was eliminated during development of the Recommended Plan to reduce the number of sites being cleared and reduce forest fragmentation.
- The west side was reduced in length to reduce potential impacts to Indiana bats, northern long-eared bats and a heron rookery.

Refer to Table VI-14 and Plate 12, C-107 for further details.

Table VI-14. Stewart Lake Topographic Diversity

Item	Quantity	Unit
Length	475	FT
Approximate Tree Clearing	4	AC
Topographic Diversity	4	AC
Quantity Capacity	19,800	CY
Average Width	300	FT
Average Top Elevation	579.80	NAVD88

c. Blue Bell Lake Topographic Diversity (East and West Bank). The west bank site is located between Small Lake and Blue Bell Lake. The site has a lower quality forest that would be cleared, then built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species.

The east bank site is located between Blue Bell Lake and Sand Burr Lake. The site follows existing contours and is in a lower quality forest. The site would be adjacent to a higher quality forest which may help future regeneration in the area in addition to Project plantings. The site would be cleared, then built to optimum elevations for tree survival. This site would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species.

This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- The west side had the overall length reduced to avoid impacts to a stand of diverse trees.
- The east side was increased in length to increase heights in more areas of poor forest diversity.

Refer to Table VI-15 and Plate 13, C-108 for further details.

Table VI-15. Blue Bell Lake Topographic Diversity

Item	Quantity	Unit
Length – West Bank	1,030	FT
Length – East Bank	2,200	FT
Approximate Tree Clearing	23	AC
Topographic Diversity	25	AC
Quantity Capacity	135,500	CY
Average Width – West Bank	350-380	FT
Average Width – East Bank	140-440	FT
Average Top Elevation	579.80	NAVD88

d. Sand Burr Lake Topographic Diversity. The Sand Burr Lake site is located between Sand Burr Lake and Hulzinger Lake and was reduced in size to limit impacts to higher quality forest on the north end. The site will follow existing topography and will ensure that an opening remains between Sand Burr Lake and Hulzinger Lake for fish passage. The site would be cleared, then built to optimum elevations for tree survival. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species.

This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- The west bank side was eliminated to reduce the overall number of placement sites, which also reduces impacts to higher quality forested areas.
- The east side was increased slightly in length to follow existing contours.

Refer to Table VI-16 and Plate 15, C-110 for further details.

Table VI-16. Sand Burr Lake Topographic Diversity

Item	Quantity	Unit
Length	1,229	FT
Approximate Tree Clearing	6	AC
Topographic Diversity	7	AC
Quantity Capacity	40,100	CY
Average Width	150-295	FT
Average Top Elevation	579.80	NAVD88

B. River Training Structures

1. Beaver Island Closure Structure. Closure structures have been proposed as a potential measure to improve aquatic habitat by deflecting sediment and reducing flows. Closure structures are

generally constructed with rock, though new design concepts involving woody material are being developed.

The closure structure selected for this Project is at the upstream end of Upper Cut/Deep Cut and is adjacent to Beaver Slough. The structure would be constructed to reduce sediment deposition into the site. Trees would be cleared at the tie in ends of the structure, and the structure would be constructed with riprap.

This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- Structure elevation increased to address intent to prevent flow down channel year round as a sediment reduction measure.

Refer to Table VI-17 and Plates 18, C-113 and 20, C-302 for further details.

Table VI-17. Beaver Island Closure Structure

Item	Quantity	Unit
Length (bank to bank)	252	FT
Upstream Slope	2	H:1V
Downstream Slope	3	H:1V
Approximate Tree Clearing	0.3	AC
Estimated Quantity	5,000	TN
Top Width	10	FT
Average Top Elevation	Top of Bank (approx. 579.5 to 580)	NAVD88

2. Chevron (Albany Island). This measure would protect Albany Island from further erosion, thereby protecting the adjacent mussel beds. This structure is designed to be exceeded ~25% of the time. The design criteria indicates a 30% exceedance duration; however, to account for increasing stage durations due to a changing climate, the design elevation was slightly increased. The risk of increased exceedance duration to the performance of the Albany Island chevron posed by climate change is considered moderate to low.

The shape of the chevron would have a rounded nose. The opening between the chevron and Albany Island would be maintained (and not increased) relative to what is shown in the feasibility alignment, approximately 85 feet away from the island as measured orthogonally. The chevron is about 250 feet upstream of Albany Island at the furthest point.

Civil parameters are shown in Table VI-18. Additional design details are provided in Appendix M, *Engineering Design*.

A mussel impact analysis was conducted to ensure chevron construction will not impact the existing mussel bed. The analysis was based on a physical characteristics diagnostic of mussel presence as identified by Zigler et al., 2007 (see Appendix H, *Hydrology and Hydraulics* reference list). The physical characteristics identified in the author's Classification and Regression Tree (CART) Model included bed slope, shear stress and relative substrate stability (RSS, defined as the ratio of modeled shear stress to critical shear for erosion) under high, medium and low flow conditions. The premise of the analysis is that if the existing conditions indicate the presence of mussels (which is known to

exist), then an evaluation of the with-chevron condition can determine whether or not the model indicates the presence of mussels or impacts to the known mussel bed. The results of the analysis, detailed in Appendix H, *Hydrology and Hydraulics*, indicated the presence of mussels is supported by the existing conditions and no significant impacts to those parameters were identified due to chevron construction.

This measure passed the ICA, and was later revised in the Recommended Plan to address the following:

- Elevation was raised to account for climate change. The higher elevation passed the floodplain analysis.
- Location and shape was changed, which increased the overall length.

Refer to Table VI-18 and Plates 17, C-112 and 22, C-304 for further details.

Table VI-18. Albany Island Chevron

Item	Quantity	Unit
Length	717	FT
Upstream Slope	2	H:1V
Downstream Slope	2	H:1V
Approximate Tree Clearing	0	AC
Estimated Quantity	5,300	TN
Top Width	6	FT
Average Top Elevation	575	NAVD88

3. Bankline Protection (Albany Island). Stone protection would be added to the upstream end of Albany Island on the Albany Slough side, as well as on the downstream side of the island on the navigation side. More details on erosion analysis are provided in Appendix M, *Engineering Design*. This measure passed the ICA and was later revised in the Recommended Plan to address the following:

- Bedding stone was dropped from the design because the majority of placement was under water and quality control would be difficult.

Refer to Table VI-19 and Plate 21, C-303 for further details. Note that Table VI-19 indicates approximate acreages that may be impacted by tree removal. Areas calculated for tree removal in the cost estimate are slightly less based on the physical work expected.

Table VI-19. Albany Island Bankline Protection

Item	Quantity	Unit
Length (Upstream)	300	FT
Length (Downstream)	1,000	FT
Slope	3	H:1V
Approximate Tree Clearing (Upstream)	2	AC
Approximate Tree Clearing (Downstream)	2	AC
Riprap Thickness	2	FT
Estimated Quantity Riprap	1,700 (U/S)+9,000 (D/S)	TN
Average Top Elevation	580 (top of bank)	NAVD88

C. Mussel Habitat

Various mussel studies have occurred in Pool 14. However, the river environments studied do not always closely match the environmental conditions present in this reach of Pool 14. An analysis of the existing mussel studies is outlined in Appendix M, *Engineering Desig*n. This review, along with input from resource agencies, aided in the development of the following criteria:

- 3ft-6ft depth
- River washed or rounded rock
- Velocity range 0.25m/s-0.76m/s
- Avoid velocity <0.1m/s to prevent Zebra Mussels
- Stable flow

River stone sized to optimize mussel habitat will be added to the Albany Island bankline protection on the Albany Slough side. Refer to Table VI-20 and Plate 21, C-303 for further details.

Table VI-20. Albany Island Mussel Substrate

Item	Quantity	Unit
Length (Upstream)	300	FT
River Stone Thickness	1	FT
Estimated Quantity	900	TN

D. Design Considerations

1. Location. The Project area is in Pool 14 between RMs 513.0 and 517.0, Clinton County, IA.

2. Survey Data. Project is in NAVD88 (converted from MSL1912, which is what the river gages read in). IL West State Plane NAD 83, US Survey Feet. Survey data has come from Corps hydrosurvey (several events), UMRR LiDAR, and Corps ground survey (Plate 3, V-101). Flat Pool at the Project location (RM 514) is 571.2 NAVD88 (572 MSL1912). Additional survey data was obtained in May 2015 near the head of Albany Island and at the Upper Cut/Deep Cut closure structure. Conversion to 1929 subtract 0.36 feet from NAVD 88. Conversion to 1912; subtract 0.81 feet from NAVD 88.

3. Access. The Project is located on an island in the Mississippi River, so all access will be by water. In order to access the excavation sites with traditional construction equipment, the Contractor will be required to work from the downstream end of the complex, then work their way inward. All other work should have sufficient water depths for conventional construction equipment.

Staging for construction and primary water access will be via the Camanche boat ramp located south of Camanche, Iowa at RM 511.0. This is a public boat ramp owned in fee by the Federal Government. Use of the ramp for various water related purposes has been granted to the City of Camanche.

Water access is also available at Albany Marina, 1st Avenue and Water Street Albany, Illinois (RM 513.6), which is maintained by the City of Albany and is a public boat ramp (Corps and ILDNR funded). It is unlikely that this ramp would be used for barges or equipment, but may be used for workers to enter smaller vessels to access the site. Boat ramp locations are shown on Plate 6, C-101.

4. Excavated Material. Excavated material will be required to construct the forest diversity sites. Geotechnical borings are provided in Appendix O, *Plates*.

5. Historic Properties. Historic properties are addressed in Section II.M. and Section IX.G. of this report. The layout and design of measures was conducted to avoid impacts to the historic properties. Design specifications will include requirements to the contractor for what to do in case historic properties are encountered during construction.

6. Hazardous, Toxic, and Radioactive Waste. As required for all earth working projects in the District, it is recommended that the Environmental Protection specification section include requirements for HTRW testing of any material to be brought onto the site or removed from the site to ensure the material is not contaminated. If contaminated material is identified, the Corps would stop work and follow the steps outlined in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects*. If any evidence of recognized environmental conditions is discovered during construction activities, operations should cease until an assessment is performed at which time the Phase I ESA will be revisited. All construction equipment should be cleaned and free of soil residues, plants, pests, noxious weeds and seeds.

7. Public Access and Security. Safety and security are important parameters which would be detailed during the P&S Phase. Of specific concern, will be the coordination of regional hunting seasons with the construction season.

E. Construction Considerations

1. Permits. Laws of the United States and the State of Iowa have assigned the Corps and the IADNR with specific and different regulatory roles designed to protect the waters within and on the State's boundaries. Protecting Iowa's waters is a cooperative effort between the applicant and regulatory agencies.

The basis for the Corps 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."

The Corps' 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 IADNR and should not be confused with the Corps of Engineer's 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 the Corps of Engineers to regulate the nonpoint source discharges of dredged or fill material into waters of the United States.

The IADNR is the State agency created by consolidating all previous duties of the IADNR of Water, Air, and Waste Management; the Conservation Commission; the Energy Policy Council; and the Iowa Geological Survey. The IADNR administers permit programs for conserving and protecting Iowa's water, recreational and environmental resources, and, for the prevention of damage resulting from unwise floodplain development. The IADNR also has jurisdiction over sovereign lands and waters and certain fee title lands of the State (Iowa Code, Chapters 106 and 111). On meandered streams and lakes, sovereign State property is that land below the ordinary high water mark.

The IADNR has authority to regulate construction on all floodplains and floodways in the State. The IADNR's administrative rules explain when a permit must be obtained for various types of floodway/floodplain-development. Examples are channel straightening, levee construction, excavation and stockpiling of overburden and rock materials, building construction, dams, stream crossings, and bank protection work. Anyone planning to perform or allow such floodplain construction must contact the IADNR to determine if a floodplain construction permit is needed.

Section 10/404 Permit. The Project will require a Section 10 and Section 404 permit. The District anticipates obtaining Nationwide Permit (NW) #27 (Aquatic Ecosystem Restoration) in order to be compliant with Section 404 of the CWA. Section 401 Water Quality Certification conditions have already been coordinated and documented as a part of the NW permit. This Project will abide by all conditions of the NW and Water Quality Certification permits. This permit will be coordinated using the Joint Application Form.

Sovereign Lands and Floodplain Permits. These permits, issued by the IADNR, will be applied for during feasibility report development using the Joint Application Form.

National Pollutant Discharge Elimination System (NPDES). The Contractor is responsible for obtaining the NPDES Storm Water Permit prior to initiating construction.

Refuge Special Use. The Corps will apply for the Special Use Permit during 100% Biddability, Constructability, Operability, and Environmental (BCOE) Analyses. Once the Government receives the permit it will be added to the specifications

Storm Water Pollution/Erosion Control. 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 1 acre. The construction contract for the Project will trigger the need for the contractor to apply for this permit. With or without the permit, the Corps 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 an erosion control mat or fence to control erosion and sediment deposition of soil prior to establishing vegetative cover. The contractor would be required to prepare an erosion control plan to ensure that unprotected soil is not allowed to leave the Project site work limits. The contractor would be required to comply with all local codes and permit requirements.

2. Construction Materials. Only common construction materials are required and can likely be obtained from local sources. Materials used for forest diversity construction include dredged material. Refer to Plate 4 (B-101, *Boring Plan*) and Plate 5 (B-301, *Boring Logs*) for more information. Stone will be used for the closure structure, bank stabilization, and chevron measures. Refer to Appendix G, *Geotechnical Considerations*, for information on gradation sizes. Plants and trees to be planted will be obtained through approved nurseries using native sources.

3. 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 (plantings will likely be a separate contract).

- No clearing of trees shall be allowed between April 1 and September 30 to avoid impacts to bat roosting trees.
- 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. The Project area located outside of the Refuge Closed Area is actively used during the hunting season.
- 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.
- Placement of dredged materials and final preparation of the topographic diversity site areas shall be completed before seeding and planting of trees will be allowed.
- Trees and shrubs shall be planted during optimum times for each species. Final planting dates will be coordinated during the design phase.
- ***REFUGE RESTRICTIONS.*** No work is allowed within the Beaver Island Closed Area (Figure VI-1) from October 15 to the end of the Iowa Duck Hunting Season (typically mid-December). This area starts at the south end of Lower Lake and extends north along the interior to the Upper Lake. The closed area is above the dredging areas, however, it is within the forest enhancement area.

4. Construction Sequence. The probable construction sequence is summarized in Table VI-21; however, no sequence will be required contractually.

F. Operational Considerations

Operation and maintenance of UMRR HREPs is similar to that undertaken by the partner agencies in day-to-day management of parks, boat ramps, wildlife management areas and other such public use areas. The purpose of assigning O&M costs to the federal or non-federal partner is to ensure commitment and accountability by the Project Sponsors. HREPs are designed and constructed to operate for 50 years with proper maintenance.

This Project was designed to reduce overall operation costs. In general, operation is limited to routine inspections to ensure that the measures are performing as designed. Total estimates of annual operation costs are shown in, Section VIII, *Cost Estimates*. A complete list of operation needs would be provided in an O&M manual following construction completion.

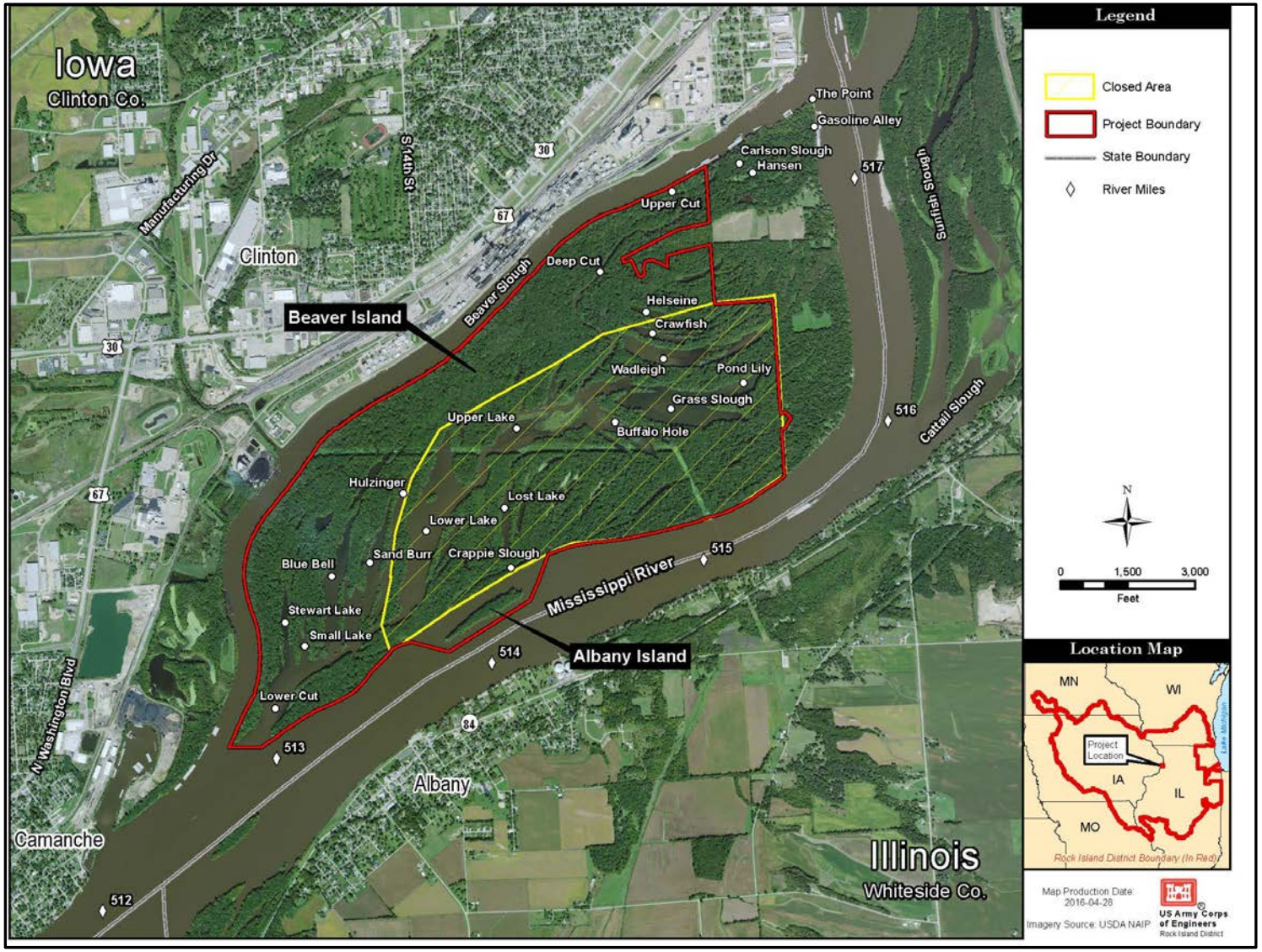

Figure VI-1. Refuge Closed Area

Table VI-21. Beaver Island HREP Probable Construction Sequence

Sequence	Construction	Instructions	Purpose
1	Construct Beaver Island Closure Structure	Tree clearing can only occur during winter months to minimize environmental impacts.	Constructing this will allow for sediment reduction in the backwater prior to backwater dredging/excavation.
2	Construct Albany Island Chevron and Bankline Protection	Tree clearing can only occur during winter months to minimize environmental impacts.	Constructing this in an earlier construction stage would ensure that Albany Island and Albany Slough will be protected sooner.
3	Add Mussel Habitat		This measure should occur at or near the same time as the bankline protection
4	Clear Trees Associated with Forest Diversity Sites	Tree clearing can only occur during winter months to minimize environmental impacts.	
5	Excavate Dredge Cuts		Provide aquatic diversity
6	Transport Material to Topographic Diversity Sites	Material likely to be handled multiple times. Sufficient drying time between placement and shaping will be required.	Elevate areas for better tree survival
7	Shape Topographic Diversity Sites		Match elevations identified in the EFM
8	Plant Seeds, Trees and Shrubs	Some trees may require a 3-year lead time to grow prior to planting	Improve forest diversity
9	Add Substrate to Excavated Cuts for Fisheries Habitat	Place logs, rock, various substrates into excavated channels	Provide additional fisheries habitat

G. Maintenance Considerations

The proposed measures have been designed to ensure low annual maintenance requirements. Maintenance will include replacing rock and removing vegetation and debris from the bankline protection measure, chevron, and closure structure. The estimated annual maintenance costs are presented in Section VIII, *Cost Estimates*. Maintenance requirements would be further detailed in the Project's O&M manual published after construction completion.

H. Repair, Rehabilitation and Replacement Considerations

Repair, rehabilitation and replacement considerations may extend outside of the typical 50-year period of analysis, as the USFWS is expected to maintain the HREP as outlined in the Memorandum of Agreement (MOA). Rehabilitation cannot be accurately measured during the design or construction phase. Rehabilitation is the reconstructive work that significantly exceeds the annual operation and maintenance requirements and is needed as a result of major storms or flood events

I. Value Engineering

A Value Management Plan was completed in 2013 and was approved in 2016 (Appendix A, *Correspondence*). Numerous VE studies, on previous UMRR HREPs with similar measures; topographic diversity, bathymetric diversity, forest diversity, and overwintering habitat, have been conducted within the past several years. The estimated Project cost at Value Management Plan completion (2013) was $9,000,000. UMRR HREPs have been constructed in the UMR since 1986 across three Corps districts (St. Paul, Rock Island, and St. Louis). Two Design Handbooks that document the array of restoration tools and lessons learned from past HREPs have been completed to aid in the design of future HREP projects. The most current version of the Design Handbook was completed in 2012.

VII. SCHEDULE FOR DESIGN AND CONSTRUCTION

Table VII-1 presents the Project implementation schedule.

TableVII-1. Project Implementation Schedule

Event	Scheduled Date
District Quality Control – Feasibility	September 2016
Agency Technical Review	October 2016
Major Strategic Command Decision Milestone Meeting	December 2016
Public Review of Draft Report	February 2017
Distribute Draft Report for Agency Review	February 2017
Submit Final Feasibility Report to MVD	June 2017
Approved Final Feasibility Report from MVD	August 2017
Execute the Memorandum of Agreement with the USFWS	September 2017
Initiate Design	June 2017
Complete All Construction Stages	November 2023

VIII. COST ESTIMATES

Table VIII-1 compares costs for the fully funded estimate (FFE) and the current working estimate (CWE) (Appendix I, *Cost Estimate*.) The FFE was calculated based on the proposed construction schedule, expected escalation costs, and a contingency factor, and represents the money expected to be spent at the end of construction. The detailed CWE of Project design and construction costs is presented in Table VIII-2. Quantities and costs may vary during final design.

Table VIII-1. Project Design and Construction Cost Estimates (October 2016 Price Level)

Account	Measure	FFE[1]	CWE
01	Lands and Damages	$0	$0
06	Fish and Wildlife Facilities	$347,000	$299,000
09	Channels	$17,225,000	$15,561,000
16	Bank Stabilization	$1,595,000	$1,537,000
30	Planning, Engineering and Design	$4,359,000	$2,563,000
31	Construction Management	$1,891,000	$1,562,000
	Project Cost Estimates	**$25,417,000**	**$21,522,000**

[1] Fully funded estimate is marked up to midpoint of construction for each construction stage

A. Monitoring and Adaptive Management. Costs for monitoring to determine the degree which the Project is meeting the success criteria and for informing potential adaptive management decisions are summarized in Table VIII-3. Adaptive management and monitoring are projected to a maximum of 10 years.

Table VIII-2. Detailed Cost Estimate of Current Working Estimate (CWE) with Contingency

Account Code	Item	Quantity	Unit	Amount	Contingency (%)	Escalation	Total Cost w/ Cont, CWE
CONSTRUCTION COSTS							
06	Adaptive Management	1	LS	$231,000	29.7	0	$299,607
09	Mobilization and Demobilization	1	LS	$839,281	29.7	0	$1,088,548
09	Lower Cut Dredging	1	LS	$3,234,573	29.7	0	$4,195,241
09	Stewart Lake Dredging	1	LS	$555,356	29.7	0	$720,297
09	Blue Bell Lake Dredging	1	LS	$1,629,951	29.7	0	$2,114,046
09	Sand Burr Lake Dredging	1	LS	$2,152,640	29.7	0	$2,791,974
09	Blue Bell to Sand Burr Dredging	1	LS	$141,165	29.7	0	$183,091
09	Sand Burr to Hulzinger Dredging	1	LS	$162,388	29.7	0	$210,617
09	Lower Cut Shaping/Planting	1	LS	$1,423,523	29.7	0	$1,846,309
09	Stewart Lake Shaping/Planting	1	LS	$297,970	29.7	0	$386,467
09	Blue Bell Lake Shaping/Planting	1	LS	$1,025,937	29.7	0	$1,330,640
09	Sand Burr Shaping/Planting	1	LS	$427,228	29.7	0	$554,115
09	TSI Measures	1	LS	$112,042	29.7	0	$145,318
16	Mobilization and Demobilization	1	LS	$122,521	29.7	0	$158,910
16	Beaver Is. Closure Structure	1	LS	$253,743	29.7	0	$329,105
16	Albany Is. Chevron	1	LS	$265,286	29.7	0	$344,076
16	Albany Is. Bank Stabilization	1	LS	$494,231	29.7	0	$641,018
16	Albany Is. Mussel Substrate	1	LS	$49,477	29.7	0	$64,172
TOTAL CONSTRUCTION COSTS				**$13,418,312**			**17,403,551**
PLANNING, ENGINEERING, & DESIGN (PED) COSTS							
30	P&S, EDC	1	LS	$2,082,000	23.1	0	$2,562,942
						TOTAL PED COSTS	**$2,562,942**
CONSTRUCTION MANAGEMENT COSTS							
31	Construction Management	1	LS	$1,342,000	16.4	0	$1,562,088
						TOTAL CONSTRUCTION MANAGEMENT COSTS	**$1,562,088**

TOTAL PROJECT COSTS $21,528,581

Table VIII-3. Estimated Adaptive Management and Post-Construction Monitoring Costs ($) (October 2016 Price Level)

				Post-Construction Years									
Objective	**Work Category**	**Activity**	**PED**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**Total**
Floodplain Forest Diversity	Monitoring and Analysis	Forest Plot Survey and Wetland Monitoring	-	$6,000	$6,000	$6,000	$6,000	$6,000	-	$6,000	-	$6,000	$42,000
												Floodplain Forest Diversity Subtotal:	***$42,000***
Albany Island Bank Stabilization	Monitoring, Analysis, Reporting	Site Inspection											
		ADCP Data Collection	$12,000	$12,000	$12,000	$12,000	-	-	-	-	-	-	$48,000
	AM: Riprap/Chevron Rock Install/Remove		-	$25,000			-	-	-	-	-	-	$25,000
												Albany Island Protection Subtotal:	***$73,000***
Albany Slough Freshwater Mussel Habitat	Monitoring, Analysis, Reporting	Mussel Survey											
		Data Analysis	$8,000	$7,000	-	$7,000	-	-	$7,000	-	$7,000	-	$36,000
												Mussel Habitat Subtotal:	***$36,000***
Backwater Fish Habitat	Monitoring, Analysis, Reporting	Backwater Bathmetry[1]											
		Water Quality											
		Data Analysis	-	$8,000	$8,000	$8,000	$8,000	$13,000	-	-	-	-	$45,000
	AM: Notch Closing Structure			$35,000					-	-	-	-	$35,000
												Aquatic Habitat Subtotal:	***$80,000***
												TOTAL	***$231,000***

[1] Fish surveys completed by the IADNR will aid in determining success of the aquatic habitat component.

B. Long-Term Performance Reporting. Costs for collection of basic site-inspection data to report long-term Project performance are summarized in Table VIII-4. These costs include preparation of Performance Evaluation Reports that summarizes the Project's long term ability to meet Project success criteria, inform O&M adjustments, and provide basic data for planning purposes. This monitoring starts following completion of post-construction monitoring and adaptive management considerations.

Table VIII-4. Estimated Long-Term Annual Monitoring Costs ($)

Site Inspections	Unit Cost	Frequency	Year Start	Quantity	Total Cost	Annualized Cost
Water Quality	$11,000	Every Year	6	20	$220,000	$3,812
Bathymetric Survey	$50,000	Every 5 Years	6	8	$400,000	$7,719
Forestry Survey	$28,000	Every 10 Years	11	2	$56,000	$1,081
Reporting	$15,000	Every 5 Years	11	8	$120,000	$1,865
					Subtotal	**$14,477**
					Contingencies (20%)	**$2,895**
					TOTAL	***$17,372***

C. Operation and Maintenance Considerations. The proposed Project measures have been designed to ensure low annual operation and maintenance requirements (Table VIII-5). Operation and maintenance may include performing inspections and debris removal from rock structures. The estimated total annual operation and maintenance cost is $9,600. These quantities and costs may change during final design. A complete list of operation and maintenance needs will be provided in an operation and maintenance manual following construction completion.

Table VIII-5. Estimated Annual Operation and Maintenance Costs (October 2016 Price Level**)**

	Quantity	Unit	Unit Price ($)	Total Cost ($)
Operation				0
Maintenance				
Site Inspections (all measures)	40	Hours	50	2,000
Debris Removal (rock structures)	80	Hours	50	4,000
			Subtotal	**$8,000**
			Contingencies (20%)	**$1,600**
			TOTAL	***$9,600***

D. Repair, Rehabilitation, and Replacement Considerations. For analysis purposes, the costs presented for operation and maintenance used the 50-year period of analysis. The USFWS is expected to operate and maintain the Project per the agreed-to terms in the Memorandum of Agreement (Appendix C) and should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. Table VIII-6 lists the major Project components and their associated frequencies of repair, rehabilitation, and replacement. Estimates of these costs will be included in the operation and maintenance manual.

Table VIII-6. Repair, Rehabilitation, and Replacement Considerations

Component	Frequency
Replace Rock Structures	Every 75 Years
Rehab Aquatic Diversity Areas	Every 60 Years

IX. ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

The following sections describe the potential environmental effects the Recommended Plan may have on the resources addressed in Section II, *Affected Environment*. The discussion is organized by potential direct, indirect, and cumulative effects on the identified resources. The No Action or Future Without Project (FWOP) Alternative is discussed in Section III. B. The PDT determined the following are effects/benefits of the proposed Project:

A. Short-Term Construction Effects

The proposed Project construction would take place within Beaver and Albany Islands. No measurable change in floodplain storage would occur as a result of the Project, and the Project would not directly induce additional development within the floodplain. More detailed information is available in Appendix H, *Hydrology and Hydraulics* and Section IX.B., *Floodplain Resources*.

Staging activities will likely occur at the Camanche boat ramp, which has a concrete parking lot and a two lane concrete boat ramp with dock. No environmental impacts or impacts to recreation are expected from use within and around the boat ramp or travel to/from construction site. Minor short-term impacts in the form of dust, noise, and temporary disruption of recreational traffic may result, at times, from increased travel to the staging and construction area.

Construction of the Project measures would require up to 81 acres (76 acres currently identified) of tree clearing to enable topographic diversity site construction and bank stabilization measures. Temporary disruptions to wildlife are likely to occur. This includes Indiana and northern long-eared bats, which, based on recent surveys, likely use a part of the area for feeding and roosting. To minimize and avoid disturbances to bats, the area designated for clearing and construction was reconfigured to avoid primary roost trees, primary feeding corridors, and areas of high bat activity. Any tree removal will be done between September 30 and April 1 to avoid the bat maternity roosting season. The Corps in consultation with the USFWS (see Appendix A, *Correspondence*) anticipates no long-term adverse effects to wildlife, Indiana bats or northern long-eared bats as a result of this Project.

Disruption of the habitat during tree planting would be minimal. Post-planting, periodic operation and maintenance procedures, such as undesirable vegetation control through hand pulling or herbicide treatments, would have little impacts on the environment. Any required herbicide treatments would be applied using state and Federal standards, and would be applied by a licensed applicator; thus, minimizing potential localized impacts.

Construction activity would temporarily increase turbidity immediately downstream of the proposed dredge cuts and chevron construction. Material will be mechanically excavated and placed in the floodplain. Although macroinvertebrate density and diversity is low, temporary disruption and minor loss is expected to occur through dredging and rock placement. These areas should be recolonized shortly following construction.

B. Floodplain Resources

The measures of the proposed plan will improve the ecological structure and function for over 500 acres of Beaver Island bottomland forested wetland habitat through an increase in floodplain elevation,

hard mast tree plantings, and implementation of timber stand improvement strategies. This is highly important as floodplains are important elements of regional landscapes, controlling ecosystem processes (e.g., sediment deposition, nutrient cycling, and community succession), ecosystem properties (e.g., soil texture, fertility, and plant species composition,) and ecosystem services (e.g., denitrification and biodiversity) making them biodiversity hotspots in the landscape. Of these floodplain characteristics, the proposed plan would directly or indirectly benefit all of them.

Section II, *Affected Environment,* explained roughly 17% of the island is at an elevation (>576 feet) suitable to contain nut producing trees, compared to the reference condition (i.e., pre-dam) of about 47.0%. The areas with mast trees present were on average over 88 years (ranged 1874 to 1964) old and contained little production in the understory. This lack of production is directly related to increased water inundation and duration. Current topography shows a significant portion of the Project area is low in elevation and below the threshold for producing a sustainable nut producing tree population. It is highly unlikely nut producing trees will regenerate without intervention in the next 50 years. The proposed plan effectively works to stop and reverse this trend; thus, increasing habitat availability and quality for migratory birds (i.e., neotropical, waterfowl, bald eagle, heron rookeries), endangered species (i.e., Indiana bat, northern long-eared bats), general wildlife, reptiles and amphibians, etc.

The following structural and functional elements contribute to the overall habitat value and benefits of the Project.

1. **Increase Topographic Diversity**. A critical element to floodplain forest diversity is water inundation duration. Lower elevations flood more often and for longer periods of time than higher elevations. This in turn influences nutrient cycling, and germination and growth of native mast tree species (DeJager et al. 2012). Benefits from the proposed measures result from the increased elevation of the Project in relation to the pre-dam reference condition. The increased elevation promotes mast tree survival, establishment, production, sustainability, and an increase in habitat complexity and diversity. Although at a small scale, nutrient uptake and cycling at the Project site could reduce nutrient delivery downstream.

2. **Increase Hard Mast Tree Species from 10 to 15 Species**. Currently 10 species of native trees are present. In addition to increases in elevation and habitat quality, benefits are accrued from an increase in tree species. An increase in hard mast species provides habitat diversity, which increases cover, food, and reproduction habitat for a wide variety of floodplain species. This is especially important for the federally endangered Indiana bat and northern long-eared bat, and numerous species covered under the Migratory Bird Treaty Act (e.g., foraging and reproductive habitat for diving and dabbling duck, herons, shorebirds, bald eagles, etc.) which will benefit from increased foraging and roosting opportunities.

3. **Increase Mast Tree Sustainability**. Over 800 trees from 12 species will be planted above the 2-year flood elevation which has been shown to be the critical threshold for mast tree survival (DeJager et al. 2012). An increase in survival increases seed production and dispersal. As such, regeneration and recruitment opportunities will increase, which in turn creates additional reproduction, foraging, and cover habitat for all floodplain species.

4. **Reduction in Forest Fragmentation**. Well-connected floodplain forest communities are critical for wildlife dispersion, migration, survival, habitat quality, and a buffer against undesirable species. Without intervention, the area would convert to a mix of silver maple forest, moist soil

species and reed canary grass, which has less habitat value than a diverse floodplain and would impact migratory birds and listed bat species that rely on well-connected diverse forest habitat for migration, nesting, and foraging purposes. The strategic locations of the constructed placement sites and associated planting of desirable species would buffer against fragmentation and provide a mosaic of interconnected habitat throughout the Project.

5. Limit invasive Species Distribution. Over time, the over-mature silver maple stand will experience significant mortality. As a result, canopy openings could increase reed canary grass establishment. This has already been documented within the UMRS and is expected to continue. An increase in elevation increases mast tree production, and the operation and maintenance of the Project will combine to limit opportunities for invasive species establishment.

6. Backwater Habitat Protection. Topographic diversity sites are likely to serve as protection for the excavated backwater lakes during high water events. Benefits include potential flow breaks which could result in reduced sediment deposition within the backwaters, decreased turbidity, increased water clarity, and flow.

C. Aquatic Resources

Additional discussion of aquatic and water quality impacts is contained in Appendix B, *Clean Water Act, Section 404 Assessment: NWP 27 Justification.* The proposed plan would benefit almost 250 acres of aquatic habitat through an increase in backwater and riverine habitat structure and function. Specifically, backwater habitat is improved through increased depths and improved water quality for aquatic organisms. Riverine habitat geomorphic processes are improved through a reduction of island erosion and restoration of side channel structure and function. This not only improves habitat for all types of riverine fish species, but it also prevents degradation of an existing freshwater mussel community containing at least one federally-listed Higgins eye.

Section II, *Affected Environment*, stated that over 90% of the Beaver Island backwaters are less than 4 feet deep at flat pool. Overwintering habitat is a limiting habitat type due to the shallow nature of the backwater, ice cover, and flows into the Project. The following structural and functional elements contribute to the overall habitat value and benefits.

1. Increased Backwater Depths. Almost 250 acres of aquatic habitat will be improved as a result of this Project. Of this, approximately 55 acres will be improved for the purposes of overwintering fish habitat with the remainder contributing significantly to the year-round habitat required by fish in the UMRS. This equates to a 26% increase in overwintering habitat. Currently, overwintering habitat is limiting in Pool 14 and is mainly attributed to reduced depths in backwaters, which is addressed by this Project. Increased depths provide areas where higher water temperatures and DO can persist in the winter. Year-round habitat is improved by increasing lateral and longitudinal connectivity for overwintering, spawning, and rearing habitat connectivity, and access to movement corridors.

2. Reduced Island Erosion and Restoration of Side Channel Function. Island habitat in the UMRS is highly valuable for habitat diversity, and has been steadily declining. Installation of a chevron at the head end of Albany Island will reduce erosive forces, restore valuable off-channel fish habitat, and facilitate the restoration of geomorphic processes and habitat function in Albany Slough. Sediment deposition at the tail-end of the island will increase island acreage, wildlife habitat diversity,

and potential tree production. The tail-end of the island will also serve as shallow, low flow sandbar habitat desired by shorebirds, turtles, and riverine species (e.g., shovelnose sturgeon, catfish, walleye). The flow refuge afforded by the island will be critical low flow foraging and nursery habitat for both backwater and riverine fish species. Finally, the chevron is critical to limit the continued deterioration of Albany Island because without the island the side channel ceases to exist. Without a side channel the freshwater mussel community inhabiting the channel and the federally-listed mussel found there will disappear.

3. Fish and Mussel Substrate Improvements. As part of the Project, fish habitat (e.g., rock substrate, large woody debris) and mussel habitat (e.g., mixture of various sizes of river rock suitable as substrate for multiple mussel species) will be installed in the backwater areas and Albany Slough. This has immediate direct benefits to the fish and mussels that inhabit the area in the form of increased habitat structure and function.

4. Increase in Endangered Mussel Habitat. One federally-endangered mussel species exists in Albany Slough and at least one additional species has the potential to exist within Albany Slough. Both species have a preference for stable substrates consisting of sand to boulders. Implementation of the chevron measure will stabilize and build additional habitat with shallow, low velocity, and stable substrate. Combined with the probable increase in fish use, an increase in the general mussel population and the likelihood of Higgins eye or spectaclecase mussel occurrence will likely increase.

D. Invasive Species

The proposed Project would buffer against reed canary grass population growth by preventing forest fragmentation and canopy openings. The increased elevation and diversity of scrub-shrub species and tree species would work to out-compete reed canary grass growth providing a long-term benefit to the environment.

The proposed Project includes measures that will increase off-channel habitat and may potentially be used by juvenile and adult Asian carp as described in Kolar et al. (2005).

E. Endangered and Threatened Species

The Higgins eye pearlymussel, Indiana bat, and Iowa Pleistocene snail are federally-endangered species potentially in the Project area, while the prairie bush clover, Western prairie fringed orchid, and northern long-eared bat are federally-threatened species listed in Clinton County, Iowa. The Corps prepared a Biological Assessment and submitted it to the USFWS on February 1, 2016. Based on the information provided, the Corps determined the proposed Project *May Affect, Not Likely to Adversely Affect* for the Indiana bat, Higgins eye pearlymussel, and northern long-eared bat. The proposed Project will have *No Effect* on the prairie bush clover, Western prairie fringed orchid, or Iowa Pleistocene snail. The USFWS replied to the Biological Assessment through informal consultation with a concurrence letter dated February 29, 2016 (Appendix A, *Correspondence*).

1. Direct Effects

a. Indiana Bat and Northern Long-Eared Bat. The proposed Project may directly affect the Indiana and Northern long eared bats by temporarily reducing the amount of potential roosting and foraging habitat and create short-term fragmented woodlands within the action area. The Project would potentially affect approximately 81 acres of floodplain forest through clearing of trees for

topographic diversity construction. The overall forested habitat which exists on Beaver Island proper is approximately 1,500 acres. When compared to the number of acres potentially affected by the Project, the District determined it to be about 5.4% of the total.

b. Higgins Eye Pearlymussel. The proposed excavation of the backwaters in Beaver Island should have no direct impacts to the Higgins eye pearlymussel because the backwaters do not appear to contain suitable habitat.

At the head of Albany Island the Project proposes to install a chevron and rip-rap bank stabilization to reduce island erosion. The construction of the bank stabilization would potentially affect approximately 680 linear feet of substrate through rock placement. Shifting sand and/or flocculent silt conditions within this footprint are generally not considered to be ideal for Higgins eye. Furthermore, they were not collected within this immediate area during extensive mussel surveys. Collectively, there is a low likelihood of presence.

Near the downstream end of Albany Slough, a single live Higgins eye was found among a mussel bed during summer surveys. As a result, the District conducted an effects analysis to determine the extent to which construction of the chevron would influence the hydraulics of the channel and thus potentially impact the structure and function of the existing mussel bed. Using a 2-dimensional hydraulic model and a CART model developed by Zigler et al. (2008) the District assessed the degree to which the presence or absence of mussels might be impacted by the chevron. When comparing existing conditions to future with-project conditions, the District found velocity, shear stress, substrate composition, and channel slope to be nearly the same. Furthermore, the CART model determined a high probability of mussel presence in the with-project condition suggesting conditions are not likely to change significantly.

c. Prairie Bush Clover. The Project should have no direct impacts to the prairie bush clover because the Project area does not have any prairie bush clover habitat.

d. Iowa Pleistocene Snail. The Project should have no direct impacts to the Iowa pleistocene snail because the Project area does not have any Iowa pleistocene snail habitat.

e. Western Prairie Fringed Orchid. The Project should have no direct impacts to the western prairie fringed orchid because the Project area does not have any western prairie fringed orchid habitat.

2. Indirect Effects. The Recommended Plan for the Beaver Island HREP includes planting over 800 trees from 12 species of native mast tree species. Also, approximately 11 acres of a mix of several species of forested wetland shrub/scrub plants will be planted. Long-term, these plantings should provide Indiana bats with habitat complexity and diversity through increased forage opportunities and potential roost tree production. Timber Stand Improvements throughout the island increases the habitat quality and value to all species, including the Indiana bat and Northern long-eared bat.

Mussel habitat improvements within Albany Slough provide increased opportunities for mussel colonization, growth, and reproduction in a pool which already contains an USFWS designated essential habitat area. Opportunities for monitoring and adaptive management provide valuable opportunities to learn more about the microhabitat/niche environments desired by Higgins eye mussels.

3. Cumulative Effects. Foresters with the District will continue to contribute to the overall health of the forest community through implementation of forest management measures after construction of this Project. Measures such as large scale clearing of non-desirable trees, large scale tree plantings, and continued implementation of timber stand improvement strategies will contribute to the continued success of the Beaver Island forest community.

Recent private tree clearing across Beaver Slough has potentially reduced the overall capacity of the area to support bats and other snag, cavity, or colony nesting animals. Although this Project will avoid the clearing of identified primary roost trees and directly facilitate the creation of future tree snags, cumulative tree clearing activities potentially impacts the structure and function of the island habitat for feeding, resting, and reproduction activities.

F. Hazardous, Toxic, and Radioactive Waste

Phase I and Phase II Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessments (ESA) for the Beaver Island HREP were conducted. The Phase I ESA revealed evidence of a Recognized Environmental Condition (REC) that could potentially affect the Project area. The REC consists of the historic and extant presence of industrial and commercial activity immediately adjacent to the Project area, as well as a documented release of hydraulic oil into Beaver Slough.

This REC had the potential to impact sediments within the Project area. As such, HTRW soil sampling was completed in March 2014 in select areas of the Project area where sediments could be potentially disturbed during HREP construction or operation. The laboratory analytical results were compared to the IADNR Soil Standards (Chapter 137 Land Recycling Program) and the U.S. Environmental Protection Agency (USEPA) Region 9 Soil Screening Levels. No chemicals of concern were detected that were above the standards.

Based on the Phase 1 ESA and subsequent Phase II HTRW investigation, no further HTRW assessment is recommended. No HTRW impacts to the Project area or surrounding environment are anticipated.

G. Historic and Cultural Resources

The BCA geomorphological evaluation identified 17.7 acres within the APE that had a moderate potential for intact archeological remains. This was confined to three areas within higher elevations on natural levees and crevasse splays. The remainder of the APE was deemed to have low to virtually no archeological potential.

The BCA pedestrian survey identified one newly recorded historic site, 13CN176. Site 13CN176 was identified initially on historic maps and appears to date to the early/mid-twentieth century. BCA did not conduct subsurface testing at this site, but recommended additional work should the Project plans be changed. The TSI portion of the APE has been modified to avoid impacts at this location. This site is located on District fee title land.

Intensive subsurface archeological survey resulted in the documentation of two previously unrecorded prehistoric archeological sites. Site 13CN177 is interpreted to be a Middle-Late Woodland bivouac with undisturbed portions of the site and high probability for intact features. The site is considered potentially eligible for inclusion for the National Register of Historic Places (NRHP). BCA recommended avoidance of site 13CN177 or Phase II testing to determine NRHP eligibility if avoidance is not possible. Site 13CN178 is interpreted to be a Late Archaic bivouac with undisturbed deposits and potential for intact features. BCA recommended avoidance of the site or Phase II testing to determine NRHP eligibility. Both sites are also located within or near TSI segments of the APE. The TSI APE was modified to avoid these sites. Both sites are located on USFWS fee title land.

Interested parties were provided a copy of the BCA report by letter dated December 24, 2014. The SHSI responded by e-mails dated January 14, 2015 with a minor editorial comment and the observation that the BCA investigation appeared to meet the District Scope of Work but that the District should resume formal consultation once the APE was fully defined (R&C# 140723069). The District provided interested parties a formal definition of the APE and determination of effect to historic properties by letter dated September 7, 2016 (Appendix A, *Correspondence*).

The District determined that the Recommended Plan will have No Effect on historic properties within the APE due to the low archeological potential as demonstrated by the geomorphological investigation in accordance with 36 CFR 800.4(d)(1). The District further has determined that this undertaking will have No Adverse Effect on sites 13CN176, 177, and 178 as this undertaking will have no direct or indirect effects on these sites in accordance with 36 CFR 800.5(b). The USFWS replied by e-mail dated September 13, 2016, stating its concurrence with the District's Determination of Effect. The SHSI concurred with the District's Determination of Effects by stamped concurrence dated September 28, 2016 (Appendix A, *Correspondence*).

While the Corps is assured that no historic properties would be affected by the Recommended Plan; if any undocumented cultural resources are identified or encountered during the undertaking, the Corps will discontinue Project activities and resume coordination with the consulting parties to identify the significance of the historic property and determine any potential effects.

H. Hydrology and Hydraulics

1. Discharge and Velocity. Velocities throughout the Beaver Island interior channel beginning at Upper Cut/Deep Cut and extending through Upper Lake and Lower Lake and down to Lower Cut will be reduced by the Upper Cut/Deep Cut closing structure, thereby providing conditions suitable for overwintering. The mussel impact analysis indicated minimal changes to the existing discharge and velocity distribution within Albany Slough and therefore no negative impacts to the existing mussel bed are expected as a result of the chevron measure

2. Inundation Duration. The topographic diversity enhancement measures will afford greater survivability to hard-mast trees by increasing the elevation in order to reduce the frequency of long duration root inundation which results in mortality.

3. Sediment Deposition. The Upper Cut/Deep Cut closing structure is intended to reduce sediment deposition throughout the Beaver Island interior backwaters, by cutting off a primary sediment source.

I. Socioeconomic Resources

1. Community and Regional Growth. No short-term or long-term impacts to the growth of the neighboring community or region would be realized as a result of the Project. The Project would improve recreation opportunities at Beaver Island, increasing the attractiveness of the area for wildlife observation, waterfowl hunting, sport fishing, boating, photography, and commercial fishing.

2. Community Cohesion. The proposed aquatic and floodplain habitat restoration Project has positive impacts on community cohesion by attracting visitors and recreationists from other communities. Overall, the Project would have no adverse impacts to the quality of the human environment.

3. Displacement of People. There are no residential properties that would be displaced.

4. Property Values and Tax Revenues. The Project area is federally-owned land managed by the IADNR and the USFWS. No change in property values or tax revenues would occur.

5. Public Facilities and Services. Temporary use of the local public boat ramps during construction will potentially limit availability for boat ramp usage. However, the proposed Project would positively impact public facilities and services by increasing habitat diversity, resulting in additional opportunities for recreational use of the area following construction.

6. Life, Health, and Safety. The Project poses no threats to the life, health, or safety of recreationists in the area. An HTRW assessment was conducted and no obvious indications of potential contamination sources were noted.

7. Business and Industrial Activity. No substantial changes in business and industrial activities would occur during construction. Long-term impacts to business and industrial development would be related to tourism and recreational activities.

8. Employment and Labor Force. Short-term employment opportunities in the area may increase slightly during construction. The Project would not directly affect employment of the labor force in nearby Illinois and Iowa counties.

9. Farm Displacement. No farms or farmsteads would be displaced as a result of the proposed Project. No prime and unique farmland would be impacted.

10. Aesthetic Values. Clearing of some woody vegetation would occur because of construction activities. Following construction, the area would be reseeded and planted with mast trees. No

permanent adverse impacts to area aesthetics are anticipated. The enhancement of habitat areas would make the wildlife area more aesthetically pleasing to visitors.

11. Noise Levels. Heavy machinery will generate temporary noise during construction, disturbing wildlife and recreationists in the area. The Project area is rural with no significant, long-term impacts.

12. Air Quality. Minor, temporary increases to air quality due to construction activity may occur as a result of construction and transportation of materials.

J. Man-Made Resources

The proposed Project should not impact flood reduction levees in Iowa or Illinois. The Project would not result in any significant change in floodplain storage. Navigation training structures will not be impacted by this Project. Impacts to the navigation channel will not occur as a result of Project implementation.

K. Probable Adverse Impacts Which Cannot Be Avoided

An unavoidable adverse impact would be the clearing of vegetation for construction. The placement sites will require approximately 81 acres of clearing to accommodate the measures footprints, grading and shaping, and access. All of the clearing will be located near the backwater lake dredging. Clearing of existing vegetation, particularly over-mature silver maple stands, would be kept to the minimum required for construction activities and post-construction maintenance, and will adhere to seasonal restrictions recommended by the Sponsors for protection of threatened and endangered species.

The loss of some benthic organisms currently inhabiting the footprint areas for bank stabilization and dredging is a likely effect of the proposed action. Following construction, benthic organisms should rapidly recolonize the excavated areas, especially the added habitat diversity created with stone placement, and increased backwater depth.

L. Short-Term Versus Long-Term Productivity

Construction activities would temporarily disrupt wildlife and human use of the Project area. Long-term productivity for natural resource management would benefit considerably by the construction of this Project. Long-term productivity would be enhanced through increased reliability of nut bearing tree production, enhancement of existing submerged, emergent and wetland vegetation and providing more dependable reproduction, foraging and resting areas for migratory birds, resident wildlife, and aquatic species. Overall habitat diversity would increase, and both game and nongame wildlife species would benefit from the proposed Project. In turn, both consumptive and nonconsumptive users would realize heightened opportunities for recreational use. Negative long-term impacts are expected to be minimal on all ecosystems associated with the Project.

M. Irreversible or Irretrievable Resource Commitments

The purchase of materials and the commitment of man-hours, fuel, and machinery to perform construction are irretrievable. Other than the aforementioned, none of the proposed actions are considered irreversible.

N. Relationship of the Proposed Project to Land-Use Plans

The proposed Project would not change the use of any floodplain or aquatic resources. If implemented, the Corps does not expect the proposed action to alter or conflict with other authorized Corps projects.

O. Cumulative Impacts

Cumulative effects occur when a relationship exists between a proposed action and other actions which have occurred, are occurring, or are expected to occur in a similar location. The primary area considered in the cumulative effects analysis is limited to Pool 14.

1. Past Actions. The most significant navigation action in Pool 14 was the authorization, construction, and operation and maintenance of the 9-foot Navigation Channel Project. Construction of L&D 14 raised water levels by as much as 7 feet. Floodplains are now inundated more often and for longer durations. Temporarily inundated wetlands were converted to permanently inundated lakes and sloughs. Several fluvial processes were disrupted, which include sediment transport and hydrologic fluctuations. The effects from the construction can still be seen today with decreased topographic diversity, floodplain vegetation diversity, lack of regeneration, and shallow backwaters.

Pool 14 is periodically excavated to maintain the navigation channel by the District. As a result, several wing dams and closure structures (including the Beaver Chute structure and nearby wing dams) have been constructed in the pool. While these areas provide some level of habitat for aquatic species, they also work to direct flows to the main channel and reduce flows in the secondary and tertiary channels. While construction of wing dams is not very likely in the near future, dredging and O&M of existing structures will continue.

Construction of the Princeton Refuge HREP (RM 504.0–506.4) was completed in 1998. The HREP was developed to reduce forest fragmentation, increase bottomland hardwood diversity, and enhance migratory waterfowl habitat.

2. Present and Foreseeable Actions. The Corps will continue to operate and maintain the 9-foot Navigation Channel Project. This includes continuation of dredging, placement of material, and operation and maintenance of river regulating structures (i.e., chevrons, closing structures, and wing dams).

Foresters with the Corps will continue to implement Timber Stand Improvements measures at locations within Beaver Island. These measures include timber harvests, mast tree plantings, and non-desirable vegetation maintenance. These efforts will continue in the future on the island

It is anticipated within the next 10 years that the Steamboat Island HREP (approximate RM 503.5 to 505.5) will commence planning efforts. This HREP would be similar to Beaver Island with objectives for increased backwater depth, topographic diversity, floodplain vegetation diversity, and restored fluvial processes.

Cumulative impacts of the proposed action are not expected to be significant. The proposed Project should have positive long-term benefits to the fish, wildlife, and other natural resources inhabiting the area. This Project, in concert with Princeton Refuge, Steamboat Island, and ongoing forestry

management strategies should counter some of the past, current, and foreseeable actions described earlier. In total, 55 HREPs have been completed benefiting nearly 102,000 acres on the UMRS. Another six projects are in construction, and 29 additional projects are in various stages of planning, engineering, or design.

3. Compliance with Environmental Statutes. See Table IX-1.

Table IX-1. Relationship of Plans to Environmental Protection Statutes and Other Environmental Requirements

Federal Environmental Protection Statutes and Requirements	Applicability/ Compliance[1]
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 11 Aug 80)	Not Applicable
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full Compliance
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Full Compliance
Clean Water Act, Sections 404 and 401	Full Compliance
Corps of Engineers Planning Guidance Handbook (ER 1105-2-100)	Full Compliance
Endangered Species Act of 1973, as amended, 16 S.C. 1531, et seq.	Full Compliance
Executive Order 11988 – Floodplain Management	Full Compliance
Executive Order 11990 - Protection of Wetlands	Full Compliance
Executive Order 12898 – Environmental Justice	Full Compliance
Executive Order 13112 - Invasive Species	Full Compliance
Farmland Protection Policy Act. 7 U.S.C. 4201, et seq.	Not Applicable
Federal Water Protection Recreation Act, 16 U.S.C. 460-(12), et seq.	Full Compliance
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et seq.	Full Compliance
Green House Gases, CEQ Memorandum 18, Feb 2010	Full Compliance
Land and Water Conservation Fund Act, 16 U.S.C. 460/-460/-11, et seq.	Not applicable
National Environmental Policy Act, 42 U.S.C. 321, et seq.	Pending[2]
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Full Compliance
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full Compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Not Applicable
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Not Applicable

[1] Full Compliance = having met all requirements of the statute for the current stage of planning, Not Applicable = no requirements for the statute required.

[2] The Project will be in full compliance with NEPA once the Finding of No Significant Impacts is signed.

X. PROJECT PERFORMANCE ASSESSMENT MONITORING

Per Section 2039 of WRDA 2007, monitoring for ecosystem restoration studies will be conducted to determine Project success. "Monitoring includes 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." This section summarizes the monitoring and data collection aspects that are not associated with Adaptive Management and Monitoring (AM&M). Post-Project performance assessment will commence following the AM&M stage, or approximately 10 years post construction. Post-Project performance assessment monitoring will help determine if the goals and objectives are being approached by the constructed measures. Information regarding the AM&M are provided in Appendix K, *Adaptive Management and Monitoring Plan*.

Table X-1 presents overall types, purposes, and responsibilities for monitoring and data collection; Table X-2 presents actual monitoring and data parameters grouped by Project phase, as well as data collection intervals; Table X-3 presents the post-construction evaluation plan, which displays the specific parameters and the levels of enhancement that the Project hopes to achieve.

Table X-1. Overall Types, Purposes, and Responsibilities of Monitoring and Data Collection

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source
Pre-Project	Pre-Project Monitoring	Identify and define problems at HREP. Establish need of proposed Project measures.	Sponsors	Sponsors	Sponsors
	Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field Station or Sponsors through Cooperative Agreements or Corps	HREP/Sponsors
Design	Data Collection for Design	Include quantification of Project objectives, design of Project, and development of Performance Evaluation Reports.	Corps	Corps	HREP
Construction	Construction Monitoring	Assess construction impacts; assure permit conditions are met.	Corps	Corps	HREP
Post-Construction	Performance Evaluation Monitoring	Determine success of Project as related to objectives.	Corps (quantitative) Sponsors (field observations)	Field Station or Sponsors through Cooperative Agreement, Sponsors thru O&M, or Corps	HREP/Sponsors
	Biological Response Monitoring	Use performance monitoring and Adaptive Management and Monitoring results to evaluate predictions and assumptions of the habitat benefit evaluation.	Corps	Corps	HREP

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Table X-2. Long-Term Resource Monitoring and Data Collection Summary [1]

	WATER QUALITY DATA						ENGINEERING DATA			NATURAL RESOURCE				
	Pre-Project Phase		Design Phase		Post-Const. Phase[3]		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
Type Measurement	**Jun-Sep**	**Dec-Mar**	**Jun-Sep**	**Dec-Mar**	**Jun-Sep**	**Dec-Mar**							**Agency**	**Remarks**
Point Measurements														
Water Quality Stations[2]													Corps	
Air Temperature	2W	6W	2W	6W	2W	6W								
Wind Direction	2W	6W	2W	6W	2W	6W								
Wind Velocity	2W	6W	2W	6W	2W	6W								
Percent Cloud Cover	2W	6W	2W	6W	2W	6W								
Wave Height	2W	6W	2W	6W	2W	6W								
Water Depth	2W	6W	2W	6W	2W	6W								
Velocity	2W	6W	2W	6W	2W	6W								
DO	2W	6W	2W	6W	2W	6W								
Water Temperature	2W	6W	2W	6W	2W	6W								
pH	2W	6W	2W	6W	2W	6W								
Specific Conductance	2W	6W	2W	6W	2W	6W								
Total Alkalinity	2W	6W	2W	6W	2W	6W								
Secchi Disk Depth	2W	6W	2W	6W	2W	6W								
Turbidity	2W	6W	2W	6W	2W	6W								
Suspended Solids	2W		2W		2W									
Chlorophyll	2W		2W		2W									
Ice Thickness		6W		6W		6W								
Snow Depth		6W		6W		6W								
Mussel Survey										1			USFWS/IADNR	
Boring Stations[4]														
Geotechnical Borings							1	1					Corps	
Fish Stations														
Electrofishing/Seining[5]										Y		Y	IADNR	
Transect Measurements														
Vegetation Survey[6]												5 Y	IADNR	
Mast Tree Survey[7]												10Y	Corps	
Sediment (Bathymetry)									5Y				Corps	
Mapping														
Aerial Imagery[8]							1		5Y				Corps	

Legend

W = Weekly	nW = n-Week Interval
M = Monthly	nY = n-Year Interval
Y = Yearly	1,2,3 = Number of times data is collected within designated Project phase

1 See Plate 32, O-102 for post construction phase monitoring. Note that the information presented in this table includes data obtained to develop the Project (Pre-Project Phase), during Project design, and Post-Construction phase. Post-construction work refers to monitoring and data collection used in the Performance Evaluation Reports

2 Pre-Project water quality stations are shown on Plate 31, O-101: W-M513.4P and W-M513.5R. Post-Construction water quality stations are shown on Plate 32, O-102: W-M513.4P and W-M513.5R.

3 Post-Construction water quality data will be collected during approximately 50% of the long term performance monitoring period.

4 See Plate 4, B-101 for geotechnical boring locations and Plate 5, B-301 for boring logs and dates.

5 Fish sampling by the IADNR will begin after completion of Adaptive Management and Post-Construction Monitoring. The IADNR's sampling data will be used to evaluate Project effectiveness and results obtained from Adaptive Management and Monitoring activities.

6 Vegetation Transects by the Sponsors will begin at year 11 following Adaptive Management and Post-Construction Monitoring to determine the effectiveness of planting measures following construction.

7 Mast tree (forestry) surveys will be conducted twice as best determined by Corps foresters approximately 10 years apart following completion of Adaptive Management and Post-Construction Monitoring activities to determine tree planting effectiveness.

8 Aerial imagery will be obtained at no cost from GIS resources such as National Agriculture Imagery Program. A review of the aerial imagery will assist with determining overall Project effectiveness.

Table X-3. Post-Construction Evaluation Plan

Enhancement Measures	Measurement	Year 1 w/ Alt	Year 20 w/ Alt	Year 50 Target w/ Alt	Measurement	Annual Field Observations by
Bathymetric Diversity of Stewart, Blue Bell, Sand Burr, and Lower Cuts	Habitat Units (HUs) of overwintering and summer backwater habitat	160 HUs	158 HUs	158 HUs	Water Quality Stations, Electrofishing, and Sediment Transects/Bathymetry	Presence of fish during overwintering, spawning, rearing, and foraging seasons.
Forest Diversity Sites Adjacent to Bathymetric Diversity Sites	Trees per acre, and species diversity	100 Trees/Acre; >7 species	75 Trees/Acre; >7 species	75 Trees/Acre; >7 species	Mast Tree Survey	Visual Observations
Albany Island Chevron	Acres of island	9 acres	9 acres	9 acres	Bathymetry and Aerial Photos	Visual Observations
Albany Slough Mussel Substrate	Mussels/m^2 and species diversity	0	5 mussels/m^2; >4 species	5 mussels/m^2; >4 species	Mussel survey techniques including pollywog and dive surveys	Pollywog surveys for mussels and substrate observation

XI. REAL ESTATE REQUIREMENTS

The Beaver Island HREP is a part of the UMRR authorized by Section 1103 of the WRDA of 1986, Public Law 99-662, as amended. The Project is located along the Mississippi River in Pool 14 between RM 513.0 and 517.0.

The Beaver Island HREP is located along the right descending bank of the Mississippi River near Clinton, Iowa. Beaver Island contains approximately 1,678 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. All lands necessary for the Project are owned by the United States. The acquisition of Project lands was administered by the Corps of Engineers and the USFWS, Savanna District, as part of the Upper Mississippi River Wildlife and Fish Refuge. Upstream portions of the Island are privately owned, but are not included in the Project area.

For this Project, the USFWS is acting as the Federal Sponsor. The Project would be 100% Federal cost. A map showing the Project area is included on Plate 6, (C-101, *Site Plan*) of this report.

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

All placement materials would be excavated from within navigational servitude and Project waters and from existing top soil on Beaver Island.

Access to the Project would be by water (Mississippi River) from a public boat ramp located approximately two miles south of the Project area near Camanche, Iowa, or from a public boat ramp located adjacent to the Project at Albany, Illinois (Appendix M, Attachment C).

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

A draft Memorandum of Agreement between the USFWS and the Corps is included as Appendix C and a Real Estate Plan is included as Appendix J. Estimated operation and maintenance costs can be found in Tables VIII-5 and VIII-6.

XII. IMPLEMENTATION RESPONSIBILITIES AND VIEWS

A. U.S. Army Corps of Engineers, Rock Island District. The Corps is responsible for Project management and coordination with the USFWS, IADNR, and other affected agencies. The Corps 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) of WRDA 1986 states that first cost funding for enhancement measures will be 100% Federal cost because the Project measures will be located on federally-owned land that is managed by the USFWS as a national wildlife refuge.

B. U.S. Fish and Wildlife Service. The USFWS is the Federal Project Sponsor and has provided a Coordination Act Report. Operation and maintenance, as described in Tables VIII-5 and VIII-6, is the responsibility of the USFWS in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. The Corps will further specify these functions in the Project Operation and Maintenance Manual, which will be provided prior to final acceptance of the Project.

C. Iowa Department of Natural Resources. The IADNR, the non-Federal Project Sponsor, has provided technical and other advisory assistance during all phases of the Project and will continue to provide assistance during implementation and monitoring.

XIII. COORDINATION, PUBLIC VIEWS, AND COMMENTS

Coordination has been made throughout the planning process with the following State and Federal agencies:

Iowa Department of Natural Resources (IADNR)

State Historical Society of Iowa (SHSI)

U.S. Fish and Wildlife Service (USFWS)

Illinois Department of Natural Resources (ILDNR)

U.S. Environmental Protection Agency (EPA)

A. Coordination Meetings

Numerous coordination meetings were held with Project cooperators to discuss potential enhancement measures. The following meetings demonstrate ongoing coordination:

- July 28, 2006. General scoping meeting and site visit with Corps, USFWS, and IADNR. Team discussed problems, opportunities, and potential enhancement measures
- August 26, 2013. Site visit with Corps, USFWS, IADNR
- January 8, 2014. Meeting with Corps, USFWS, IADNR to discuss public meeting arrangements
- March 7, 2014. General scoping meeting with Corps, USFWS, IADNR to discuss general resource identification and other Project elements
- March 26, 2014. Public Meeting at the Erickson Center in Clinton, Iowa
- October 16, 2014. General scoping teleconference with Corps, USFWS, and IADNR to define Project objectives
- October 31, 2014. General scoping meeting with Corps, USFWS, and IADNR held at the Savanna District USFWS Refuge Office in Thomson, Illinois. Team discussed potential enhancement measures
- December 15, 2014. General scoping meeting with Corps, USFWS, and IADNR to discuss potential measures, schedules, and milestones
- January 7, 2015. General scoping teleconference with Corps, USFWS, and IADNR to discuss survey data, modeling and other Project datasets
- April 20, 2015. General scoping meeting with Corps, USFWS, and IADNR to review Project problems/opportunities/objectives, discuss trade-offs of proposed measures and decide on measures to retain
- June 24, 2015. General scoping teleconference with Corps, USFWS, and IADNR to discuss quantities, habitat units, potential measures and other Project elements
- July 20, 2015. General scoping teleconference with Corps, USFWS, and IADNR to discuss the mussel measure and make decisions on topographic measures

- July 29, August 1 and August 20, 2015. Mussel surveys accomplished by IADNR, ILDNR, MNDNR, USFWS, Corps, INHS, EPA, Exelon Nuclear Power Plant and volunteers.
- August 27, 2015. General scoping teleconference with Corps, USFWS and IADNR to discuss Project alternatives, including the cost effective options and Best Buy Plans.
- September 1, 2015. General scoping teleconference with Corps, USFWS and IADNR to discuss the habitat evaluation results.
- November 6, 2015. General scoping meeting with Corps, USFWS and IADNR to refine the TSP.
- December 3, 2015. General scoping meeting with Corps, USFWS and IADNR to further refine the TSP.
- January 13, 2016, February 10, 2016, and March 9, 2016. General scoping teleconference with Corps, USFWS and IADNR to refine the TSP.
- February 8, 2016. General scoping teleconference with Corps, USFWS and IADNR to develop the Adaptive Management Plan.
- March 7, 2016. General scoping meeting with Corps, USFWS and IADNR to discuss tree and understory plantings.

B. Coordination by Correspondence

- Letter dated April 24, 2006, from the MVD Director of Programs to the Rock Island District Commander approving the Beaver Island HREP fact sheets
- Public Review After Action Report documenting the open house held March 26, 2014, and the comments received from the public
- Letter dated August 11, 2014, from the MVD Director of Programs to the Rock Island District Commander approving the Review Plan for the Beaver Island HREP
- Letter dated July 16, 2014, from the Rock Island District to resource agencies and cultural groups initiating coordination of historic properties and requesting information from consulting parties
- Letter dated December 24, 2014, from the Rock Island District to the State Historical Society of Iowa (SHSI) requesting comments and concurrence on the Project and the District's determination
- Email dated January 6, 2015, from the USFWS providing mussel data gathered during the August 14, 2014, mussel survey
- Email dated January 14, 2015, from the State Historic Preservation Office providing comments and concurrence with the draft BCA report 2104
- Email and photos dated April 16, 2015 from Ed Britton, Savanna District Manager, Upper Mississippi River National Wildlife and Fish Refuge (UMR NWFR), regarding a site visit and assessment of existing wetlands

- Meeting Read Ahead package dated April 20, 2015 describing estimates of excavation and topographic diversity sites for the Beaver Island HREP to the PDT for discussion and refinement at a general scoping meeting
- Email dated December 4, 2015, from the IADNR providing a summary of the data gathered during the August 20, 2015, mussel survey
- Email dated December 10, 2015, from the USFWS to the Rock Island District providing concurrence with the Tentatively Selected Plan
- Email dated December 10, 2015, from the IADNR to the Rock Island District providing concurrence with the Tentatively Selected Plan
- Value Management Plan approved by the Rock Island District, signed and dated by the Value Engineering Officer on January 5, 2016
- Email dated February 1, 2016, from the Rock Island District to the USFWS providing a biological assessment and requesting concurrence with determinations made by the District regarding federally-endangered or threatened species listed under the Endangered Species Act
- Letter dated February 29, 2016, from the USFWS to the Rock Island District transmitting concurrence on the biological assessment and determinations made by the District regarding federally-endangered or threatened species listed under the Endangered Species Act
- Letter of Support dated August 3, 2016 from Tim Yager, Deputy Refugee Manager, UMR NWFR, regarding the Beaver Island HREP and value of the project
- Letter of Support dated August 15, 2016 from Chuck Gipp, Director, IADNR, regarding the Beaver Island HREP and value of the project
- Letter dated August 24, 2016 providing the Draft Coordination Act Report from Kraig McPeek, U.S. Fish and Wildlife Service
- Letter dated September 7, 2016, from the Rock Island District to resource agencies and cultural groups describing the proposed project and results of historic property surveys.
- E-mail concurrence dated September 13, 2016, from the USFWS in response to District's letter dated September 7, 2016
- Stamped Concurrence dated September 28, 2016, from the SHSI in response to District's letter dated September 7, 2016
- Letter dated January 12, 2017, from the Rock Island District to resource agencies and cultural groups describing the Tentatively Selected Plan, results of historic property surveys, effect determination and requesting comments on the project
- Letter dated March, 24, 2017, from USFWS to the Rock Island District providing the Final Coordination Act Report
- Letter dated March 30, 2017, from the USFWS to the Rock Island District providing comments on the Public Review Draft Feasibility Report with Integrated EA

- Letter dated March 31, 2017, from the USEPA to the Rock Island District providing comments on the Public Review Draft Feasibility Report with Integrated EA
- Beaver Island HREP Open House After Action Report dated May 24, 2017

C. Public Views and Comments. An open house was held on March 26, 2014, in Clinton, Iowa, to discuss the initiation of the Feasibility Study and proposed Project with interested members of the public and to gather public input (Appendix N, *Distribution List*). Representatives from the Corps, USFWS, and IADNR were present to talk one-on-one with attendees. Displays were placed around the room showing the UMRR program, information about the Corps, historic and current imagery of Beaver Island, 2013 water depths of Beaver Island, Real Estate map of Beaver Island, other HREP projects in the UMR and information about the UMR Fish and Wildlife Refuge. Ninety-seven members of the public attended the evening session. Eighteen comment sheets were returned (Appendix A, *Correspondence*). Respondents indicated they used the area for wildlife viewing, bird watching, recreation, fishing, boating, camping, and hunting. Generally, the most common concern from the open house was the lack of deep water, overwintering habitat and fishing/boating opportunities due to the backwater channels and sloughs being significantly silted in. The change in water depth has affected the fish and wildlife populations as well. Respondents indicated that they would like to see dredging and channel restoration occur at Beaver Island, for both wildlife and recreation benefits.

An additional open house was held in a similar format on February 21, 2017, in Clinton, Iowa to discuss the TSP. Thirty-seven members of the public attended the evening session. Eleven comment sheets were returned (Appendix A). Respondents generally supported the project and indicated that they would like to see additional dredging occur besides what was currently proposed.

An additional opportunity to gain public feedback occurred during the public review period. The draft report was released for review in February 2017; the review period ended on April 7, 2017. Two emails were received during the review period and are detailed below. The two comment letters received during this time are included in Appendix A, with responses as follows:

U.S. Fish and Wildlife Service letter, dated March 30, 2017

Comment: By letter dated July 1, 2016, we provided the Corps comments to the previous draft report dated May 2016. Unless noted below, the Corps appropriately addressed those comments in this Public Review Draft Feasibility Report.
Response: Concur. Revisions were made to the report to include these comments.

***Comment*:** The final Feasibility Report shall include a copy of the draft Memorandum of Agreement (MOA) for the operation, maintenance, repair, and rehabilitation of the project. The Regional Director's letter on the final Feasibility Report will include the certification of support for operation and maintenance.
Response: Concur. The MOA will be included in the final report.

Comment: This work will be accomplished under the authority of WRDA 1986 (Section 1103), as amended. The annual O&M costs are estimated at $9,600. As the project sponsor, the USFWS would be responsible for 100% of the O&M costs. The Services' financial support would be dependent, of course, on total cost, appropriations authority, O&M responsibility, and benefits to the natural resources.

Response: Comment noted.

Comment: Our Rock Island Field Office staff has completed the Fish & Wildlife Coordination Act Report, and has provided it to the Corps under separate correspondence.
Response: Concur. The Fish & Wildlife Coordination Act Report has been received and is included in Appendix A.

Comment: Timber stand improvements are a significant part of this project, but there is no clear plan for implementation at this time. We would like to ensure that this feature is implemented in a timely fashion.
Response: Additional details on implementing improvements to the timber stand will occur during plans and specs development.

Comment: Regarding Indiana bats, the acoustic survey was conducted in accordance with the Service's 2015 Range-wide Indiana Bat Summer Survey Guidelines (USFWS, 2015). The acoustic survey results were analyzed using two different call detection programs, resulting in a total of 217 Indiana bat calls detected by both programs. Per the Service's 2015 Range-wide Indiana Bat Summer Survey Guidelines and as discussed in our February 29, 2016 coordination letter, this information documents the presence of Indiana bats within the Project area. Although no Indiana bats were captured during the mist netting efforts, it is likely the area is used as foraging grounds for Indiana bats.
Response: There is stated limitation of no tree clearing during the federally endangered Indiana bat and northern long-eared bat maternity season of April 1 to September 30 to minimize impacts. See USFWS letter dated February 29, 2016 for concurrence.

Comment: In the Memorandum of Agreement, please add a statement that the Corps will provide the USFWS an Operation and Maintenance Manual at Project completion and turnover. Refer to the Harper's Slough HREP MOA as an example.
Response: Concur. The final MOA will include this statement.

Comment: Please note that for the Memorandum of Agreement, the USFWS address has not been updated. The address is 5600 American Blvd. West, Suite 990, Bloomington, MN 55437-1458
Response: Concur. Address will be revised.

Comment: Table III-2 "Beaver Island UMR Significance" was added to this document. We will provide a recommended list of Institutional Recognition USFWS-relevant components under separate correspondence.
Response: Additional information was received and incorporated into the report.

U.S. Environmental Protection Agency, Region 7 letter dated March 31, 2017

Comment: The Feasibility Report/EA is thorough and comprehensive, and covers in depth various potential impact and mitigation measures. We commend your coordination efforts with various other agencies and entities throughout the development of this project. We would encourage continued coordination with local, state, and federal agencies to ensure that all laws, ordinances, and regulations are followed and all necessary permits acquired. While we have no objection to the project itself, or the recommendation of a Finding of No Significant Impact, we would like to offer the suggestion that

all feasible mitigation and monitoring measures outlined in the EA are followed to minimize potential impacts to human health and the environment.
Response: Comment noted. Monitoring will be conducted per Appendix K.

Paul Witt email dated March 18, 2017

Comment: Although I did not note a specific statement that the rock closure structure at the upper entrance would block all boat traffic, I am concerned that may be true. I expect that a small lock operated by boaters would not be feasible or durable enough to consider.
Response: The closure will essentially block all down bound boat traffic, but access is available from the lower end of the island. A small lock or other structure was briefly considered, but dropped because access was still possible from the island's lower end.

Comment: To me the condition of Sunfish Slough helps predict success for your proposed Beaver Island project although I do not know why there is less sea weed in Sunfish Slough. Does blocking the inflow decrease the fertilizer or the carbon dioxide that nourish the sea weed or does the increased fish population eat the sea weed? Probably it is too complicated for a simple answer. I know it does not matter, but I support your project and appreciate your efforts.
Response: Sunfish Slough (on Illinois channel side at ~RM 517.0) was investigated in the very early stages of this project, but was found to be in excellent condition. The Corps and our sponsors are aware of its current condition and will try to determine how it has maintained itself to apply to future projects, where feasible. The closure structure was designed to deflect heavy sediments from reaching the island's interior and to reduce flows to benefit overwintering fish.

Unknown Sender email dated March 29, 2017

Comment (repeated throughout the email): Unfortunately, everyone I have spoken (approximately 40 people myself in person despite being very ill myself) (about the same total attendance of your "public input meeting in Clinton on a Tuesday night at 6PM 2-21-2017 with only 40 total attendees") regarding this 22 Million Dollar Project that was indicated many years ago when it was proposed to be an entire dredging of the island from Beaver Slough Upper Deep Cut to the lower end outlet to the main channel of the river has been cut without prior public knowledge or input to an extremely pathetic and nearly worthless waste of 22 million taxpayers' dollars from everyone that I have spoken with personally and shown the entire color coded maps.
Response: Public involvement is essential to this and other projects throughout the USACE. Two open houses were conducted to provide opportunities for public feedback in assisting with development and selection of the plan. See Appendix A for comments received. Social media was also utilized to reach a wider range of audience and to accommodate those unable to attend.

Comment: Those extremely few that actually knew of the project, once I showed them the maps were very upset and disappointed, but not at all surprised that the entire project was not at all what they had been promised, as my first question to everyone was "what is your understanding of the Beaver Island project?" Those few who knew said that the information they had been provided said that the entire island waterway was going to be dredged and they were extremely upset and disappointed that they the entire project has been so grossly misrepresented by the USACE and all other federal agencies involved!
Response: Communication with other agencies was ongoing throughout the entire planning process. Certain criteria have to be followed per federal policies. These criteria can have constraints on the

amount and/or locations of dredging/placement. The report demonstrates those constraints, alternatives formed, alternatives evaluated, and eventually the alternative selected to balance the needs of all agencies and stakeholders involved.

Comment: As I discussed with city officials from Camanche at the Ducks Unlimited meeting several weeks ago some of the highest ranking public officials from the City of Camanche said that this single Tuesday Night 2-21-17 6PM meeting that was so poorly advertised and other required multiple meetings should have been published on the front page of both the Clinton Herald and Quad City Times not only letting people know that this was their only meeting (which absolutely would not happen in the QC area), but as one project manager informed me she said, (it's only a Clinton area issue and only affects Clinton people so there is no need for more than one meeting, which is so false as it affects people within at least a 50 mile area).
Response: Public involvement is essential to this and other projects throughout the USACE. Two open houses were conducted to provide opportunities for public feedback in assisting with development and selection of the plan. See Appendix A for comments received. Social media was also utilized to reach a wider range of audience and to accommodate those unable to attend.

XIV. CONCLUSIONS

The Recommended Plan selected for the Beaver Island HREP (mechanical backwater dredging, topographic diversity berms, closure structure, floodplain forest plantings and timber stand improvements, bank stabilization, mussel substrate, and a chevron) is designed to meet the Project's goals of restoring and protecting off-channel aquatic and wetland habitat and restoring floodplain forest habitat, which would allow the Project area to realize the highest benefit to fish, migratory birds, and resident wildlife.

This ecosystem restoration Project will result in improved overwintering conditions for a variety of fish species. Increasing backwater depths with the resulting improvement in water quality and fish habitat structures should promote and improve seasonal refugia with resulting benefits to the warm-water fisheries communities. Placement of mussel substrate should promote and improve mussel habitat quality with resulting benefits to many mussel species, including the federally and state-listed Higgin's eye pearlymussel. Additional habitat gains will result for floodplain forest quality through increasing hardwood forest stand species diversity, age, and structure. This will provide long-term benefits to resident and migratory bird and bat species, while providing increased foraging and shelter habitat diversity to other species relying on hardwood mast trees as a source of food and shelter. While improvements would occur with each restoration measure on Beaver Island, the impact of these improvements will extend well beyond the confines of Beaver Island and are expected to benefit the fish and wildlife communities located upstream and downstream.

Further, this Project is consistent with and fully supports the overall goals and objectives of the UMRR, the USFWS Comprehensive Conservation Plan, the North American Waterfowl Management Plan, and the Partners in Flight Program.

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

BEAVER ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 513.0-517.0
CLINTON COUNTY, IOWA

RECOMMENDATIONS

I have weighed the outputs to be obtained from the full implementation of the Beaver 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 expenditure of Federal funds. I recommend that the Division Engineer approve the proposed Beaver Island HREP to include excavating backwaters, constructing topographic diversity areas using the excavated material, establishing floodplain forest with a mast tree component on the topographic diversity areas, and using rock for bank stabilization, mussel substrate placement, and an off-shore chevron at Albany Island.

The total Federal estimated Project cost, including general design and construction management, is $21,522,000.

6/21/2017

Date

Craig S. Baumgartner
Colonel, U.S. Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

BEAVER ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 513.0-517.0
CLINTON COUNTY, IOWA

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 the proposed Project in Pool 14, Clinton County, Iowa, 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 following array of management measures were considered from which alternatives were derived:

1. excavating within Beaver Island backwaters;
2. placing excavated material in the floodplain to make areas of topographic diversity;
3. establishing native floodplain forest species on topographic diversity sites;
4. implementing timber stand improvement methods, such as tree releases, girdling, and interspersed tree plantings; and
5. constructing a chevron, closure structure, bank stabilization, and mussel substrate on Albany Island.

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 overall habitat value of Beaver Island for fish, and to improve the diversity of the floodplain forest community.
2. Aside from temporary disturbances during construction, no long-term significant adverse impacts to natural or cultural resources are anticipated. No tree clearing during the federally endangered Indiana bat and northern long-eared bat maternity season of April 1 to September 30. No federally-protected species would be adversely affected by the proposed action.
3. Land use after the Project should remain unaltered, and no significant social or economic impacts to the Project area are expected.
4. The Project complies with Sections 401 and 404 of the Clean Water Act.

10/10/2017

Date

Craig S. Baumgartner
Colonel, U.S. Army
Commander & District Engineer