UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

FINAL
NOVEMBER 2013

US Army Corps of Engineers®
Rock Island District

POOL 18
UPPER MISSISSIPPI RIVER
RIVER MILES 421.2 THROUGH 425.4
DES MOINES COUNTY, IOWA

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EXECUTIVE SUMMARY

The *Huron Island Habitat Rehabilitation and Enhancement Project* (Project) is located in Des Moines County, Iowa, approximately 20 miles upstream of Burlington, Iowa, in Pool 18 between Upper Mississippi River river miles 421 and 425. All Project lands are in Federal ownership.

The Project area contains more than 2,600 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. The Project is comprised of moderate to poor quality habitat. Current stressors include sedimentation and increased water levels due to construction of the lock and dam system. These stressors are likely to continue and the quality of aquatic and floodplain habitat will decline. The opportunity exists to protect and restore habitat for fish, wildlife, and resident and migratory birds before it is lost as well as to protect natural geomorphic processes.

The goals of the Project are to:

(1) Manage for a diverse and dynamic pattern of habitats to support native biota;

(2) Manage for viable populations of native species within diverse plant and animal communities; and

(3) Manage for processes that shape a physically diverse and dynamic river-floodplain system

The objectives of the Project are to:

(1) increase the areal coverage as measured in acres of emergent and submersed aquatic vegetation in backwater areas during the growing season;

(2) increase diversification of year round floodplain forest and scrub-shrub habitat on Huron Island, as measured in acres;

(3) increase the structure and function of year-round aquatic habitat diversity, as measured by acres and native fish use of spawning, rearing, and overwintering habitat in the Project area; and

(4) maintain side channel riverine hydrodynamic, sediment transport and geomorphic processes in Huron Chute.

The following enhancement features were considered to achieve the Project objectives:

(1) construct bathymetric and topographic diversity adjacent to and in backwater areas;

(2) construct topographic diversity in non-diverse forested areas;

(3) establish native aquatic and floodplain forest vegetation and trees;

(4) construct a closure structure in Garner Chute; and

(5) protect small side channel islands in Huron Chute from erosion.

The design life for this Project is 50 years. Cost and habitat benefits were estimated. 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 115.65 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 below flat pool, providing overwintering and year-round habitat for fish. Excavated material will be used to construct land and aquatic areas to enhance bathymetric and topographic diversity. These areas will be planted with native aquatic and floodplain forest vegetation and trees. A rock closure structure will be constructed in Garner Island to reduce overwintering water velocities while maintaining necessary levels of dissolved oxygen. Rock will be constructed at the head of two small islands in Huron Chute to protect from erosion.

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-Environmental Management Program.

Section 906(e) of the 1986 Water Resources Development Act (WRDA) specifies that first cost funding for enhancement features “located on lands managed as a national wildlife refuge” will be 100 percent Federal. All Project features would be located on federally-owned lands managed through a cooperative agreement with the U.S. Fish and Wildlife Service (USFWS); responsibility for the operation, maintenance, and repair of the lands has, in turn, been given to the Iowa Department of Natural Resources (IA DNR) by the USFWS through a cooperative agreement. Per Section 107(b) of the 1992 WRDA, the IA DNR will accomplish project maintenance at an estimated average annual cost of $10, 290.

The Rock Island District’s District Engineer has reviewed the Project outputs, a gain of 115.6 net average annual habitat units, and determined that the implementation of the Recommended Plan is in the Federal interest. Therefore, the District Engineer recommends construction approval for the Huron Island Project at an estimated construction expense of $10.5 million, including contingency and adaptive management measures. The estimated Total Project Cost, including; planning, engineering and design; adaptive management measures; contingency; and escalation; is $12.8 million.

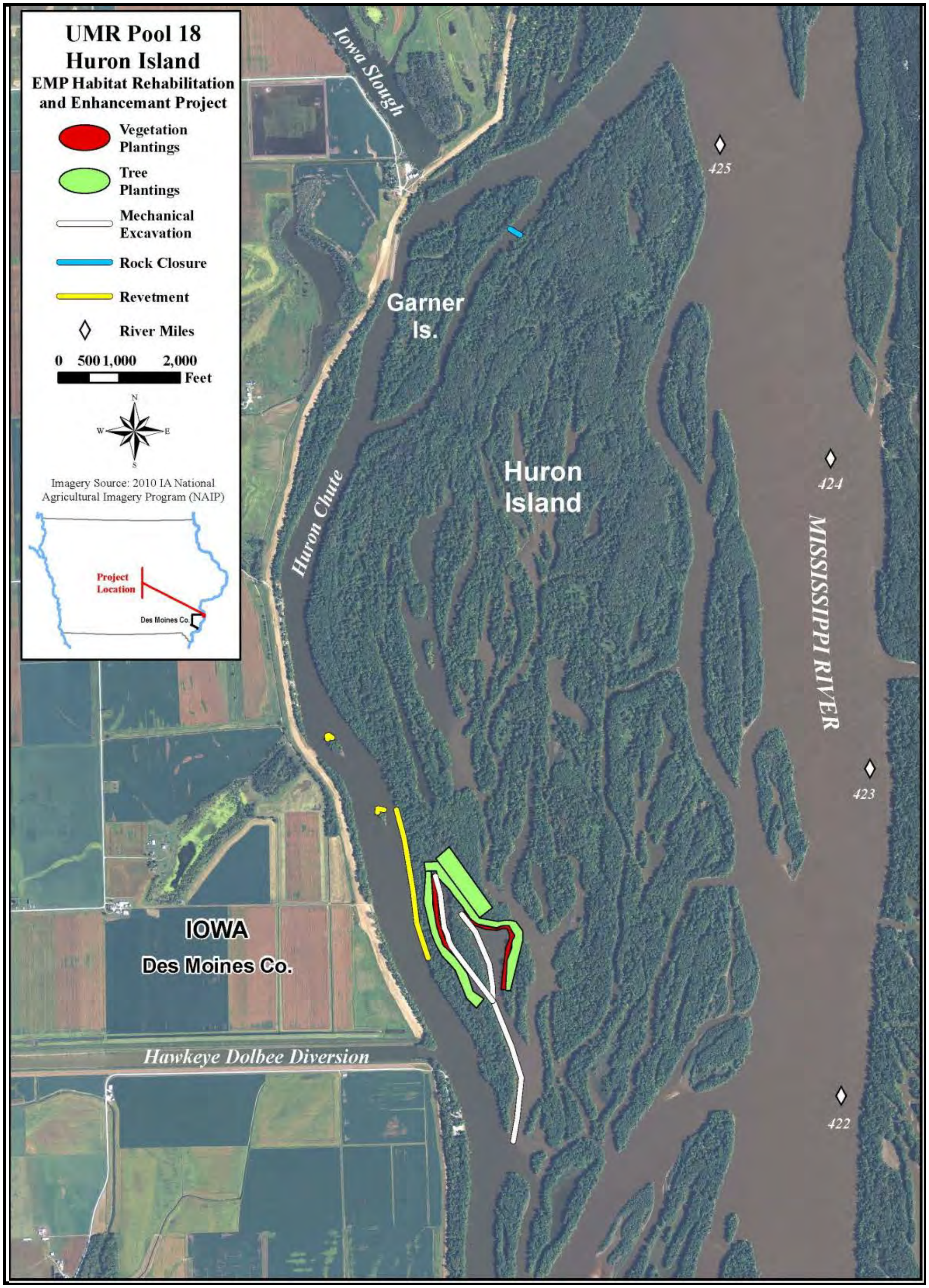

Figure ES-1. Project Features

UPPER MISSISSIPPI RIVER RESTORATION
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I. INTRODUCTION

A. Location

The area of the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project) is located along the right descending bank of the Upper Mississippi River (UMR) in the northern portion of Des Moines County, IA. It is in Pool 18 between river miles (RM) 421.2 and 425.4, approximately 20 miles upstream of Burlington, IA. The Iowa River enters the Mississippi River roughly 12 miles upstream of the island complex. Areas considered as part of this Project and described as the "Project Area" include Buffalo Slough, Gun Slough, Cody Chute, Beaver Chute, Huron Chute, and areas associated with Garner Island. The Project Area contains more than 2,600 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. At low flow there are 815 acres of aquatic habitat compared to 1,850 acres of floodplain habitat. Figures 1 and 2 and Plates 1 (G-002) and 10 (C-101) provide vicinity and specific location maps for Huron Island.

The Project lands, which are part of the National Wildlife Refuge System and federally-owned by the U.S. Army Corps of Engineers, Rock Island District (Corps), are out granted to the U.S. Fish and Wildlife Service (USFWS) through a cooperative agreement dated July 31, 2001. Responsibility for the operation, maintenance, and repair of the lands has, in turn, been given to the Iowa Department of Natural Resources (IA DNR) by the USFWS through a cooperative agreement dated March 22, 2012.

B. Purpose & Need

The Corps proposes to rehabilitate and enhance Huron Island through construction 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 Huron Island. This Definite Project Report (DPR) with an integrated Environmental Assessment (EA) presents 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 Project is based on the following factors:

- The existing aquatic habitat is generally shallow, turbid, and lacks aquatic vegetation important for year-round habitat functioning. Without action the existing aquatic habitat will cease to function as fish habitat.
- The existing topography lacks diversity and is nearly 99 percent inundated during a 50 percent exceedance probability event. Consequently, floodplain forest regeneration, growth, and survival are reduced. Floodplain habitat will decrease in quality through succession to reed canary grass, which is an invasive species.
- Huron Chute, the existing secondary channel habitat, has degrading geomorphologic features. In time small islands will continue to degrade impacting velocity and fish resting areas.

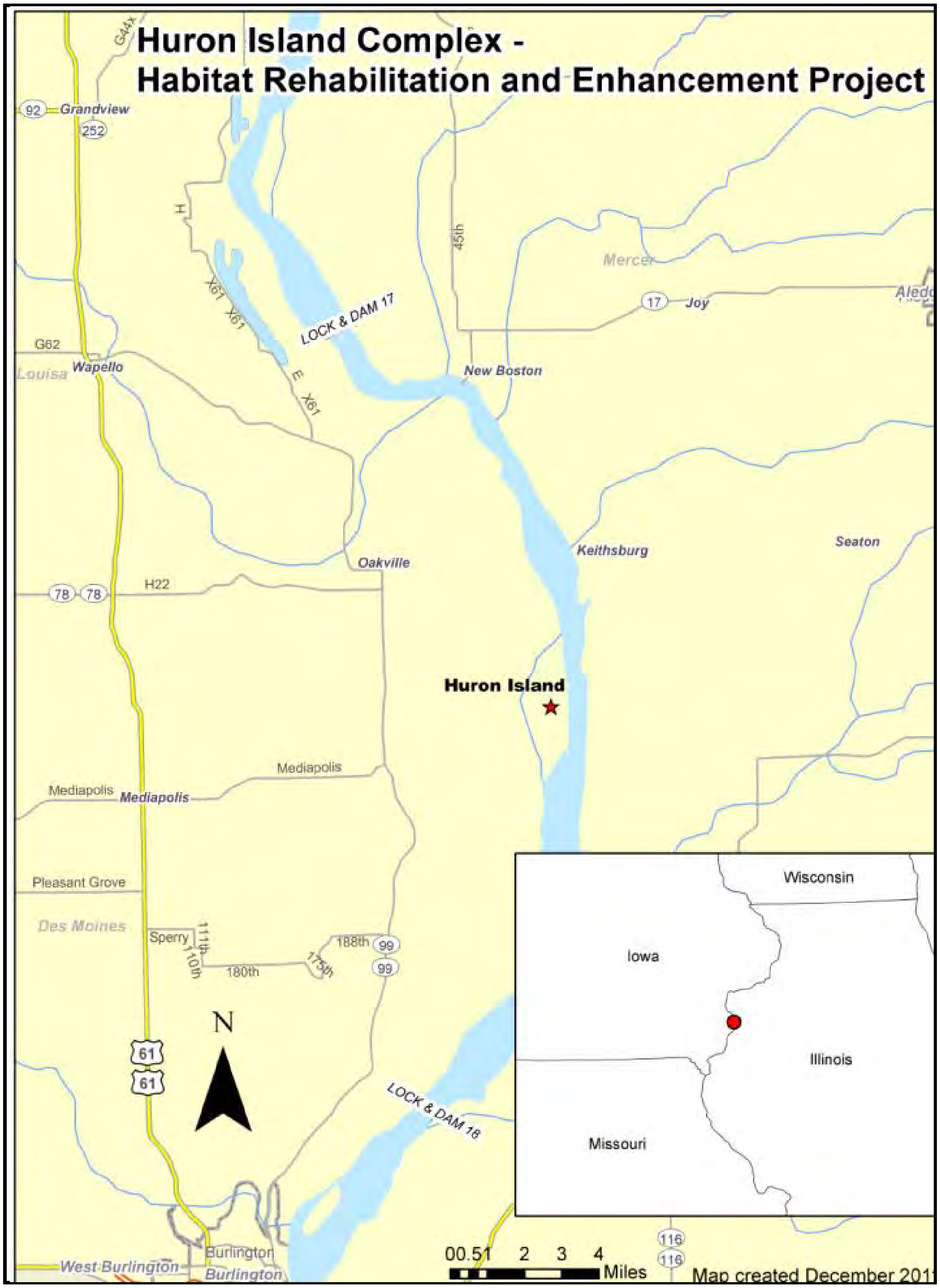

Figure 1. Vicinity Map

Figure 2. Project Area Map

C. Resource Problems and Opportunities

The Project is comprised of moderate to poor quality habitat. Current stressors include sedimentation and increased water levels due to construction of the lock and dam system. These stressors are likely to continue and the quality of aquatic and floodplain habitat will decline. The opportunity exists to protect and restore habitat for fish, wildlife, and resident and migratory birds before it is lost. Identified problems and opportunities are further described in Section III, *Development of Project Objectives*.

D. Project Selection

The IA DNR nominated the Huron Island Project for inclusion in the Corps' Upper Mississippi River Restoration-Environmental Management Program (UMRR-EMP). The Fish and Wildlife Interagency Committee (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 River Resources Coordinating Team as providing significant aquatic, wetland, and floodplain benefits with opportunities for habitat enhancement. Development of this DPR was actively coordinated with the USFWS and IA DNR. Coordination occurred during on-site visits to the Project Area, team meetings, and phone conversations (Appendix A, *Correspondence*).

E. Scope of Study

The scope of this study focuses on proposed project features 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.

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 2011 to evaluate the species composition and average age of the existing forest. An Indiana bat survey was also conducted in 2012.

The IA DNR has made wildlife and resident fish observations within the Project Area. These observations, along with future studies and monitoring, will assist in evaluating project performance.

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

1135 Mast Tree Planting. 58 acres of plantings were proposed as part of an 1135 project for establishment of a mast tree component at Huron Island in 1990. Trees were planted at the existing topography and resulted in 90 percent mortality due to flooding and herbaceous competition.

404 Vegetation Study. This study evaluated the effects of dredged material placement on existing herbaceous vegetation. Trees experienced high mortality over several years.

Johnson Island Dredged Material Management Plan. In 1996 approximately 20 acres of dredged material was placed on Johnson Island and planted with tree seedlings. In 2004 the site was also planted with 100 bareroot seedlings and 74 containerized trees. Plantings resulted in high mortality due to a lack of organic material in the dredged material.

Upper Mississippi River System-Environmental Management Program, Pools 17-18 Lake Odessa Habitat Rehabilitation and Enhancement Project, Corps, Rock Island District, June 2005. This HREP is located in Louisa County, Iowa upstream of Huron Island Project. This report describes the habitat and restoration improvements made to Lake Odessa in Pool 17 & 18 under UMRR-EMP.

Upper Mississippi River System-Environmental Management Program, Pools 17 Big Timber Habitat Rehabilitation and Enhancement Project, Corps, Rock Island District, June 2005. This HREP is located in Louisa County, Iowa upstream of the Huron Island Project. This report describes the habitat and rehabilitation improvements made to Big Timber in Pool 17 under UMRR-EMP.

Ecological Status and Trends of the Upper Mississippi River System, 1998. A report of the Long Term Resource Monitoring Program. US Geological Survey (USGS), Upper Midwest Environmental Sciences Center, La Crosse, WI. 1998. This was the first report following the inception of the UMRR-EMP and beginning of data collection under LTRMP in which the monitoring data are summarized into one report, alongside historical observation and other scientific findings. This report also serves as background material for the Corps' Report to Congress that provided recommendations for future environmental management of the UMRS. The report provided a timely assessment of river conditions.

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 UMR System (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 habitat projects 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 to maintain it.

Upper Mississippi River Environmental Design Handbook. Corps, Rock Island District, Rock Island, IL, August 2006. This Design Handbook of the UMRR-EMP evaluates project features and incorporates lessons learned throughout the lifetime 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-EMP. 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 Restoration Environmental Management Program. Corps, Rock Island District, Rock Island, IL. This report is the most recent formal evaluation of the UMRR-EMP 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 Restoration 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.

G. Authority

The UMRR-EMP's original authorizing legislation was the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), Section 1103. The UMRR-EMP was originally comprised of five elements: HREPs; Long-Term Resource Monitoring Program (LTRMP); Recreation Projects; Economic Impacts of Recreation; and Navigation Monitoring. Currently, the UMRR-EMP 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 LTRMP. The other UMRR-EMP elements have either been successfully completed or are now carried out under other authorities.

The original authorizing legislation has been amended three times since its enactment. The 1990 WRDA, Section 405, extended the original UMRR-EMP authorization an additional five 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 LTRMP program. 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-EMP as a continuing authority with reports to Congress every six years and changed the cost sharing percentage from 25 percent to 35 percent. Huron Island is located on federally-owned refuge lands so the Project is 100-percent federally-funded. The text of the authorization is as follows:

Environmental Management 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), and Section 2 of the Water Resources Development Technical Corrections of 1999 (P.L. 106-109).

WATER RESOURCES DEVELOPMENT ACT OF 1986
P.L. 99-662

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.

(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.

II. AFFECTED ENVIRONMENT
A. Resource History of the Study Area

The Mississippi River, and what is presently Pool 18, 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 Pool 18 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 marsh were prevalent throughout the area.

According to residents and historical newspaper articles (former IA DNR Biologist Bill Aspelmeier 2011; Mediapolis Centennial Book1875-1975), the floodplain around the Project once supported numerous hunting and fishing clubs, cabins, and even a hotel. Fishing occurred throughout the year and during the spring and fall hunting seasons cabins were filled with hunters of ducks and geese.

Channel manipulations to clear the channel and improve navigation began around 1825. Measures to deepen the channel occurred from the 1880s until present. Levee construction began on the UMRS in the 1880s. By 1900 most modern levee alignments had been established. Completion of Lock and Dam 18 in 1937 increased water levels at the dam almost 10 feet. The implementation of these channel modifications and drainage improvements immediately eliminated the lakes and marshes from the floodplain of Pool 18. Over time the impacts of channel modification have contributed to a decrease in the overall acreage of aquatic vegetation, mesic bottomland hardwood forest, scrub-shrub, semi-permanently flooded emergent wetlands, wet floodplain forest, and wet meadow within Huron Island. This has led to a decrease in the habitat associated with each land cover type, as well as fish and wildlife using the habitat.

B. Description of Project Area and Current Management

The Project encompasses approximately 2,600 acres of aquatic and floodplain resources. Huron Island, Garner Island, Charlie Island, Johnson Island are the main islands of the Project while Beaver Chute, Gun Slough, Goose Lake, Little Cody Chute, Buffalo Slough, Huron Chute, Garner Chute and Lovers Lane are the principal water bodies.

Management of the Project was given to the IA DNR through a cooperative agreement with the USFWS, but the Corps retains the forestry rights. Current forestry 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 3) used in this report are expressed using the Mean Sea Level 1912 Vertical Datum (MSL1912), unless otherwise stated. Huron Island contains approximately 1,850 acres of floodplain habitat (Table 1), which was considered to be above an elevation of 530.0 feet. Based on a 2011 forest community survey, the floodplain located within the Project Area is comprised of 1,760 acres (95 percent) of broad-leaved deciduous forest habitat and 90 acres (5 percent) of open canopy habitat (of which 54 acres are reed canary grass). Sections 1 and 2 on the following pages further describe the forest, wildlife, wetland communities and the habitat each community offers.

Table 1. Huron Island Floodplain Habitat Elevation Intervals, Acres Per Elevation Range, Percent of Total Area, and Cumulative Percent

Elevation Contour	Acres	Total	Cumulative
530 - 531	551.0	29.8%	29.8%
531 - 532'	469.0	25.4%	55.1%
532 - 533'	370.0	20.0%	75.1%
533 - 534'	277.0	15.0%	90.1%
534 - 535'	123.0	6.6%	96.8%
535 - 536'	43.0	2.3%	99.1%
>536'	17.0	0.9%	100.0%
TOTAL ABOVE WS	1,850.0	100.0%	--

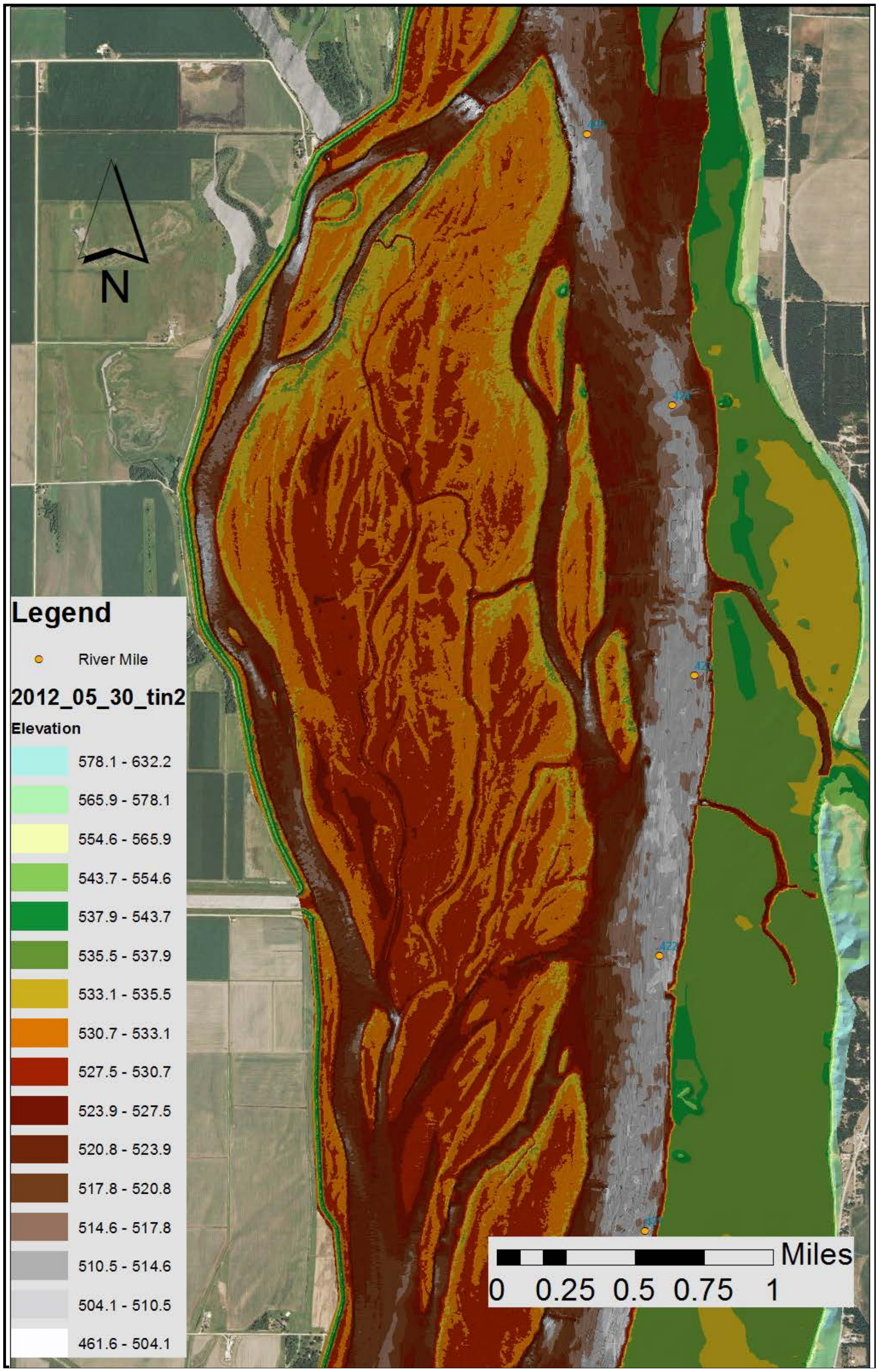

Figure 3. Topographic and Bathymetric Elevation Map for Huron Island

1. Forest Diversity & Habitat. Large floodplain forests like Huron Island are distinctive features of the landscape. As dynamic habitats, exposed to frequent disturbances, they provide scarce resources for many groups of animals. Huron Island floodplain is no exception to disturbances and dynamic processes.

Following lock and dam construction on the UMR, water levels in Pool 18 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, nearly the entire site is located at or below an elevation of 535 feet, as shown in table 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). Nut producing trees are critical food sources for many species of waterfowl and floodplain wildlife.

Roughly 3.2 percent of the island is at an elevation (>535 feet) suitable to contain nut producing trees, compared to pre-dam conditions which was more than 35 percent (*see Appendices D & H*). During a 2011 forest inventory, only 47 (1.2 percent of total) hard mast trees were recorded out of a total of 4100 trees (figure 4). Mast tree species recorded as present included northern pecan, pin oak, and shellbark hickory. Additionally, the areas with mast trees present were typically over 150 years old and contained little production in the understory. This lack of production is directly related to the increased water inundation and duration described earlier. Results from the 2011 forest survey also indicate the remaining 96.8 percent of the Project Area is dominated by water tolerant species such as silver maple or eastern cottonwood. Smaller components of moderately flood tolerant species such as American elm or green ash are also found. The average age these forest stands at Huron Island is 115 years with little development in the understory.

Foresters from the Corps, IA DNR, and USFWS are concerned about the lack of species diversity and forest regeneration as a result of the low elevation, increased water inundation, and duration. A comparative analysis of the data from the 1982 and 2011 forest surveys results in a marked decrease in numbers of hard mast trees. Similar trends have been shown with other restoration projects in which hard mast tree reestablishment was attempted at the existing elevation and water inundation stage. For example, a Section 1135 ecosystem restoration project was conducted at Huron Island to attempt to reestablish hard mast tree diversity. Approximately 58 acres of hard mast trees were planted at the existing elevation in 1995. At present, over 90 percent of the plantings have experienced mortality from increased flood frequency and duration. Evidence from Huron Island and the 1135 project further reinforces the notion that to have a healthy sustainable mast tree community at Huron Island increased elevation (decreased water inundation duration) is the key.

The existing extensive stands of even-aged mature silver maple are also concerning because their inevitable mortality (old age or flood induced) creates openings in the canopy which encourages the growth of nondesirable herbaceous vegetation. This dense growth prevents recruitment of desirable tree species through direct competition of tree saplings. Examples of this cycle can be found at Huron Island where natural mortality of mature trees has resulted in dense stands of the invasive reed canary grass and limited recruitment of desirable trees.

Possibly the largest concern is without intervention the Project Area is likely to experience severe forest fragmentation and an influx of invasive species; essentially transitioning from forest to grassland over time. Consequently, neotropical and other migratory birds, Indiana bats, and the other floodplain species which rely on the forest resources of the Project Area, will be severely impacted.

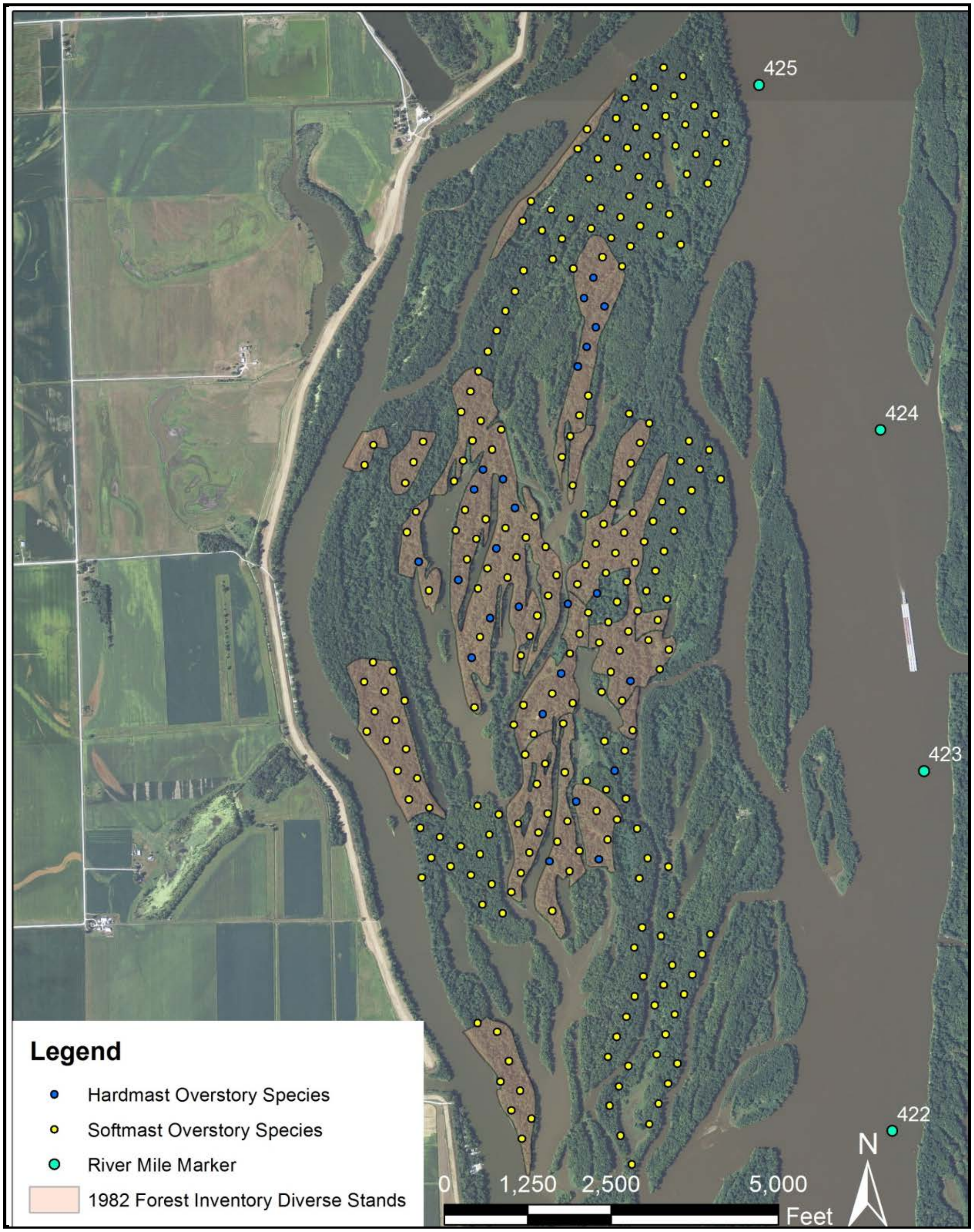

Figure 4. Broad-Scale Results of the Huron Island Forest Inventory Conducted in 2011

Each point represents an inventory plot (N=272).
Blue points (n=25) represent surveys which recorded a hard mast tree as present.
Yellow points (n= 247) represent typical plots without hard mast trees.

2. Wetlands. All but 20 acres of floodplain habitat is at an elevation less than 535 feet. The remainder is a mix of riverine, lacustrine, and palustrine wetland types. Approximately 807 acres of the floodplain habitat is classified as palustrine seasonally flooded broad-leaved deciduous forest and 927 acres are 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.

D. Aquatic Resources

Huron Island contains approximately 815 acres of aquatic habitat. The site offers both lentic (i.e., backwater; 347 acres or 43 percent) and lotic (i.e., riverine; 468 acres or 57 percent) 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 which currently exists at Huron Island.

1. Backwater Fishery Habitat. The IA DNR conducted fish sampling at several sites in Huron Island and Pool 18. Fish species sampled in Pool 18 and Huron 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 Huron Chute during different times of the year.

In general, Huron Island backwater aquatic areas can be described as shallow (table 2) and turbid backwaters, which lack 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 rarely is dissolved oxygen concentrations lethal.

Table 2. Huron Island Backwater Aquatic Habitat Depth Intervals, Acres Per Depth Contour, Percent of Total, and Cumulative Percent

Reference Water Surface (530' MSL at Keithsburg, IL Gage)

Depth Contour	Acres	Total	Cumulative
0 - 1'	201.0	59.2%	59.2%
1 - 2'	67.0	19.9%	79.1%
2 - 3'	41.0	10.7%	89.8%
3 - 4'	19.0	6.3%	96.1%
4 -5'	15.0	3.0%	99.1%
> 5'	4.0	0.9%	100.0%
Total Below WS	347.0	100.0%	--

Spawning habitat for centrarchid fish species (e.g., largemouth bass, bluegill, black and white crappie) does not appear to be limiting within Huron Island. IA DNR electrofishing data in the backwaters in the summer and fall typically shows a high proportion of the total catch is comprised of young (Age-0, 1) bluegill (<5.9 in) and largemouth bass (<11.9 in).

The apparent successful spawning is most likely due to the relatively stable (i.e., average water level change from June 10 – 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.

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 dissolved oxygen) and abundant foraging opportunities for maximum growth. The average water temperature during the growing season (July – September) within Huron Island is approximately 26.0°C. However, due to the shallow nature of the backwaters, midsummer water temperatures intermittently exceed 30.0°C and dissolved oxygen concentrations dip below 5.0 mg/L. These conditions often contribute to the movement of centrarchids out of the backwaters and into nearby areas of deeper flowing water such as the transitional area between Huron Chute and Gun Slough.

Water velocity is not as much of a factor for centrarchids during the growing season as it is during the spawning and overwintering seasons. In fact, anecdotal evidence suggests large adult centrarchids will move from the backwaters to areas of deeper water with increased water velocity during the summer and early fall (USGS, personal communication). These areas are beneficial due to increased foraging opportunities the flowing river provides. Although this sometimes coincides with periods of suboptimal water quality conditions in the backwater, the movement appears to be correlated more with foraging opportunities.

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 dissolved oxygen 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 in the Project Area do not contain suitable overwintering habitat. Of the 347 acres of backwater habitat, almost 60 percent is less than 1 foot deep and another 36 percent is between 1 and 4 feet deep (see table 2). As a result, 4 percent of the entire backwater complex is greater than 4 feet deep and are sporadically located in small disconnected areas of the Project Area. Dissolved oxygen in areas greater than 1 foot deep rarely reach lethal concentrations (<1 mg/L; Appendices D and E) in the winter.

As water temperatures begin to rise in the spring, centrarchids begin to stage in the deep water adjacent to the flats containing spawning areas. When they reach 18-20°C they move into spawning areas. Interconnected overwintering and spawning habitat is critical to reduce energy expenditure and increase spawning capabilities. Currently, the backwaters contained in Huron Island do not provide these connected habitat types. As such, fish must make substantial movements from overwintering sites to spawn in the backwater areas.

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 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 Huron and Garner Chutes (468 acres). Both secondary channels have similar characteristics with average depths near 15 feet, and flows, temperatures, and water quality measurements similar to the main channel during the course of the year. Huron Chute offers minimal habitat diversity mainly in the form of two small islands midway through the Chute. Island habitat within secondary channels in the UMRS is highly valuable for habitat diversity and should be restored or enhanced (UMRCC Fisheries Plan 2010). Researchers have hypothesized the habitat afforded by islands in the UMRS function similarly to riffle-pool systems in smaller streams based on the fish community present and the functions provided. Islands provide protection for fish and vegetation from flow and waves. Transitional gradients between aggradation and depositional forces create unique microhabitat for fish, invertebrates, and waterfowl feeding.

Islands are steadily declining in the UMRS (UMRCC Fisheries Plan 2010). Based on historic aerial photographs from the 1930's to 2010, both islands have lost significant surface area over time. The upstream island has degraded almost 400 linear feet with respect to the direction of flow since the 1930s. The downstream island has degraded nearly 350 feet since the 1950's. Losing almost 5 feet per year, the islands would not be expected to last the life of the Project. This has resulted in a reduction in habitat diversity (i.e., shallow sand bar, low flow refugia, and transitional habitat). As a result, Huron Chute would offer minimal resting or feeding habitat for migratory fish.

Garner Chute is similar with a lack of low velocity refuge and habitat structure. Fish species use is mainly limited to riverine species (e.g., shovelnose sturgeon, walleye) for foraging and migratory corridors. Improved fish habitat in the Chutes should focus on providing low velocity refuge areas and increased feeding and resting habitat in the form of island protection and habitat diversification (i.e., shallow to deep transitional areas, structure, varying substrates).

3. Mussels. Three surveys within Pool 18 have been conducted since 2006. These studies include a 2006 shallow water mussel qualitative study, 2007 pool wide population survey and a 2008 population estimate of mussels in shallow water areas of Pool 18 (ESI 2009). Each of the pool wide surveys had sample points located within the peripheral areas of Huron Island (i.e., Huron Chute and riverward side of the site) and provide insight into the potential mussel community within Huron Island.

Pool 18 appears to harbor around 25 live unionid species. Twenty-three of these species were found alive in the 2007 pool wide survey, and 20 were found in the 2006 shallow water qualitative survey. The 15 species that were found live in the 2008 shallow water study were also found in the previous two Pool 18 studies. Few, monkeyface *Quadrula metanevra* (1) and hickorynut *Obovaria olivaria* (2) ,were found during the 2006 shallow water study. Other infrequent species found in the 2006 shallow water survey that were not collected in the 2008 survey include flat floater *Anodonta suborbiculata*, black sandshell *Ligumia recta*, and rock-pocketbook *Arcidens confragosus*. The most abundant mussel species in Pool 18 in both studies was threeridge *Amblema plicata*. In the 2007 pool wide survey a worn shell of *Potamilus capax* was retrieved. The historic range of Higgins eye pearlymussel *L. higginsii* includes Pool 18 but shells have not been found there from past or recent surveys.

4. Aquatic Vegetation. Surveys conducted in 1975 by USFWS documented the presence of various species of submergent, emergent, and rooted floating aquatic vegetation within the Project Area (figure 5). The highly desirable sago pondweed *Potamogeton pectinatus*, water celery *Vallisneria americana*, and American lotus *Nelumbo lutea* species were found within the backwaters of Huron Island. In 1989 a greater acreage of submerged, emergent, and floating-leaved aquatic vegetation was found in the Project Area, which included sago pondweed, water celery, and American lotus (figure 5). By 2000 most of the floating-leaved vegetation had disappeared from the backwaters and only a limited amount of submerged vegetation was present (figure 5). Finally, in 2011 floating-leaved and submerged aquatic vegetation were totally absent from the backwaters (figure 5). Although some emergent vegetation can be found today, it mostly consists of small isolated patches located randomly within the Project Area. Species which can be encountered currently include common duckweed and common reed.

Other poolwide surveys have been conducted in recent years including a survey in 2005 (MACTEC 2005). In total, 8 submerged and 9 emergent aquatic beds containing a total of 9 species (Canadian waterweed *Elodea Canadensis*, common duckweed *Lemna minor,* American lotus, sago pondweed, wild celery, broadleaf arrowhead *Saggitaria latifolia*, common reed *Phragmites australis*, curlytop knotweed *Polygonum lapathifolium,* and purple loosestrife *Lythrum salicaria)* were found during a 2005 poolwide survey.

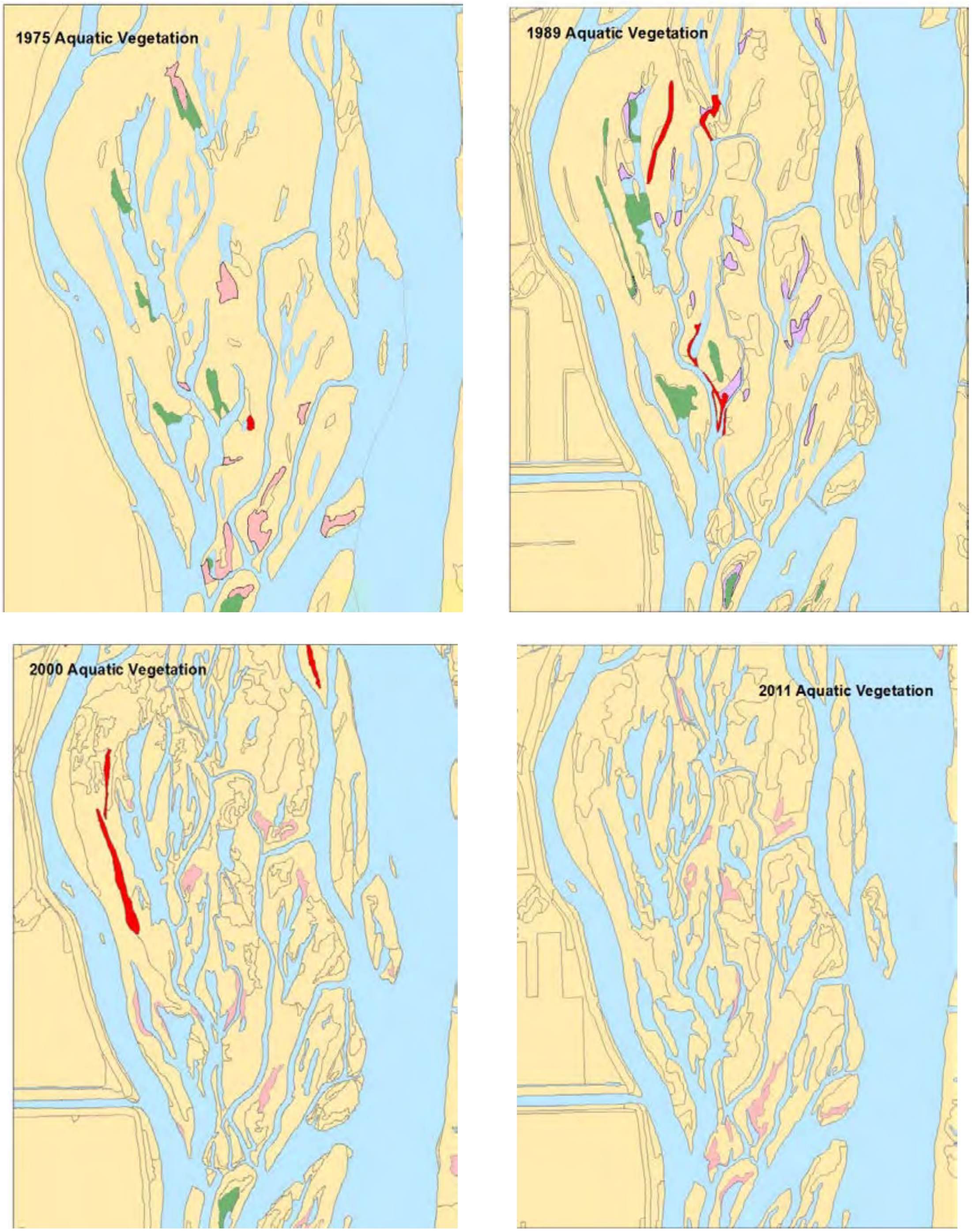

Figure 5. Documented Presence of Submerged, Emergent, and Floating-Leaved Aquatic Vegetation in Huron Island From 1975, 1989, 2000, and 2011

= submerged aquatic plant species,

= emergent/moist soil wetland plant species,

= floating-leaved aquatic plant species

E. Endangered, Threatened, and Candidate Species

The USFWS has identified the Indiana bat *Myotis sodalis*, prairie bush clover *Lespedeza leptostachya,* Western prairie fringed orchid *Platanthera praeclara,* and Higgins eye pearlymussel *Lampsilis higginsii,* spectaclecase mussel *Cumberlandia monodonta* as federally-endangered or threatened species that have the potential to occur within Des Moines County, Iowa.

1. Indiana bat. The Indiana bat's range includes much of the eastern half of the United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. They 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.

Indiana bats travel, forage, and roost within a variety of interconnected forested habitats, including riparian corridors, bottomlands, and uplands. Indiana bats typically roost under exfoliating bark, in cavities of dead and live trees, and in snags (i.e., dead trees or dead portions of live trees). Roost trees with some sun exposure seem to be preferred because they are warmer. Trees in excess of 16 inches 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.

Critical habitat has not been listed in Iowa. However, maternal activity has been recorded at 26 locations in Iowa, including 2 locations in Des Moines County. Additionally, an Indiana bat survey conducted in May 2012 resulted in 3 Indiana bat captures (1 male, 2 female).

2. 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 which 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, and 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 Huron Island floodplain offer suitable habitat for establishment or survival.

3. 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 1 population in Manitoba (USFWS 1996). Approximately 90 percent of known western prairie fringed orchids in the United States occur 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.

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. The USFWS lists potential habitat statewide. However, the species has not previously been recorded in the area nor does Huron Island floodplain offer suitable habitat for establishment or survival.

4. 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. The USFWS's recovery plan for Higgins eye (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. EHAs are not listed in Pool 18.

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. Although this type of habitat does not exist within the interior backwaters of the Project Area and Higgins eye were not collected in this area during surveys from 2006-08, Huron Chute and the riverward side of the complex appear to have the potential to offer suitable habitat.

5. Spectaclecase mussel. The spectaclecase is a freshwater mussel the USFWS has listed as an endangered species. It is a large mussel that can grow to at least 9 inches in length. The shape of the shell is elongated, sometimes curved, and somewhat inflated. Today, the spectaclecase is found in only 19 streams. However, populations are highly fragmented and restricted to short stream reaches, including the UMR.

The spectaclecase generally inhabits large rivers, and is found in microhabitats sheltered from the main force of current. It occurs in substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current. Specifically, collection reports indicate the species is often found in firm mud between large rocks in quiet water but near the interface with swift current. They have even been reported in tree stumps, root masses, and aquatic vegetation.

Similar to Higgins eye, spectaclecase were not collected during mussel surveys in and around Huron Island from 2006-08 and the interior aquatic areas do not offer suitable habitat. However, it appears Huron Chute and the riverward side of the Project Area have the potential to offer suitable habitat.

6. State Threatened or Endangered Species. In addition to federally-listed species, the IA DNR identified state threatened or endangered species that have the potential to occur within Des Moines County (table 3):

Table 3. State Threatened or Endangered Species

Common Name	Scientific Name	Class
Mudpuppy (t)	*Necturus maculosus*	Amphibian
Red-shouldered Hawk (e)	*Buteo lineatus*	Bird
Grass Pickerel (t)	*Esox americanus*	Fish
Orangethroat Darter (t)	*Etheostoma spectabile*	Fish
Western Sand Darter (t)	*Ammocrypta clara*	Fish
Butterfly (t)	*Ellipsaria lineolata*	Freshwater Mussel
Creeper (t)	*Strophitus undulatus*	Freshwater Mussel
Pistolgrip (e)	*Tritogonia verrucosa*	Freshwater Mussel
Blue Ash (t)	*Fraxinus*	Plant
Downy Woodmint (t)	*Blephilia ciliata*	Plant
Dwarf Dandelion (e)	*Krigia virginica*	Plant
French-grass (e)	*Orbexilum onobrychis*	Plant
Virginia Snakeroot (t)	*Aristolochia*	Plant
Water Willow (e)	*Justicia americana*	Plant
Waxleaf Meadowrue (e)	*Thalictrum revolutum*	Plant
Winged Monkey Flower (t)	*Mimulus alatus*	Plant
Yellow Monkey Flower (t)	*Mimulus glabratus*	Plant
False Hellebore (t)	*Veratrum woodii*	Plant
Green Arrow Arum (e)	*Peltandra virginica*	Plant
Oval Ladies'-tresses (t)	*Spiranthes ovalis*	Plant
Slender Ladies'-tresses (t)	*Spiranthes lacera*	Plant
Blanding's Turtle (t)	*Emydoidea blandingii*	Reptile
Western Worm Snake (t)	*Carphophis amoenus*	Reptile
Yellow Mud Turtle (e)	*Kinosternon flavescens*	Reptile

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. Although there are numerous migratory birds that utilize Huron Island, the following migratory birds are the most relevant in the area that would be potentially affected by the alternatives of the Project:

1. Bald Eagle *Haliaeetus leucocephalus*. The bald eagle is also 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 Huron Island during the winter months, and has been recorded as nesting in the area during spring and summer. One documented active bald eagle nest is present within the Project Area. Observations of bald eagle use of the nest have been recorded several times since 1984.

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 are vulnerable in the UMR because the availability of suitable nesting habitat is declining. Huron Island contains suitable habitat for heron foraging, roosting, and nesting. An active heron rookery has been recorded within the Project Area and likely has 75 to 100 active nests.

3. Waterfowl. Illinois Natural History Survey aerial census data from Pool 18 shows duck use days have declined since the 1970s. Duck use of non-refuge habitat in lower Pool 18 (Oquawka – Keithsburg) was very low through the 1990s. Wildlife refuge duck use days have been much lower than historic high abundance, but the refuges continue to attract ducks 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. Huron 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 Huron 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 Pool 18 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,* adult silver carp *Hypophthalmichthys molitr*ix and adult bighead carp *H. nobilis*. According to the Iowa DNR, Pool 18 is also the farthest upstream location where juvenile silver and bighead carp have been observed on the Mississippi River.

H. Subsurface Soil Characterization

The United States Department of Agriculture (USDA) publishes soil surveys for most counties in the United States. Information contained in these reports pertains to soil within 5 feet of the surface. These soils are mapped by soil series. A soil series is a group of soils having almost identical profiles. All soils of a particular series have horizons that are similar in compositions, thickness, and arrangement. Information in a pre-published soil survey indicated that the types of soils that are present in and around Huron Island generally classify as fluvaquent soil series, which is described as an alluvium product in the USDA classification system. This series is described as frequently flooded, the water table is said to vary between ground surface and 1 foot deep.

The Corps conducted an extensive subsurface exploration to characterize the composition and engineering properties of soils present at Huron Island. Borings were taken at locations shown on Plate 7 (B-101). On each boring, samples were taken at sufficient intervals to classify all the strata encountered. Representative samples were taken for visual classification, moisture content on enough samples to verify classifications.

1. Borings HI-11-01 through HI-11-08 were taken by hand-augers from a boat to characterize soils that have been deposited in the proposed excavation areas and channels. Borings were approximately 12.5 feet deep. Borings showed similar types of materials, below ground surface, a combination of soft lean clays (CL) and soft silts (MH) showing gradual change into firm fat clay (CH) with increased depth, underlying this clay layer down to bottom of the hole is clayey sand approximately 4-9 feet down from ground elevation. For boring performed in channels the soft fat clay strata is thinner, as clayey sand was found as shallow as 4 feet below ground surface. Clays throughout the Project Area consistently classify as fat clay with liquid limits ranging between 82 and 61, and plastic limits between 29 and 15.

2. Borings HI-11-09 through HI-11-12 were taken throughout Cody Chute in order to determine how much sediment material was deposited in this area. The majority of these borings showed coarse grain soils in the immediate bottom of the chute and beyond. Although in HI-11-12 a thin layer of soft clay was found between the top sand strata, in general evidence of fine grain sediment were not found in any of the borings performed throughout Cody Chute.

3. Borings HI-12-13 through HI-12-16 were performed in the proposed topography diversity area. This area is characterized by a top layer of clay, with several arrangements throughout the site as several minor stratification breaks were noted averaging approximately 10 feet in depth before getting into sand. This top layer, a combination of firm lean clays and fat clay constitute a proper foundation for the proposed loading arrangement. Similar borings were performed on the areas expected to be used as excavated material disposal. These borings, HI-12-17 through HI-12-20 revealed similar materials to the one encountered in the proposed topography diversity area, with mostly clayey soils on the top layer with some minor variations in the strata and properties. The difference being the presence of some sand mixed in the varied minor stratifications of the clay top layer. Underlying this clay strata, which varied from 6 to 10 feet in depth, is fine sand.

4. Borings HI-12-21 through HI-12-23 were performed in the general area were embankment protection is being proposed, in order to identify the underlying soils and what kind of interaction can be expected once the load of the reinforcing stone is in place. These borings showed a very thin layer of clay material in contrast to previous inland explorations, the top clay layer varying from 2 feet to 8 feet. Tests on the sampled clay material exhibit liquid limits (42) close to its natural moisture content (40), denoting that some consolidation will be taking place, but due to the nature of the load no major issues are expected.

5. Borings HI-12-24 through HI-12-26 were performed in Huron Chute each located upstream of different island for which protection from erosion is being designed and proposed. All exploration showed no fine grained material, sand was found in all of them which were to be expected due to the high velocities of Huron Chute. The soil characterization of Huron Chute was made possible with the use of a sand tube, coupled with a check valve that allowed sampling of coarse grain soil under water.

I. Water Quality

Baseline water quality monitoring was initiated at Huron Island by Corps personnel on May 31, 2006 at sites W-M422.5C and W-M422.2G (figure 6). On December 27, 2006, sites W-M422.7E and W-M422.3I were added. Sampling ceased at the “flowing” sites W-M422.2G and W-M422.3I on September 9, 2009 and was initiated at the “backwater lake” sites W-M422.4E and W-M422.7F on December 21, 2009, in an effort to obtain baseline water quality data from additional areas on the interior of the island that were less subject to flow. Water quality monitoring is accomplished through a combination of collecting surface grab samples and deploying continuous monitors. The monitoring sites include three (W-M422.5C, W-M422.4E and W-M422.7F) that are lentic (lake-like) in their characteristics and three (W-M422.7E, W-M422.2G and W-M422.3I) that are lotic (riverine) in their characteristics, results from these collections are summarized in table 4. Grab sample results indicate the lentic sites had lower median velocity and dissolved oxygen (DO) values relative to the lotic sites. Median velocity values ranged from 0.55 to 0.97 cm/s at the lentic sites and from 11.40 to 40.12 cm/s at the lotic sites. Median DO concentrations ranged from 6.79 to 8.25 mg/L at the lentic sites and from 10.51 to 11.95 mg/L at the lotic sites. Minimum DO concentrations ranged from 0.72 to 5.17 mg/L at the lentic sites and from 3.83 to 6.50 mg/L at the lotic sites.

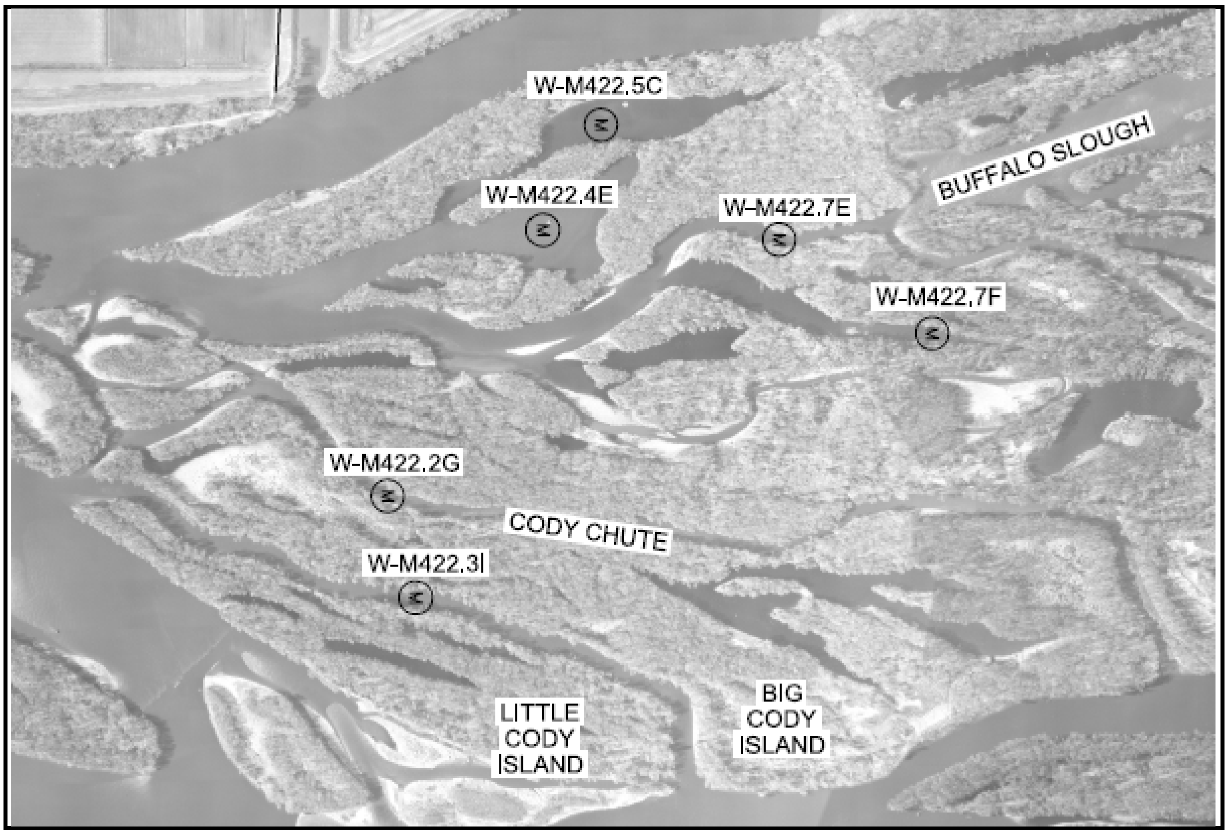

Figure 6. Water Quality Monitoring Locations

Table 4. Water Quality Summary

Site	Water Depth (M)	Velocity (Cm/Sec)	Water Temp. (°C)	Dissolved Oxygen (Mg/L)	pH (Su)	Secchi Disk Depth (Cm)	Turbidity (Ntu)	Suspended Solids (Mg/L)
W-M422.5C								
Min.	0.340	0.09	0.4	0.72	7.10	11.0	3.2	7
Max.	3.035	47.68	31.0	26.32	9.10	60.0	137.0	170
Avg.	1.030	2.83	19.9	9.59	-	26.6	36.8	56
Median	0.825	0.97	24.9	8.25	8.00	26.0	30.0	44
W-M422.7E								
Min.	1.148	0.52	0.1	4.67	7.30	7.0	2.1	3
Max.	3.970	89.68	30.7	18.57	9.30	85.0	603.0	150
Avg.	1.905	19.42	18.4	10.61	-	25.6	48.8	55
Median	1.685	11.40	24.2	10.74	8.00	23.5	39.7	51
W-M422.2G								
Min.	0.370	0.32	0.0	3.83	7.30	4.0	3.9	1.0
Max.	2.650	58.13	31.6	18.47	9.40	58.2	860.0	129
Avg.	1.016	20.38	20.4	11.62	-	30.0	56.8	54
Median	0.890	17.54	24.6	10.51	8.20	28.0	32.0	51
W-M422.3I								
Min.	0.580	1.86	-0.1	6.50	7.20	3.0	3.6	5
Max.	2.660	71.48	30.2	16.94	9.50	43.0	950.0	160
Avg.	1.236	41.94	18.7	11.66	-	25.2	78.8	82
Median	1.160	40.12	24.1	11.95	8.10	26.3	48.7	80
W-M422.4E								
Min.	0.480	0.11	0.1	5.17	7.30	13.0	3.7	22
Max.	2.880	4.88	31.1	26.34	9.00	46.0	237.0	344
Avg.	1.265	1.60	17.4	9.55	-	24.6	38.9	73
Median	1.160	0.79	24.8	6.79	7.90	22.0	31.0	50
W-M422.7F								
Min.	0.970	0.16	0.7	4.68	7.00	19.0	3.7	22
Max.	3.370	7.96	30.9	18.83	8.20	39.5	56.1	53
Avg.	1.832	2.24	20.1	8.22	-	28.8	24.3	38
Median	1.655	0.55	25.0	7.30	7.80	28.4	24.4	40

Minimum water temperatures ranged from 0.1 to 0.7°C at the lentic sites and from -0.1 to 0.1°C at the lotic sites; while the maximum water temperature at all sites was close to 31.0°C. Values for pH occasionally exceeded 9 at the lotic sites, with the following maximums: 9.30 at W-M422.7E, 9.40 at W-M422.2G and 9.50 at W-M422.3I, all occurring on August 26, 2008. On this date, water levels and velocity values were relatively low and DO concentrations were supersaturated at all three sites. The high pH and DO values were likely due to extreme algal photosynthesis.

When continuous water quality monitors were deployed, they were typically suspended one to two feet above the river bottom and collected data for a period of about 2 weeks during the summer to six weeks during the winter. In general, during the summer the lentic sites exhibited noticeable diurnal DO concentration oscillations, typically in the 5 to 10 mg/L range but occasionally exceeding 15 mg/L. During 2010 and 2011, when water levels were high for most of the summer, diurnal DO oscillations were more subdued. Nighttime DO concentrations often fell below 5 mg/L but most often recovered the following day. However, on at least one instance, each of the three lentic sites experienced DO concentrations below 5 mg/L for more than 2 continuous days. On one occasion, the DO concentration remained below 5 mg/L for the entire 2-week deployment: June 15 through 29, 2010 at site W-M422.5C. At the lotic sites, summer DO concentrations were generally higher and diurnal DO oscillations were more subtle, with nighttime DO concentrations sometimes falling below 5 mg/L but always recovering the following day.

Winter DO measured with a continuous monitor at the lentic sites varied from below 5 mg/L to supersaturated concentrations. Winter DO concentrations at site W-M422.4E were all above 5 mg/L, with minimal diurnal oscillations, while at sites W-M422.5C and W-M422.7F values below 5 mg/L were measured. During the January 29, 2009 deployment at site W-M422.5C, on approximately 21 days of the 39-day deployment, DO concentrations remained below 5 mg/L. During the February 4, 2010 deployment (33-days) at site W-M422.7F, except for a few hours at the beginning and end, all DO concentrations were below 5 mg/L. During all three of these deployments, snow-covered ice was present.

Of the three lotic sites monitored, W-M422.3I is the closest to the main channel of the Mississippi River and exhibited the highest velocity measurements. Velocities at times here are sufficient to move considerable amounts of bed material. This was evident during the summers of 2008 and 2009 when discharge was high and during a 2-week deployment the continuous monitor here was buried under several inches of sand.

Additional water quality information can be found in Appendix F.

J. Hydrology and Hydraulics

1. Pool 18 and Iowa River. Huron Island is located in the middle of Pool 18, approximately fourteen miles downstream of Lock and Dam 17 and 13 miles upstream of Lock and Dam 18. The island complex comprises over 2,600 acres and is located on the right descending bank. The Mississippi River borders the eastern edge of the island and Huron Chute flows along the western edge. Two Rivers Levee and Drainage District is located on the right descending bank of Huron Chute.

Placed into operation in 1937, Lock and Dam 18 provides navigable channel depths by maintaining a water surface elevation of 528 feet (flat pool) or higher. Pool 18 is regulated using a dam control point. 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, thereby limiting overall fluctuations in river stage. However, the degree of influence of the impounding dam diminishes as you move upstream of the dam, where greater variation in river stage occurs (figure 7a). The Keithsburg gage is located near the middle of Pool 18, approximately two miles upstream of Huron Island. Therefore the Project does experience some annual fluctuation in river stage.

Pool 18 drains 113,600 square miles. Average annual discharge at Dam 18 is approximately 80,650 cubic feet per second (cfs; period of record 1986-2005). The long term average annual hydrograph (figure 7b) illustrates a spring to early summer flood followed by low summer flows from mid-July through September. Discharge frequently increases slightly during fall and is generally low and more stable during winter.

The annual elevation-duration curve at the Keithsburg gage indicates a median river elevation of 531.09 feet (figure 7c; period of record 1980-2010). A comparison of elevation duration curves for different time periods throughout the Keithsburg gage period of record indicates river stages have increased over the last 30 years, (both low river stages and high river stages) (figure 7d). Part of the reason for this stage increase is due to a change in the operation at the dam during the winter months that began in 1980 as an effort to limit the pool draw down for environmental reasons.

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

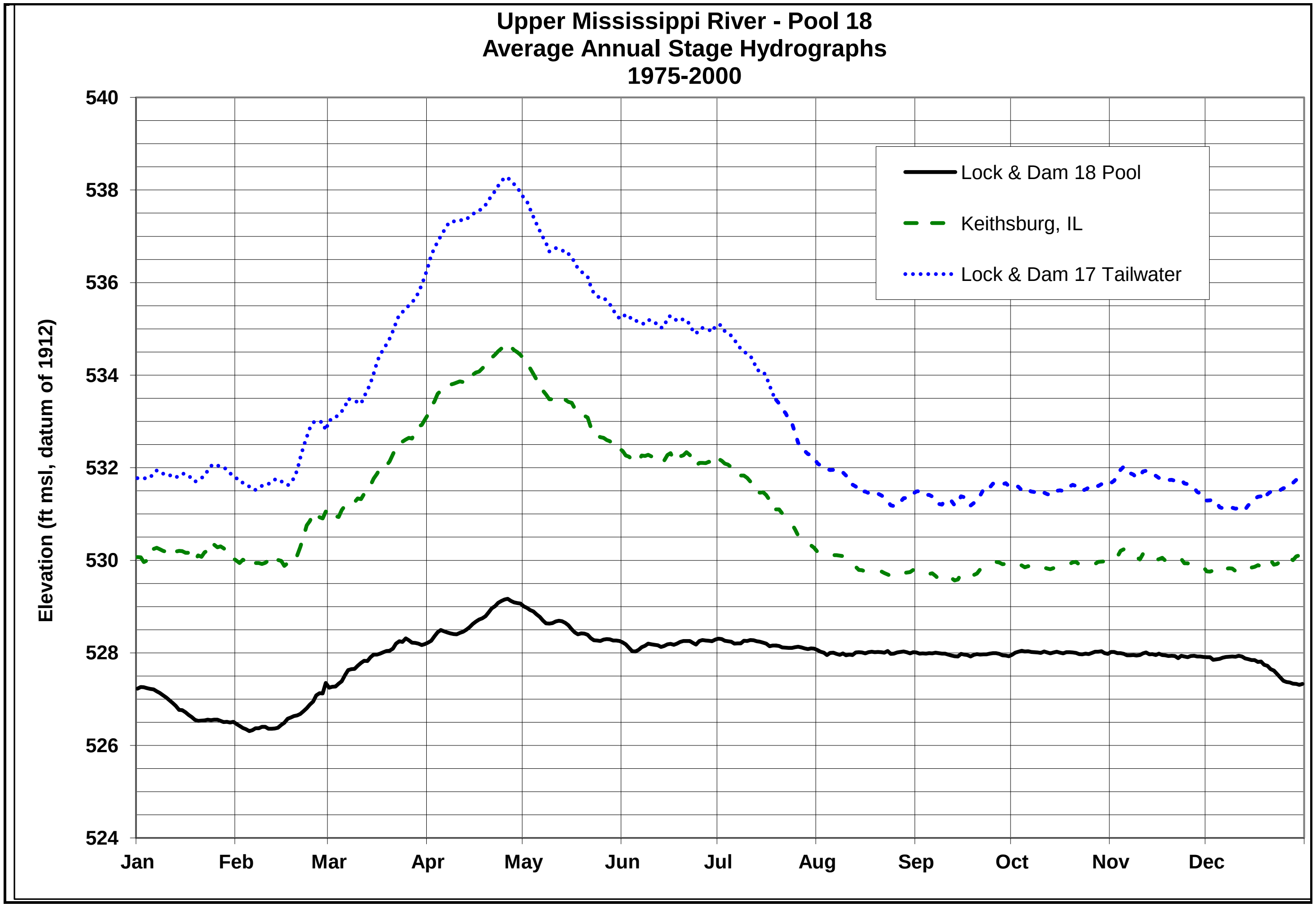

Figure 7a. Average Annual Stage Hydrographs - Upper, Middle, and Lower Portions of Pool 18 1975–2000

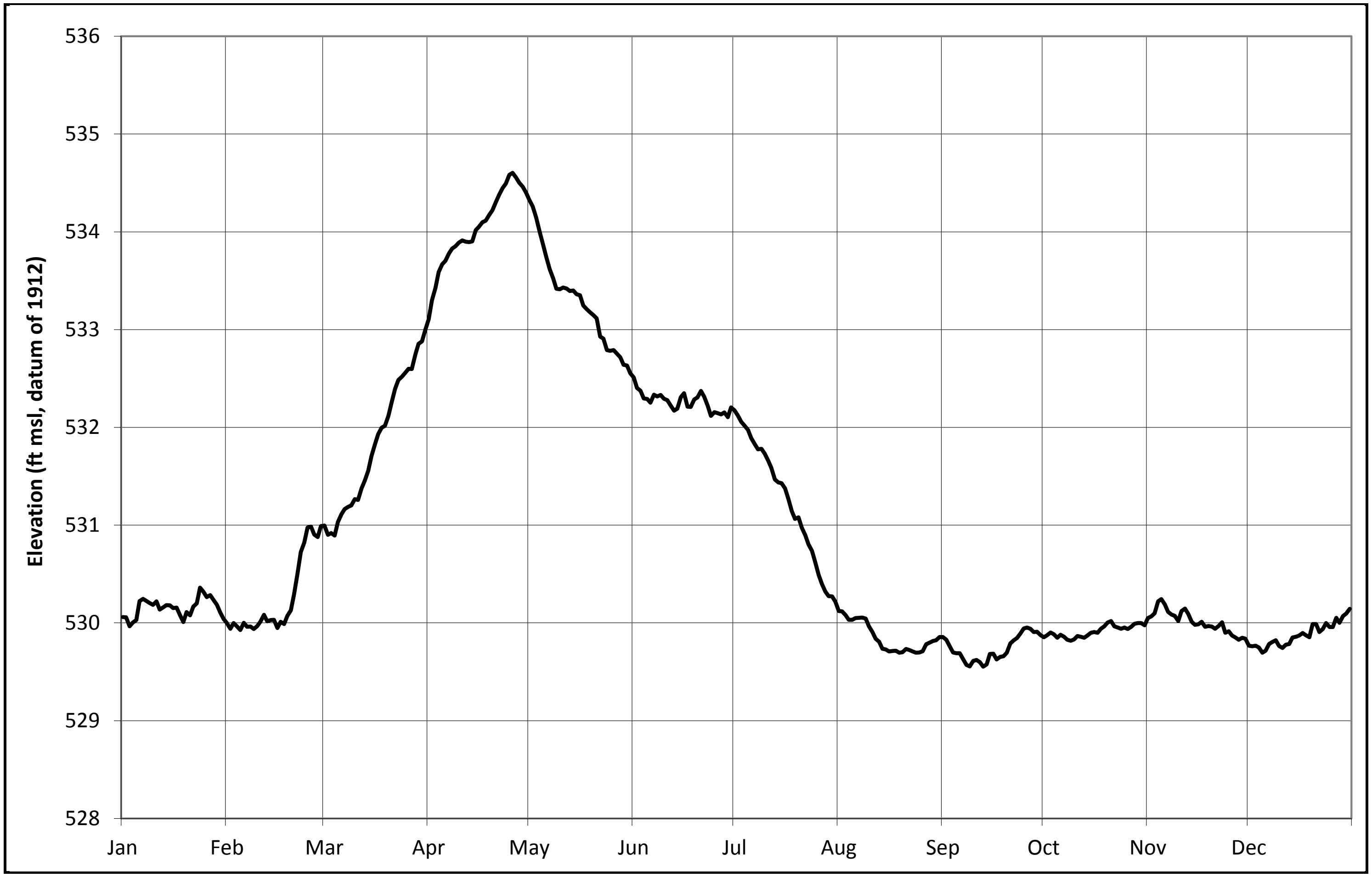

Figure 7b. Average Annual Elevation Hydrograph at the Keithsburg Gage - 1940 – 2007

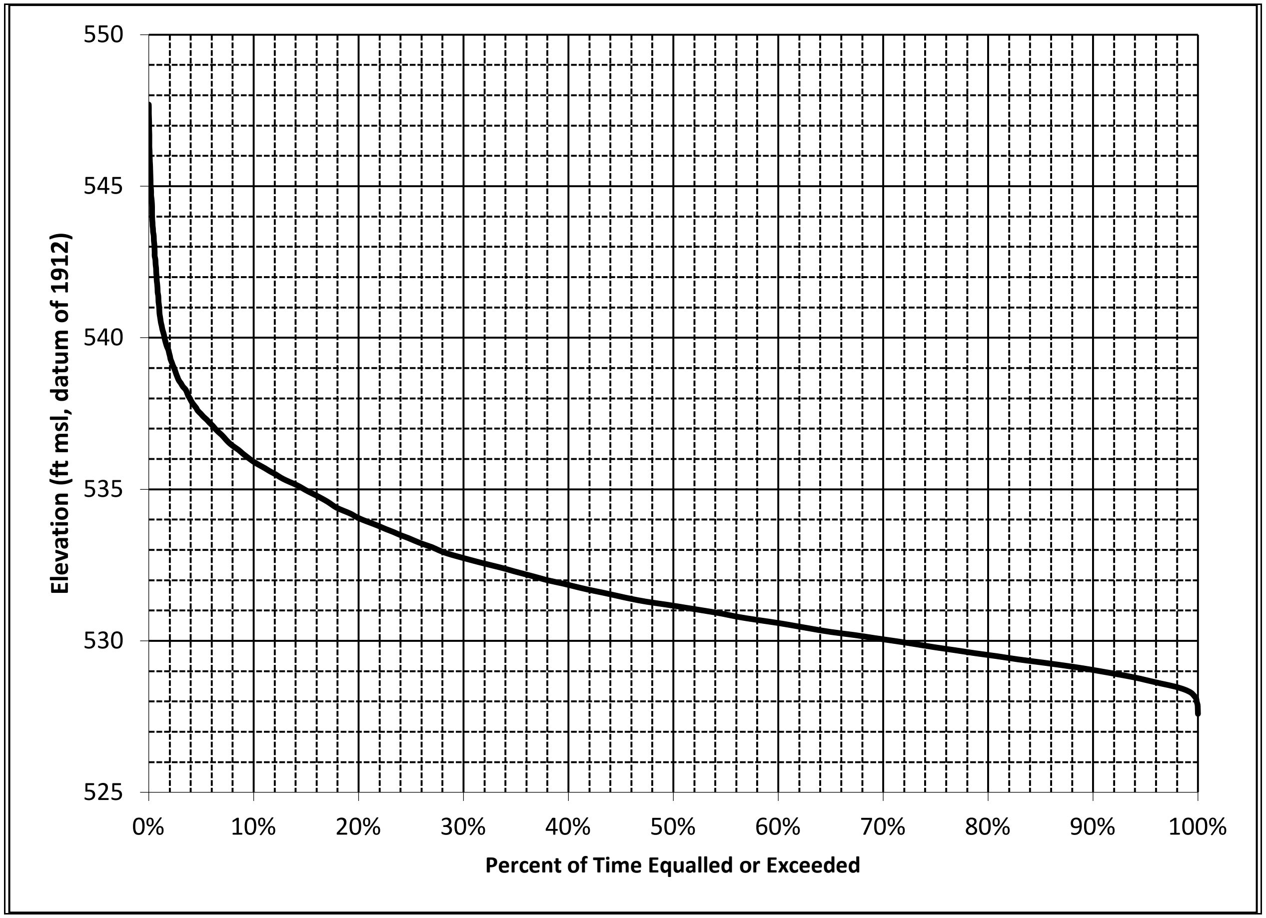

Figure 7c. Annual Elevation-Duration Curve at Keithsburg Gage - 1980-2010

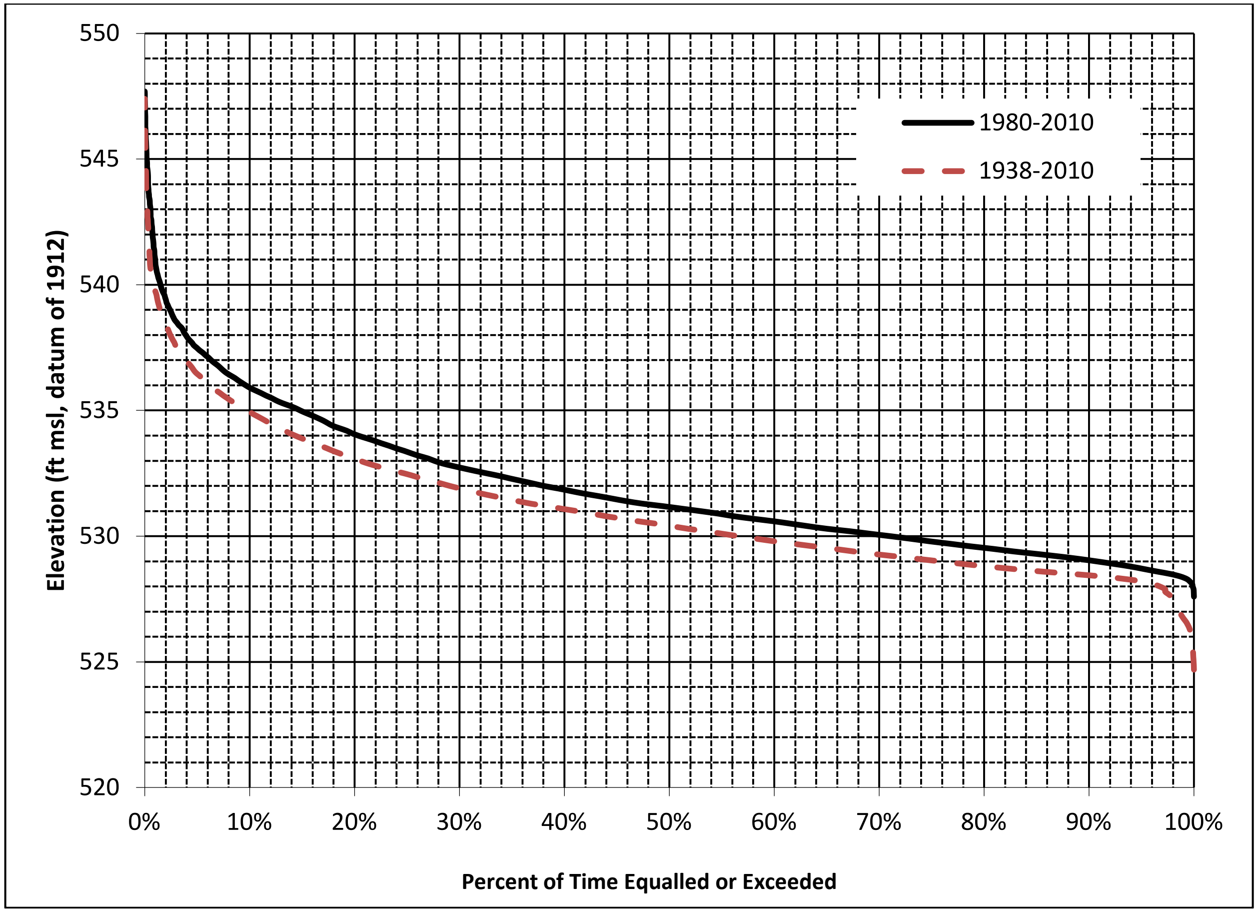

Figure 7d. Comparison of Annual Elevation-Duration Curves for Different Time Periods

High water events at the Keithsburg gage have occurred in 2008, 1993, 2001, 1965, 1973 and 2011 (listed in order of decreasing magnitude). The highest flood on record occurred in June of 2008 at a river elevation of 547.68 feet. The 2008 event was higher than the 0.002 exceedance probability (500-yr flood) stage.

The Iowa River is the biggest tributary within the Pool 18 reach, draining over 12,500 sq. miles of which 93 percent are in agricultural land use (http://iowacedarbasin.org/watershed, accessed 11-8-11). The Iowa River delivers a significant amount of nutrients and sediment to Pool 18 as a result of these land use practices. Consequently, Pool 18 is one of the most heavily dredged pools in the Rock Island District.

The interior of the Project is made up of a network of backwater lakes and channels. Some of the areas considered as part of the complex include Buffalo Slough, Gun Slough, Little Cody Chute, Beaver Chute and areas associated with Garner Island. Garner Island is a smaller island located immediately to the north and west of Huron Island. Some of the channels convey water throughout much of the year and others only convey water and sediment when the river stage is high enough to provide connectivity. Nearly 99 percent of the island is inundated at the 50 percent exceedance probability (2-yr flood) stage.

A seasonal duration analysis for the critical low water period (defined as November through February) was completed for the 1980-2010 period of record. The results of this duration analysis indicate that the water surface elevation of 530 feet is exceeded 64 percent of the time. A water surface elevation of 530 feet at the Keithsburg gage, results in a water surface elevation of 529.8 feet at the upstream end of the island and a water surface elevation of 529.3 feet at the downstream end of the island. Aquatic habitat benefits at Huron Island are defined with respect to this reference water surface. Everything above this reference water surface is considered floodplain.

A seasonal duration analysis for the growing season beginning April 10 through October 28 was completed for the calculation of floodplain benefits. The median water surface elevation during this growing season is 531.5 feet, the 90 percent exceedance duration is 529 feet and the 10 percent exceedance duration is 537 feet. Elevations within Huron Island range from 513 feet and 545 feet. However, the elevation of nearly 85 percent of the island complex area is between 529 feet and 534 feet. This lack of topographic diversity results in limited age and species diversity for the floodplain forest.

2. Huron Chute Wing Dam. A persistent navigation channel dredging exists between RM 426 and 425, near the entrance to Huron Chute. In order to increase velocities within this shoaling reach the Corps Committee to Assess Regulating Structures (CARS) considered the construction of a new structure just above the inlet to Huron Chute. The proposed CARS regulating structure was run through the AdH hydrodynamic model. Initially two different wing dam alignments located just upstream of the Huron Chute inlet were identified for evaluation. The initial intent was to evaluate these structures independently and together to see which configuration would result in the greatest increase in main channel velocities in the vicinity of the shoaling problem. Based on the results in table H-13, the wing dam alternatives do not change the discharge distribution between Huron Chute and the main channel. Therefore a wingdam will not be constructed near the entrance to Huron Chute and the Corps CARS will continue to develop a strategy to alleviate the persistent dredging issue. More information on the CARS structure can be found in App H.

K. Sedimentation

The Iowa River enters Pool 18 approximately 12 miles upstream of the Project and as previously mentioned, provides a significant source of sediment delivery to the Pool 18 Reach. The main stem river delivers about 9.7 million tons/year and the local tributaries, primarily the Iowa River contribute another 3.7 million tons/year of sediment (WEST, 2000). Resulting sedimentation causes backwater infilling and reduced navigation. Maintenance dredging within Pool 18 occurs regularly to address these sedimentation issues.

At RM 424, across the northern portion of Huron Island, survey transects were taken pre-impoundment in 1938 and 2004 (figure 8). The results from this transect data suggest that over the 65-year period deposition in both overbank areas and in streams has been occurring.

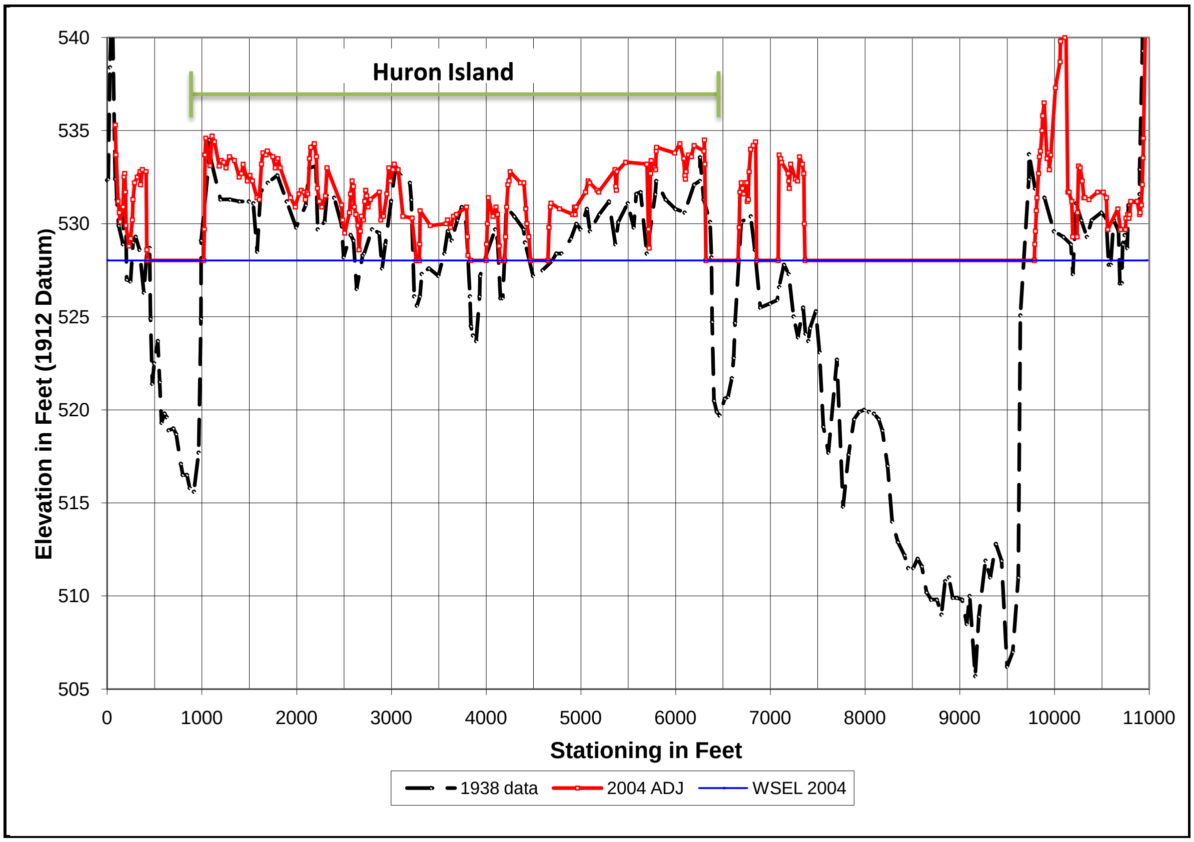

Figure 8. Pre- and Post-impoundment Survey Transects at RM 424

Elevations within Huron Island range from 513 feet and 545 feet. However, the elevation of nearly 85 percent of the island complex area is between 529 feet and 534 feet. The only high ground on the island is located along the northern tip of the island and the northwestern edge of the island, with some sparse areas on the eastern edge of the island. This elevation pattern is likely created by the deposition of suspended sediment as an island-overtopping-water surface is slowed down by the vegetation.

Studies of backwater sedimentation rates within the UMR have focused within Pools 4-10 and 13

(Eckblad et al., 1977; McHenry et al., 1984; Korschgen et al., 1987; Rogala and Boma, 1996; Rogala et al., 1997). Sedimentation rates from these studies range from as little as 0.2 cm/yr (Pool 7) to as high as 4 cm/yr (Pools 4-10). A sedimentation rate of 0.8 cm/yr for Pool 13 was reported by Rogala & Boma (1996). Measurements of sedimentation rates within Huron Island were taken by former IA DNR Biologist Bill Aspelmeier. His observations were made at 4 locations within Huron Island over two 5-year periods (1984-1989 and 1989-1994). Observations from the Little Cody Chute indicate consistent aggradation over the 10 year study period. However, observations made in Buffalo Slough suggest that degradation is occurring at that particular location. Sedimentation rates for Huron Island reported by the Aspelmeier study vary as much as (-1.16 cm/yr to +3.47 cm/yr).

The variability seen among these estimated sedimentation rates is caused by a number of different factors including when each measurement was taken with respect to a recent high water event. Variability within estimates for Huron Island itself indicates that there are many different and dynamic processes at work and that sedimentation rates are also dynamic. Sedimentation rates within Huron Island are a function of the discharge magnitude and the rainfall distribution in the contributing watershed, as well as the spatial and temporal variability in vegetation and spatial and temporal variability in natural impoundments such as beaver dams.

In order to obtain another estimate of sedimentation rates within the Project Area, a sediment transport model has been developed as part of the feasibility study. The purpose of the AdH sediment transport model is to evaluate the design elevation and alignment of project features in terms of their effectiveness in reducing sedimentation and to provide another sedimentation rate value for comparison with previous estimates. Based on the sediment transport modeling results, under existing conditions the average annual sedimentation rate in Goose Lake Pool 1 is 1.2 cm/yr (0.040 ft/yr) and 0.68 cm/yr (0.022 ft/yr) in Goose Lake Pool 2. These rates are comparable to the sedimentation rates cited in the reports discussed above.

L. Historic and Cultural Resources

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

Based on the nature of the Project the Corps contracted Bear Creek Archaeology, Inc. (BCA) to conduct an archaeological and geomorphological evaluation of Huron Island. The resulting report is entitled *Phase I Archeological and Geomorphological Survey for the Huron Island Complex Habitat Rehabilitation and Enhancement Project, Huron Township, Des Moines County, Iowa*, dated February 2011. Messrs. Lowell Blikre and David W. Benn of Bear Creek Archeology, Inc. of Cresco, Iowa (BCA) prepared the report for the Corps Contract W912EK-08-D-0002, Work Order #0023.

BCA determined that the peripheral areas of Huron Island are relatively young and have no archaeological potential. The margins and southern quarter of Huron Island have little to no potential for archaeological resources due to the low and wet conditions. Only the central core of Huron Island is old enough to have prehistoric archaeological potential. BCA noted that one archaeological site had been recorded in 2009 on the northern portion of Huron Island. The site is based on the presence of a cabin on the Government Land Office maps and has not been field checked.

The BCA intensive archaeological survey recorded an historic boat landing on the west side of the island and an historic scatter of artifacts near the center of the island. Neither site was considered eligible for listing in the National Register of Historic Places.

M. Socioeconomic Resources

Water based activities dominate recreation use, with boating, boat fishing, and sightseeing being the most popular activities. The majority of the recreating public is drawn from the immediate bordering counties, and most visits are day trips.

Recreational boating is the most popular and economically important recreational activity on the UMR. Recreational boating activity on the UMR has been increasing in number of boats, size and horsepower of boats, number of docks and marina slips, and number of shore developments such as restaurants and hotels that support recreational boating. A 2000 study by Carlson, Bartell, and Rouse (Carlson, et al. 2000) estimated recreational boating activity within Pool 18 as 52,728 trips per year.

Sport fishing, both from boats or shore/docks, nearly equals boating in popularity as a recreational pursuit on the UMR. Tournament fishing for game fish (e.g., largemouth bass, walleye, sauger, and catfish) began in the late 1980s and has become increasingly popular in some UMR Pools. According to the State of Iowa permitting database, there were 65 fishing tournaments permitted for Pool 18 from 2001 – 2010. The fishing tournaments were generally small in size, consisting of an average of 17 boats.

N. Hazardous, Toxic, and Radioactive Waste

An Environmental Assessment (ESA) Transaction Screening Process was completed on 15 June 2011 for the proposed work and staging areas for Huron Island in general conformance with ASTM Practices E 1528-06, ER 1165-2-132, and MVD DIVR 1165-2-9. The inquiry consisted of an inspection of aerial photographs (1930, 1950, 1960, 1990, 2004, and 2010), and 1837 Land Survey Map, a USGS Topographical Map, records research, and an interview. These inquiry activities revealed no evidence of hazardous substances, HTRW, or other regulated contaminants in connection within the Project Area (Appendix E).

III. DEVELOPMENT OF PROJECT OBJECTIVES

A. Future Without Project Conditions

1. Hydrology and Hydraulics. As illustrated in figure 7d and figure 8, river stages in the Project vicinity have increased. As the stage duration at Keithsburg increases so does the duration of island-inundating flows. Sediment delivery from the Iowa River into Pool 18 will continue, resulting in a continued sediment supply for deposition within the Huron Island backwater area. If sedimentation rates as high as 0.039 ft/yr, (as observed by the AdH sediment transport model), continue over the 50-year project life, accumulation of as much as 2 feet of sediment or greater may occur within the Goose Lake backwater areas.

2. Aquatic Habitat. Under the previously described sedimentation rates, backwater habitat could be reduced by as much as 70 percent over the next 50 years. It is not likely the loss would be linear as most sedimentation occurs during flooding events. Nonetheless, a 70 percent reduction would result in a little more than 100 acres of shallow (<2 feet) backwater habitat over 50 years. 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. Huron Island numbers are comparable to predictions made for Pool 18 during the Cumulative Effects Study (WEST 2000), table 5. The study also projected an overall loss of backwater aquatic habitat, but minimal loss of flowing channels.

Table 5. Cumulative Effect Study: Predicted Future Conditions for Pool 18 Aquatic Habitats (WEST 2000)

		Acres of Aquatic Habitat by Strata						
	Years	**Main Channel**	**Secondary**	**Contiguous Backwater**	**Isolated Backwater**	**Island Area**	**Island Perimeter**	**Total Open Water**
Upper Pool RM 437.1-418.0	1989	4,104	1,910	905	164	4,804	628,850	7,083
	2050	3,858	1,910	499	126	4,948	638,213	6,393
	% Change	**-6%**	**0%**	**-45%**	**-23%**	**3%**	**1%**	**-10%**

It is probable Huron 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 18. Finally, overwintering habitat (areas with depths >4 feet.) will be reduced to zero within the next 50-years.

Without intervention the two islands within Huron Chute will continue to erode. The islands 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. Huron Chute would continue to offer high velocity deep water habitat, but would be nothing more than a migration corridor for fish. Garner Chute will continue to function much the same as Huron Chute.

3. Floodplain Habitat. Influencing factors at Huron 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 an over-matured, even-aged monoculture of silver maple, 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 critical threshold for producing a sustainable nut producing tree population. It is highly unlikely nut producing trees will regenerate without intervention. A comparison of survey results from the 1982 and 2011 inventories indicate a negative trend in numbers of hard mast individuals and species. Other projects have shown similar downward trends when reestablishment of hard mast trees in attempted at the current elevation. Significant mortality results from flood inundation and duration.

Based on the results of a 2011 forest inventory, it is anticipated that a large percentage of the current forest will experience substantial 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 grassland habitat as a considerable portion is replaced by moist soil vegetation and reed canary grass, which has far less habitat value to floodplain wildlife.

Increased elevation and a reduction of water inundation duration (similar to pre-dam conditions) are critical to the structure and function of the floodplain. Achievement of a healthy age distribution and species diversity of floodplain trees increases the numbers of nut producing trees and provides the structure 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 likely 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 likely increase and those requiring the structure and/or mast provided by cottonwood, elm, and oak will likely decline.

B. Problem 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 in the Project Area. These alterations have reduced native plant and animal populations, degraded the quality of remaining natural resources and plant communities, impaired ecosystem functions, and threaten the future sustainability of the river-floodplain ecosystem.

1. Problem. Decreased Reliability of Aquatic Vegetation. Alterations of the historic water level regime within the past 100 years have limited the ability of the Project Area to produce and sustain the native plant community that historically dominated the region and provided habitat for the diverse native wildlife community. Vegetation surveys for Pool 18 show significant changes in the aquatic resources. Aquatic vegetation present in 1975 and 1989 were not found in 2000 (Yin et al 2003). Vegetative bed sampling analysis, done by USFWS in 2009, shows that the existing seed bank of aquatic vegetation used as food source by migratory waterfowl was lacking in diversity and abundance.

Opportunity. There is an opportunity to increase the extent of both submersed and emergent aquatic vegetation by increasing topographic diversity and enhancing the existing seed bank.

2. 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 sedimentation in off-channel areas. The regular occurrence of maintenance dredging in Pool 18, specifically near the mouth of Huron Chute, exemplifies the sedimentation problem occurring in this reach.

Side channel habitat diversity afforded by islands in the UMRS is highly valuable and has been steadily declining. The habitat provided by islands functions to provide shallow low flow sandbar habitat, flow refugia critical to fish for foraging and nursery habitat, and resting habitat for migratory fish species.

Opportunity. Restoration of backwater areas would improve habitat conditions for a large variety of backwater and channel fish species. 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 flow during low flow), adequate water depths (> 4 feet), aquatic vegetation, and a diversity of substrates and structure.

Restoration of side channel island structure and function would improve habitat for riverine fish species and potentially backwater species during different parts of the year. Specifically, spawning, rearing, and foraging habitat improvements would result from restoration of natural fluvial processes such as sediment aggradation and degradation.

3. 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 percent 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 Huron Island floodplain forest 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 in Huron Island provide necessary habitat for a large number of animal species.

It is possible to restore the topographic conditions and tree populations which existed prior to construction of Lock and Dam 18. This Project is a big step in that direction. However, under the current hydrology it is highly unlikely desirable tree species will regenerate without action.

C. Resource Significance

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

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

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

2. Public Recognition. Ecosystem restoration and monitoring on the UMRS provide substantial benefits to the river communities, the UMRS region, and the nation. UMRR-EMP, throughout its 25-year history, has created thousands of employment opportunities related to HREP planning, construction, and evaluation, and LTRMP monitoring and research. Once completed, habitat projects create new opportunities for outdoor recreation, scientific investigation, and environmental education, further stimulating local and regional expenditures on equipment, facilities, food, and lodging. For example, an HREP project may enhance fish and wildlife habitat; improve water quality; and attract visitors to fish, hunt, bird watch, and simply enjoy the restored area.

On average, UMRR-EMP has generated about 600 jobs annually (EMP Report to Congress 2010). While monetizing these social and economic benefits is often difficult, program- and project-specific data and anecdotal information suggest that UMRR-EMP contributes in important ways to economic activity on the UMRS that is ecosystem-oriented. For example, the UMR National Wildlife and Fish Refuge (UMR NWFR) is host to 26 completed HREPs. Located along 261 miles of the UMR, from Wabasha, Minnesota to Clinton, Iowa, the UMR NWFR hosted over 3,500,000 visitors in 2008 alone. Of those visitors, an estimated 2,430,000 boated, 1,386,000 fished, 244,000 observed wildlife, 203,000 photographed nature, 180,000 hunted, and 28,000 participated in environmental education activities and nature related interpretive programming.

A 2000 study by Carlson, Bartell, and Rouse (Carlson, et al. 2000) estimated recreational boating activity within Pool 18 as 52,728 trips per year. The IA DNR reported 65 fishing tournaments between 2001 – 2010 (IA DNR Permitting database; Schonhoff 2010). The proposed Project should help preserve the economic, aesthetic, and recreational benefits of Huron Island as described above.

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

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

As part of the UMR, the Project is included as part of the technical efforts and recognition. Technical resource agencies view the resources in Pool 18 as significant and are reflected in the ongoing habitat rehabilitation efforts in the pool including Huron Island, Pool 18 Drawdown, Boston Bay HREP, and Keithsburg Division HREP.

D. UMRR-EMP Goals and Objectives

1. **Over Arching Program 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 (hydrology and hydraulics)
   - Manage for processes that shape a physically diverse and dynamic river-floodplain system
   - Manage for processes that input, transport, assimilate, and output material within the UMR basin river-floodplains: e.g. water quality, sediments, and nutrients
   - 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 Reach Objectives.** To maximize the benefits of individual projects the FWIC were tasked to define ecosystem restoration objectives at the river reach and system level. In a report titled *Upper Mississippi River Restoration Ecosystem Restoration Objectives 2010*, FWIC states the reach objectives for the Upper Mississippi Lower Impounded Reach:

   - Modify contiguous backwater areas
   - Modify the channels and floodplains of tributary rivers
   - Restore hydro-geomorphic processes that create, maintain, and improve bathymetric diversity, islands, sandbars, shoals and mudflats
   - Increase topographic diversity
   - Restore a more natural hydrologic regime in the navigation pools
   - Increase storage and conveyance of flood water on the floodplain
   - Naturalize the hydrologic regime of tributaries
   - Reduce sediment loadings to the rivers and backwaters
   - Reduce nutrient loading from tributaries to rivers
   - Enhance Water Quality
   - Increase vegetated riparian buffers along tributaries and ditches in the floodplain
   - Modify the extent, abundance and diversity of submersed aquatic plants
   - Modify the extent, abundance and diversity of emergent aquatic plants
   - Provide pathways for animal movements

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 18 and proposed actions specific to the Huron/Johnson Island Complex are taken directly from the report *Environmental Pool Plans Corps of Engineers, Rock Island District Mississippi River, Pools 11-22.*

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. High turbidity prevents colonization of aquatic plants
- 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 18 contribute to significant water quality and habitat problems, which impact natural resources. Issues include accelerated sedimentation, and associated channel maintenance problems, loss of backwaters, nutrient and contaminate delivery
- Locks and Dams 17 and 18 restrain fish passage between pools.
- Information is needed to better assess and manage Pool 18 mussel populations.
- The current water management regime, especially avoidance of seasonal low water, removes much potential for periodic regeneration of aquatic habitats.

Proposed Actions

- Inventory and monitor side channel characters, especially bathymetry, of Huron Chute and Johnson Island side channel and establish an objective to maintain existing quality. Utilize a combination of training structure modification or new construction to achieve goal.
- Reduce sediment accumulation in backwaters by diverting high flows with a sediment deflection berm designed to simulate a natural levee. Utilize material from the Willow Bar channel maintenance dredged material containment, and fine sediments, to construct a non-erosive structure and plant trees.
- Restore bathymetry in Huron Island backwaters utilizing selective dredging to ensure representation of a full range of depths from ephemeral pools to deep habitats.
- Intensively manage forest resources to maintain a full complement of bottomland forest species.

- Design and complete 'mound and swale' disposal of channel maintenance dredging material on portions of Johnson Island to further evaluate potential to improve diversity of terrestrial habitats.
- Provide fish over-wintering habitat within Johnson Island backwaters.

F. Huron Island Goals, Objectives and Potential Enhancement Features

The reach and pool objectives, as well as input from state and Federal agency natural resource managers, were used to guide the development of the Huron Island Project objectives. Resource problems, opportunities and constraints, specific habitat requirements, and desirable hydraulic and sediment transport conditions to sustain habitat were factors used to develop these objectives. The Huron Island goals, objectives and potential enhancement features are shown in table 6.

G. Planning Constraints

The following constraints were considered in plan formulation:

1. Navigation. Ensure features do not negatively impact 9-foot navigation channel.

2. Environmental Laws and Regulations. Construct features consistent with Federal, state, and local laws.

3. Flood Heights. Restoration features should not increase flood heights or adversely affect private property or infrastructure.

4. Aesthetics. Features should be designed to minimize negative impacts to aesthetics.

Table 6. Project Goals, Objectives, and Potential Enhancement Features

Goal	Objective	Potential Rehabilitation/Enhancement Measures
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 Manage for processes that shape a physically diverse and dynamic river-floodplain system	Increase diversification of year round floodplain forest and scrub-shrub habitat on Huron Island, as measured in acres. Increase the structure and function of year-round aquatic habitat diversity, as measured by acres and native fish use of spawning, rearing, and overwintering habitat in the Project Area. Maintain side channel riverine hydrodynamic, sediment transport and geomorphic processes in Huron Chute. Increase the areal coverage as measured in acres of emergent and submersed aquatic vegetation in backwater areas during the growing season.	Plant aquatic vegetation at specified elevations Construct habitat using excavated material from the floodplain or navigation channel material for several species of tree plantings. Improve tree stand improvement by planting mast trees and/or timber harvest Construct closure structures to reduce bedload sediment and provide oxygenated water Excavate backwater area to provide variable depth diversity for several centrarchid habitats Construct aquatic habitat improvement structures to provide habitat for riverine fish species Construct erosion protection measures of side channel islands in order to maintain side channel riverine hydrodynamic process

IV. POTENTIAL PROJECT FEATURES

This section discusses potential enhancement features that will meet the goals and objectives outlined in Section III, *Development of Project Objectives*. These potential enhancement features were initially screened based on their contribution to the Project goals and objectives, engineering considerations, and local restrictions or constraints. Features that were determined not feasible or did not meet the Project objectives were not subject to further evaluation and are shown on Plate 12 (C-103). Measures that will be evaluated further are found on Plate 11 (C-102). Symbols (ex. T1, F2, I1) were assigned to the measures at a January 2012 interagency meeting to aide in the documentation of the planning process.

A. Excavation

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. Several potential areas in the Project Area were evaluated for excavation.

1. Hydraulic Dredging. Bathymetric diversity would be accomplished using a hydraulic dredge. The materials in the lakes contain stiff fat clays which would be inefficient to hydraulically dredge. There is also significant woody debris in the channel that will make it difficult to use hydraulic techniques. This measure will not be retained for further evaluation.

2. Mechanical Dredging. Bathymetric diversity would be accomplished using a mechanical dredge. Mechanical dredging would necessitate adjacent placement by way of a crane loaded barge or a floating excavator. The area is surrounded by mature trees which overhang the pool, so tree clearing would be required prior to sidecasting the material. This measure will be retained for further evaluation.

3. Potential Areas for Excavation

a. Goose Lake Pool 1 Bathymetric Diversity (T1, T2). Goose Lake Pool 1 would be excavated to provide aquatic diversity through the direct act of dredging and to provide sufficient material for floodplain forest topographic diversity. Access dredging from Huron Chute to Goose Lake Pool 1 is required for equipment to access the proposed excavation site. This measure will be retained for further evaluation.

b. Goose Lake Pool 2 Bathymetric Diversity (T3, T4). Goose Lake Pool 2 would be excavated to provide aquatic diversity through the direct act of dredging and to provide sufficient material for floodplain forest topographic diversity. Access dredging from Huron Chute to Goose Lake Pool 1 is required for equipment to access the proposed excavation site. This measure will be retained for further evaluation.

c. Little Cody Chute Bathymetric Diversity (T5). This measure includes excavation to variable channel depths to increase habitat. Based on analysis of existing data, the chute experiences a continually shifting substrate and has a high sand bedload moving through the channel. Due to these circumstances, the team was unable to design for sustainable channel depths in Little Cody Chute. This measure will not be further evaluated.

d. Lovers Lane Bathymetric Diversity (T6). This measure includes excavation to variable channel depths to increase habitat. Based on analysis of existing data, the chute experiences a continually shifting substrate and has a high sand bedload moving through the channel. Due to these circumstances, the team was unable to design for sustainable channel depths in Lovers Lane. This measure will not be further evaluated.

e. Upper Buffalo Slough Bathymetric Diversity (T7). This measure includes excavation to variable channel depths to increase habitat. However, this area is difficult for fish and equipment to access. Based on access concerns, this measure will not be further evaluated.

f. Buffalo Slough Bathymetric Diversity (T8). This measure includes excavation to variable channel depths to increase habitat. However, this area is difficult for fish and equipment to access. Based on access concerns, this measure will not be further evaluated.

B. Plantings

Vegetative plantings are proposed as a potential measure to improve the aquatic and floodplain habitat in Huron Island through restoration of foraging, cover, nursery, and reproduction habitat for a variety of aquatic and wildlife species.

1. Aquatic Vegetation. Aquatic vegetation restoration would be accomplished by planting 3 growth forms (i.e., emergent, submergent, and floating-leaved), 3 propagule types (i.e., containerized, tubers, and existing seed bank), and at multiple elevations based on species specific water tolerances. Engineering Research and Development Center (ERDC) would help collect, grow and manage the aquatic vegetation design. Refer to Plate 35 (L-602) for planting schedules.

2. Floodplain Forest and Temporarily Inundated Forested Wetland Shrubs. Restoration of native floodplain forest species and temporarily inundated forested wetland shrub species would be accomplished through a stratified vegetative planting design which uses various sizes, species, planting elevation. Three sizes (i.e., #3, 5, 15) and 15 species of root production method ® (RPM) trees would be planted at 2 elevations. Temporarily inundated forested wetland shrubs would be planted along transition zones between aquatic and floodplain forested habitat using the same method of RPM for shrubs. Refer to Plate 33 (L-501) for tree planting details and to Plate 34 (L-601) for planting schedules.

3. Potential Areas for Plantings

a. Aquatic Plantings in Goose Lake Pool 1Bathymetric Diversity (T1, T2). This measure would include planting aquatic vegetation adjacent to areas excavated in Goose Lake Pool 1. This measure will be retained for further evaluation.

b. Aquatic Plantings in Goose Lake Pool 2 Bathymetric Diversity (T3, T4). This measure would include planting aquatic vegetation adjacent to areas excavated in Goose Lake Pool 2. Refer to Plate 26 (L-102) for vegetation planting plan views. This measure will be retained for further evaluation.

c. Floodplain Forest and Temporarily Inundated Forested Wetland Shrubs in Goose Lake Pool 1. (F1, F2). This feature would provide topographic and floodplain forest diversity. The excavated material from measures T1 or T2 would be shaped into tiers and a 8H:1V slope. The tiers and side slopes would then be planted with appropriate species. This measure will be retained for further evaluation.

d. Floodplain Forest and Temporarily Inundated Forested Wetland Shrub Plantings in Goose Lake Pool 2. (F3, F4). This feature would provide topographic and floodplain forest diversity. The excavated material from measures T3 or T4 would be shaped into tiers and a 8H:1V slope. The tiers and side slopes would then be planted with appropriate species. This measure will be retained for further evaluation.

e. Floodplain Forest Diversity in Non-Diverse Forest Location (F5-F8). This feature would provide topographic and floodplain forest diversity by constructing a multi-tiered pad and planting several species of trees to include soft mast and hard mast (refer to section 2 for planting methodology) using existing soil to restore ridge and swale habitat. Varying tier elevations were considered for measures F5 and F6. Potential materials for construction are existing soil (F5, F6), excavated material from backwater areas (F7), or dredged material from the main channel (F8). The use of navigation sand would require significant capping with existing soil, and the distance from the navigation dredging sites is several miles, therefore, measure F8 was not evaluated further. The use of excavated material would have required handling the excavated material numerous times in order to get sufficient quantities to the site so measure F7 alone was not evaluated further. The use of adjacent existing soil material, measure F5 and F6, will be retained for further evaluation.

f. Forest Diversity in Existing Diverse Forested Area Using Existing Soil (F9). This feature would involve planting several species of trees to include soft and hard mast trees on two different elevation tiers as well as temporarily inundated forested wetland shrubs on excavated existing soil. The equipment and area necessary for moving existing soil could have a negative impact on the existing diverse forested area. Therefore, this measure was removed from further consideration.

C. Closure Structures and Potential Sites

Closure structures have been proposed as a potential measure to improve aquatic habitat by deflecting sediment and reducing flows in the Project Area. Closure structures are generally constructed with rock, though new design concepts involving woody material are being developed. Closure structures were identified for consideration at several sites in the Project Area.

1. Garner Chute Closure Structure (T9). This measure includes the construction of a rock closure structure near the upstream end of Garner Chute between Garner Island and Huron Island. Construction of the closure structure would result in lower flows for fish resting habitat during overwintering conditions. The closure structure would also deflect sediment from Garner Chute and from the inlet to Upper Buffalo Slough. This measure will be retained for further evaluation.

2. Northwest Corner of Huron Island Closure Structure (T10). This structure would reduce bed load sediment from entering Perow Slough. Based on the proposed CARS feature discussed in existing conditions as well as the higher bottom elevation of this inlet the closure structure would not reduce bed load sediment, therefore this measure will not be evaluated further.

3. Downstream of Northwest Corner of Huron Island Closure Structure (T11). This structure would reduce bed load sediment from entering Buffalo Slough. Based on the variable flows in this location and the risk of sediment closing the Buffalo Slough inlet this measure will not be further evaluated.

4. Cody Chute Closure Structure (T12). This structure would reduce sedimentation in Cody Chute. However, evaluation of the existing conditions in the chute determined that it was a shifting bedload and a closure structure would not address sedimentation issues. This measure will not be further evaluated**.**

5. Pool 1 Gated Closure Structure (T13). This measure would include a screw gate or similar structure which would connect Goose Lake Pool 1 to Goose Lake Pool 2 during winter conditions. If oxygen levels dropped, the structure could be opened to allow for oxygenation of the backwater area. This would only be constructed if Pool 2 was excavated. Analysis of baseline water quality monitoring in the proposed excavation areas indicates adequate oxygen levels; therefore a gated structure will not be required in this location. This measure will not be evaluated further.

6. Pool 2 Gated Closure Structure (T14). This measure would include a screw gate or similar structure which would connect Huron Chute to Goose Lake Pool 2 during winter conditions. If oxygen levels dropped, the structure could be opened to allow for oxygenation of the backwater area. This would only be constructed if Pool 2 was excavated. Analysis of baseline water quality monitoring in the proposed excavation areas indicates adequate oxygen levels; therefore a gated structure will not be required in this location. Additionally, this structure would increase sediment transport from Huron Chute into Pool 2 causing loss of aquatic habitat over time. This measure will not be further evaluated.

D. Training Structures

River training structures have been proposed to improve aquatic habitat by modifying the flow and sediment response of the river. Training structures are generally constructed with rock, but other materials may be used. Training structures were identified for consideration at several sites in the Project Area.

1. Vanes. This measure would be accomplished by placing material perpendicular to the river flow to modify flow and restore aquatic habitat diversity.

2. Wingdam Notches. This measure would be accomplished by reducing material in a particular area of a wingdam restoring diverse river habitat.

3. J-Hooks. Design criteria are similar to those for the rock vane with the inclusion of a hook in the shape of J at the end of the vane. The J-hooks require almost double the material of a rock vane while providing similar protection and habitat value.

4. Potential Areas for Training Structures

a. Gun Slough Channel Training Structures (T15). This measure would include river training structures such as rock vanes and j-hooks to restore variable flows, scouring, and fish habitat. Based on hydraulic evaluation, it was determined that the flows were too low for these structures to be functional. This measure will not be further evaluated.

b. Charlie Island Vanes (I3). Rock Vanes were proposed to manipulate flows in between Huron Island and Charlie Island. The vanes would be constructed to stop sediment from filling in and closing off the connection between the Mississippi River and Huron Chute. However, based on a review of this area, it was determined that this is a dynamic system, and flows through the area are adequate to maintain the connection without it closing off over time. Therefore, this measure will not be retained for further evaluation.

c. Charlie Island Wing Dam Notching (I4). The navigation wing dam located near the main channel and connecting Huron Island to Charlie Island was proposed to be notched to ensure that flow could continue into the backwater habitat. A review of existing conditions determined that this wing dam was already notched. Therefore, this measure will not be retained for further evaluation.

E. Bank Protection

Bank protection has been proposed to control erosion of the islands in the Project Area. 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 several sites in the Project Area.

1. Vanes. This measure would be accomplished by placing material perpendicular to the river flow to modify flow and restore aquatic habitat diversity.

2. Chevrons. This measure would be accomplished by placing material parallel to the flow in an arch shape.

3. Bank Stabilization. This measure would be accomplished by placing material along the exposed shoreline.

4. J-Hooks. Design criteria are similar to those for the rock vane with the inclusion of a hook in the shape of J at the end of the vane. The J-hooks require almost double the material of a rock vane while providing similar protection and habitat value.

5. Potential Areas for Bank Protection

a. Huron Island Bank Stabilization (E1). This measure would consist of riprap protection along the shore of Huron Island near Goose Lake Pool 2. This measure will be evaluated further as a subcomponent of measure T1through T4.

b. Huron Island Rock Vanes (E2). This measure would consist of bank line protection by placement of rock vanes. Rock vanes would tie into the bankline at elevation 537 and extend approximately 40 feet from the bankline at a 20 degree angle from the bank and be spaced approximately every 120 feet. The quantities to construct this feature were significantly higher than similar bankline protection features as indicated in item E1. The size of the structures would likely have an adverse impact on the floodplain analysis. Therefore, this feature was not further evaluated.

c. Huron Island J-Hooks (E3). This measure would consist of bank line protection by placement of J-Hooks. Rock vanes would tie into the bankline at elevation 537 and extend approximately 40 feet from the bankline. The J-hooks required almost double the material of a rock vane while providing similar protection. These structures are better served in a smaller stream. Therefore, this feature was not further evaluated.

d. Huron Chute Small Islands Bank Stabilization (I1). Two small islands located in Huron Chute have been eroding significantly since inundation as indicated on Plate 6 (V-103). Providing bankline stabilization in the form of stone placement along the upstream end of the island would stop future erosion. Therefore, this measure was retained for further evaluation.

e. Huron Chute Small Islands Chevrons (I2). Chevrons would be constructed to maintain and restore side channel islands. This feature would not only restore natural riverine processes, but also provide essential aquatic habitat for riverine fish species. Construction of chevrons upstream of the islands will provide additional forested wetland habitat, diversity in the main back channel, and aquatic habitat in scour areas caused by the chevrons. The hydraulic analysis described in detail in Appendix H, *Hydrology and Hydraulics,* determined this measure produced an increase in water surface elevation at the upstream cross sections that exceeds State of Iowa no rise criterion. As a result, this measure was not retained for further evaluation.

F. Constructed Soil Units

Constructed soil units were proposed as a measure to restore wildlife habitat for migratory waterfowl, reptiles, amphibians, and other wildlife in the Project Area.

1. **Ephemeral Wetland (P1).** 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. These were considered being for construction in existing areas containing reed canary grass. This feature was eliminated from further consideration since the habitat diversity exists in the area and the measure would not be successful in eliminating invasive species.

2. **Seasonally Flooded Perched Wetlands (P2).** Adjacent to the Forest Diversity In Non-Diverse Forest Location a perched wetland could be constructed to provide wet habitat for an extended time period. However, perching the wetland does not meet the objectives set forth by this study and will not be evaluated further.

3. **Moist Soil Management Unit (MSMU) (T17).** MSMUs would be constructed to restore aquatic vegetation. It would be difficult to maintain proper water elevations due to the remote nature of the site. This measure will not be further evaluated.

G. Non-Structural Methods

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

1. **Best Management Practice (BMPs) (B1).** BMPs are defined by the U.S. Environmental Protection Agency (EPA) as non-regulatory guidance for agriculture issued to farmers to reduce non-point source pollution. By implementing these BMPs, the public has the capability to reduce sediment loads and increase the water quality of the Mississippi River significantly. The eight basic types of BMPs are Conservation Tillage; Crop Nutrient Management; Pest Management; Conservation Buffers; Irrigation Water Management; Grazing Management; Animal Feeding Operation Management; and Erosion and Sediment Control. Since this measure is outside of Corps authority, the District recommends it be evaluated further by the responsible persons rather than in this report.

2. **Education and Outreach (B2).** Education motivates people to think about the world, their relationship to it, and their ability to influence it. Without education the public may not be well-informed about public measures available to aide in the restoration of the environment. Education measures related to Huron Island includes, but is not limited to, information on non-point source pollution, point source pollution, agriculture practices, invasive species, threatened and endangered species, floodplain, and wetlands. Education and Outreach programs are established through local, state and Federal agencies as well other public forums. Several education programs have been implemented by the USDA and EPA regarding BMPs and other agriculture practices. The IA DNR 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. The 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. **Tree Stand Improvement (F10).** This measure is a combination of selective harvest and crop tree release and planting trees within existing timber stands. The harvest and tree release would clear old trees and benefit desirable understory by decreasing competition. Currently, tree age in the island is such that a catastrophic elimination of forest stands is possible with no action. This measure will not be evaluated further since the understory is not abundant enough to warrant the action.

4. **Forest Fragmentation Reduction (F11).** Trees would be planted in past harvest locations and current harvest locations in order to reduce forest fragmentation. This measure is being evaluated by the Rock Island District Operations Division (Forestry) to be conducted using Operation and Maintenance funding. Therefore, this measure will not be further evaluated.

V. EVALUATION OF FEASIBLE PROJECT MEASURES AND FORMULATION OF ALTERNATIVES

This section describes measures that meet the goals and objectives of this Project. Each measure was evaluated to determine its potential for environmental restoration and enhancement. Cost estimates were also derived for each of the feasible alternatives.

A. Feasible Project Features

Table 7 summarizes all potential measures evaluated**.** Plate 11 (C-102) shows the locations of all feasible Project features described in subsections 1 through 12 following the table. Project feature alternatives were identified and evaluated by the interagency team to aid in the development of the Recommended Plan.

Table 7. Potential Measures

Measure	Description
T1	Goose Lake Pool 1 Bathymetric Diversity (537 Top)
T2	Goose Lake Pool 1 Bathymetric Diversity (539 Top)
T3	Goose Lake Pool 2 Bathymetric Diversity (537 Top)
T4	Goose Lake Pool 2 Bathymetric Diversity (539 Top)
F1	Forest Diversity Adjacent to Pool 1 (537 Top)
F2	Forest Diversity Adjacent to Pool 1 (539 Top)
F3	Forest Diversity Adjacent to Pool 2 (537 Top)
F4	Forest Diversity Adjacent to Pool 2 (539 Top)
T9	Garner Chute Closure Structure
I1	Huron Chute Diversity Island Bank Stabilization
F5	Forest Diversity In Non-Diverse Forest Location Using Existing Soil (537 Top)
F6	Forest Diversity In Non-Diverse Forest Location Using Existing Soil (539 Top)

Measures T1, T2, T3, and T4 include bank protection of 2,415 feet in the form of riprap along the bankline of Huron Island near Goose Lake Pool 2. Analysis of historic and existing photographs shows that significant active erosion on the bankline along the southwestern portion of Huron Island is occurring. It was estimated that the average rate of erosion is 1.33 feet per year. Currently only 25 feet of bankline remains between Huron Chute and Goose Lake Pool 2. Several potential measures were analyzed to reduce the active erosion but were costly and had the potential to impact flood heights; however the team felt that to protect the investment of Goose Lake Pools bathymetric diversity it was necessary to include an erosion protection measure. The team chose the least costly erosion protection measure, riprap. Riprap would consist of IADOT (Class A) or ILDOT (RR-5) size stone. Bedding sizes would be IADOT (No. 3) or IL DOT (RR-1).

1. **T1 - Goose Lake Pool 1 Bathymetric Diversity (537 Top)** involves mechanically dredging material in Goose Lake Pool 1 and side casting the material on the existing floodplain .The excavation site is 2,402 feet long. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project, while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides immediate access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute.

The placement site would be constructed to an elevation of 537 feet. This elevation was developed using the Hydrologic Engineering Center's Ecosystem Functions Model (HEC-EFM). The criteria used in the evaluation included tree species and their tolerance to sustained water inundation (i.e., maximum duration the group can withstand inundation, beyond which mortality sets in), growing season, and then applied an exceedance probability. The resulting elevation of 537 feet was based on a minimal tolerance (25-35 consecutive days; DeJager et al. 2012) to sustained water inundation, a growing season of April 10 – October 28, and a 25 percent probability of exceedance.

The placement consists of an upper site extending 1,002 feet and a lower site extending 1,163 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement site (El. 529-532 feet). Plantings will incorporate a stratified design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

2. **T2 - Goose Lake Pool 1 Bathymetric Diversity (539 Top)** involves mechanically dredging material in Goose Lake Pool 1 and side casting the material on the existing floodplain. The excavation site is 2,402 feet long. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project, while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides immediate access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute.

The placement site would be constructed to an elevation of 539 feet. This elevation was developed using HEC-EFM. The resulting elevation of 539 feet was based on minimal tolerance (25 to 35 consecutive days; DeJager et al. 2012) to sustained water inundation, a growing season of April 10 – October 28, and a 10 percent probability of exceedance.

The placement site consists of an upper site extending 1,002 feet and a lower site extending 1,163 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement site (El. 529-532 feet). Plantings will incorporate a stratified design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

3. **T3 - Goose Lake Pool 2 Bathymetric Diversity (537 Top)** involves mechanically dredging material in Goose Lake Pool 2 and side casting the material on the existing floodplain. The excavation site is 2,642 feet long. The pool would be excavated to a minimum of 520 feet deep, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project, while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute.

The placement site would be constructed to an elevation of 537 feet based on the same criteria as measure T1. The placement site extends 2,642 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement site (El. 529-532 feet). Plantings will incorporate a stratified design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

4. **T4 - Goose Lake Pool 2 Bathymetric Diversity (539 Top)** involves mechanically dredging material in Goose Lake Pool 2 and side casting the material on the existing. The excavation site is

2,642 feet long. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project, while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides immediate access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute.
The placement site would be constructed to an elevation of 539 feet based on the same criteria described in T2. The placement site extends 2,642 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement site (El. 529-532 feet). Plantings will incorporate a stratified planting design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

5. **F1-Forest Diversity Adjacent to Pool 1 (537 Top)** involves shaping the 2,165 feet long placement site contained in Measure T1as follows: The placement site would slope up at a 8H:1V slope to elevation 535 feet at which point a 30 foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to elevation 537 feet . The top of the placement site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which include treatments of tree container size, protection, and elevation. Tree container sizes include #3, #5, and #15 Root Production Method™ (RPM) containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 537 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 537 feet) would be planted for this measure. Also, to increase ground cover post-construction approximately 3 acres of an understory seed mix would be included (El. 533-537 feet).

6. **F2-Forest Diversity Adjacent to Pool 1 (539 Top)** involves shaping 2,165 feet long excavated material placement site contained in Measure T2 as follows: The placement site would slope up at a 8H:1V slope to elevation 535 feet at which point a 30 foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to elevation 539 feet . The top of the placement site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which would include treatments of tree container size, protection, and elevation. Tree container sizes would include #3, #5, and #15 RPM containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 539 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 539 feet) would be planted for this measure. Also, to increase ground cover post-construction approximately 3 acres of an understory seed mix would be included (El. 533-539 feet).

7. **F3-Forest Diversity Adjacent to Pool 2 (537 Top)** involves shaping 2,642 feet long placement site contained in Measure T3 as follows: The placement site would slope up at a 8H:1V slope to elevation 535 feet at which point a 30 foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to elevation 537 feet . The top of the placement

site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which would include treatments of tree container size, protection, and elevation. Tree container sizes would include #3, #5, and #15 RPM containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 537 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 537 feet) would be planted for this measure. Also, to increase ground cover post-construction approximately 3 acres of an understory seed mix would be included (El. 533-537 feet).

8. F4-Forest Diversity Adjacent to Pool 2 (539 Top) involves shaping 2,642 feet long excavated material placement site contained in Measure T4 as follows: The placement site would slope up at a 8H:1V slope to elevation 535 feet at which point a 30 foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to elevation 539 feet. The top of the placement site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which would include treatments of tree container size, protection, and elevation. Tree container sizes would include #3, #5, and #15 RPM containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 539 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 539 feet) would be planted for this measure. Also, to increase ground cover post-construction approximately 3 acres of an understory seed mix would be included (El. 533-539 feet).

9. T9- Garner Closure Structure involves the construction of a rock closure structure near the upstream end of Garner Chute between Garner Island and Huron Island. The structure would be constructed of riprap and built to elevation 532 feet. The top width (upstream to downstream) would be 15 feet. Upstream slopes would be 2H: 1V, and downstream slopes at 3H:1V. Garner Chute currently has adequate depths to support year-round fish habitat, but the average flow (>3 cm/sec) is too high to support centrarchid overwintering habitat. Construction of the closure structure would reduce water velocities and provide optimal overwintering habitat.

10. I1 – Huron Chute Diversity Island Bank Stabilization involves protection in the form of riprap along the head end of both the upstream and downstream islands. This measure is included to reduce active erosion and potentially allow the islands to expand on the downstream end over time. Riprap would be placed along 300 feet of bankline at both the upper and lower islands at a 2H:1V slope at a 24 inch thickness on 12 inches of bedding stone, with a 6 foot weighted toe. Riprap would consist of IADOT (Class A) or ILDOT (RR-5) size stone. Bedding sizes would be IADOT (No. 3) or IL DOT (RR-1).

11. F5-Forest Diversity in Non-Diverse Forest Location Using Existing Soil (537 Top) involves constructing a ridge and swale habitat that extends just over 1,000 feet. This feature was further modified throughout the planning process to include both excavated material and exiting soil to reduce costs and decrease disturbance of potential Indian bat habitat. The ridge and swale would be constructed with three tiers at 2 elevations, with the highest tier being in the middle at elevation 537 (with a width of 80 feet), and the lower two tiers on either end at elevation 535 feet (each one with a width of 50 feet). Native floodplain vegetation including trees, scrub/shrub wetland plants, and an understory seed mix would be incorporated in the design. In order of increasing elevation, seasonally inundated scrub/shrub plants (slope between El. 533-535 feet), temporarily inundated scrub/shrub plants (tiers at El. 535 & 537 feet), and temporarily inundated wetland trees (tiers at El. 535 & 537 feet) would be planted for this measure. Also, to increase ground cover post-construction approximately 7.0 acres of an understory seed mix would be included (El. 533-537 feet). This feature was further modified throughout the planning process to include both excavated and exiting soil to reduce costs and decrease disturbance of potential Indian bat habitat.

12. F6-Forest Diversity in Non-Diverse Forest Location Using Existing Soil (539 Top) involves constructing a ridge and swale habitat that extends just over 1,000 feet. This feature was further modified throughout the planning process to include both excavated material and exiting soil to reduce costs and decrease disturbance of potential Indian bat habitat. The ridge and swale would be constructed with three tiers at 2 elevations, with the highest tier being in the middle at elevation 539 (with a width of 80 feet), and the lower two tiers on either end at elevation 535 feet (each one with a width of 50 feet). Native floodplain vegetation including trees, scrub/shrub wetland plants, and an understory seed mix would be incorporated in the design. In order of increasing elevation, seasonally inundated scrub/shrub plants (slope between El. 533-535 feet), temporarily inundated scrub/shrub plants (tiers at El. 535 & 539 feet), and temporarily inundated wetland trees (tiers at El. 535 & 539 feet) would be planted for this measure. Also, to increase ground cover post-construction approximately 7.0 acres of an understory seed mix would be included (El. 533-539 feet).

B. Habitat Benefit Evaluation

A habitat benefit evaluation was conducted to evaluate environmental benefits of alternative plans for aquatic and floodplain habitat improvements. The evaluation was conducted by a multi-agency team which included representatives from the USFWS, IA DNR, 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 Topographic Diversity Index (TDI).

1. 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 life of the Project (50-years). HU's are calculated for select target years and annualized (using the Institute for Water Resources (IWR) Planning Suite II tool annualizer) over the life of the Project to derive net Average Annual Habitat Units (AAHUs). Net AAHUs are used as the output measurement to compare the features and alternatives for the proposed project.

The HEP procedures were used to evaluate the effects of the proposed Project features on aquatic habitat quantity and quality. The largemouth bass (Approved for Use per EC 1105-2-412) and bluegill (Approved for Regional Use per EC 1105-2-412) HSI models were used to assess backwater aquatic habitat; whereas, the channel catfish and walleye HSI models (Approved for Use per EC 1105-2-412) were used to assess the riverine components. Assessment of existing Project Area conditions, projected future conditions without the Project, and expected impacts of proposed Project features was completed. A detailed description of the habitat analysis is provided in Appendix D.

2. Topographic Diversity Index. The TDI (Single-Use Approval per EC 1105-2-412) was developed to estimate the relative area (acres) of Huron Island HREP Project within specific flood zones. The acreage in each flood zone is compared among several reference conditions to assess physical changes affecting plant communities. It is an integrated GIS mapping and hydrologic analysis that incorporates input from digital elevation maps and river stage frequency analyses to estimate areas that occurs within specific flood zones.

The theory behind the TDI is firmly entrenched in plant community ecology; plants are adapted to specific moisture tolerance. Many plant species drown when inundated, whereas some tree species have adaptations that allow them to move oxygen and carbon dioxide in and out thorough pores above the flood stage water line. The quantity metric is acres within specific flood zones that are relevant to the survival and distribution of trees. A quality factor is applied to the quantity within each flood zone to provide the overall habitat suitability related to the survival, growth, and regeneration of hard mast trees in the floodplain.

The TDI was used to evaluate the effects of the proposed Project features on floodplain habitat quantity and quality. Assessment of the reference (pre-lock and dam construction) condition, existing Project Area condition, projected future without Project condition, and expected impacts of proposed Project features was completed. A detailed description of the habitat analysis is provided in Appendix D, *Habitat Evaluation and Quantification*.

C. Formulation of Project Alternatives

Potential management measures were combined into alternatives using the IWR Planning Suite II tool. IWR Planning Suite II tool was developed to aide environmental and ecosystem restoration planning studies perform cost-effectiveness and incremental cost analyses (CE/ICA) on alternatives. CE output determines which alternatives are the least costly for a given level of environmental output. ICA evaluates the efficiency of the cost-effective alternatives, to determine which provide the greatest increase in output for the least increase in cost.

Primary assumptions and constraints used to conduct the Huron Island CE/ICA are as follows:

1. AAHUs for all analyzed habitats were assumed to have equal value in comparing alternative plans.

2. The features Forest Diversity Adjacent to Pools (F1-F4) were assumed to be dependent on their corresponding features T1-T4 (Goose Lake Pools Bathymetric Diversity) since an increased topographic diversity measure is necessary to implement the forest diversity measure.

3. The cost to stabilize the Huron Island bank would be the same for any combination of the T1 through T4 measures. In order to appropriately reflect the cost of the bank stabilization for all T1 through T4 measures it was added as a separate measure, E1. Then, measures T1 through T4 were given a dependency relationship to the bank stabilization, E1 measure. This ensured that any

combination of alternatives that include measures T1 through T4 contain the cost of the bank stabilization without double counting it.

4. Measures T1 and T2 are mutually exclusive of each other.
5. Measures T3 and T4 are mutually exclusive of each other.
6. Measures F5 and F6 are mutually exclusive of each other.

Changes to symbols were necessary to use the IWR Planning Suite II tool. See Appendix D, *Habitat Evaluation and Quantification*, for further information. A total of 300 Project alternatives were developed from all possible combinations. See table D-18 in Appendix D.

D. Cost Estimate for Measures

Table 8 shows an estimated cost of the Project measures. A more detailed breakdown of costs is outlined in Section VIII, *Cost Estimates.* Cost estimates were prepared using October 2012 price levels. Annualized costs include construction costs, planning, engineering and design (PED) costs, construction management costs and OMRR&R costs. Project features are on Federal lands, consequently, there are no lands and damages or relocation costs. Total Project costs were annualized based on the Fiscal Year 2013 discount rate of 3.75 percent and a 50-year project life.

Table 8. Environmental Output and Costs of Each Feature
(October 2012 Price Level – 50 year period of analysis using 3.75 discount rate)

Feature	Symbol	Output[1]	Annualized Cost in $[2]	Annualized O&M	Total Annualized Cost
Goose Lake Pools Bathymetric Diversity					
No Action	T0	0	0	0	0
Excavate material to create elevation 537 in Pool 1	T1	23.6	$70,568	$198	$70,766
Excavate material to create elevation 539 in Pool 1	T2	23.6	$84,966	$198	$85,164
Excavate material to create elevation 537 in Pool 2	T3	20.9	$74,020	$198	$74,218
Excavate material to create elevation 539 in Pool 2	T4	20.9	$74,293	$198	$74,491
Bank Stabilization of Huron Island[4]			$49,710	$6,015	$55,725
Closure Structure					
No Action	T0	0	0	0	0
Garner Chute Closure Structure	T9	14.0	$28,503	$300	$28,803
Floodplain Forest Diversity					
No Action	F0	0	0	0	0
Forest Diversity Adjacent to Pool 1 (537 Top)	F1	22.2	$17,405	$257	$17,662
Forest Diversity Adjacent to Pool 1 (539 Top)	F2	22.8	$24,038	$257	$24,295
Forest Diversity Adjacent to Pool 2 (537 Top)	F3	17.7	$10,830	$304	$11,134
Forest Diversity Adjacent to Pool 2 (539 Top)	F4	18.2	$14,942	$304	$15,246
Forest Diversity in Non-Diverse Forest Location (537)	F5	12.2	$69,521	$415	$69,936
Forest Diversity in Non-Diverse Forest Location (539)	F6	13.1	$94,002	$415	$94,417
Huron Chute Diversity Island Bank Stabilization					
No Action	I0	0	0	0	0

Feature	Symbol	Output[1]	Annualized Cost in $[2]	Annualized O&M	Total Annualized Cost
Bank Stabilization	I1	2.9	$20,478	$3,211	$23,689

[1] Outputs are calculated as net Average Annual Habitat Units (AAHUs).
[2] Annualized cost includes construction, PED, CM, and contingency
[3] Bank stabilization is not a separate measure but is a an item included for any or all T1-T4 measures

The IWR planning suite II tool was rerun after the inclusion of adaptive management costs were added to all 300 possible alternatives (table D-20), no additional assumptions or constraints were necessary. There were 40 cost effective alternatives (table 9 and figure 9) and 8 best buy plans (table 10 and figure 10), including the No Action Plan.

Table 9. Cost Effective Alternatives

Total and Average Cost 8/21/2013

Cost Effective Plan Alternatives **Planning Set:** CEICA Analysis 12

	Counter	Name	AAHUs (Output)	Costs (Cost)	Average Cost
1	1	No Action Plan	0.00	0.00	
	2	I1	2.90	28,157.00	9,709.31
2	3	T9	14.10	33,311.00	2,362.48
	4	T9I1	17.00	53,587.00	3,152.18
	5	F5T9	27.60	97,963.00	3,549.38
	6	F5T9I1	30.50	118,239.00	3,876.69
	7	F6T9I1	31.40	138,640.00	4,415.29
	8	T3F3	39.30	142,206.00	3,618.47
	9	T1F1	46.10	144,761.00	3,140.15
	10	T2F2	46.70	162,287.00	3,475.10
	11	T1F1I1	49.00	165,036.00	3,368.08
	12	T3F3T9	53.40	167,635.00	3,139.23
	13	T1F1T9	60.20	170,190.00	2,827.08
	14	T2F2T9	60.80	187,717.00	3,087.45
	15	T1F1T9I1	63.10	190,466.00	3,018.48
	16	T1T4F4	63.40	204,864.00	3,231.29
	17	T1T3F1	67.00	206,642.00	3,084.21
	18	T1T3F1F3	85.10	215,971.00	2,537.85
	19	T1T4F1F4	85.60	219,625.00	2,565.71
	20	T2T3F2F3	85.70	233,498.00	2,724.60
	21	T1T3F1F3I1	88.00	236,247.00	2,684.63
	22	T1T4F1F4I1	88.50	239,901.00	2,710.75
3	23	T1T3F1F3T9	99.20	241,401.00	2,433.48
	24	T1T4F1F4T9	99.70	245,055.00	2,457.92
	25	T2T3F2F3T9	99.80	258,927.00	2,594.46
	26	T1T3F1F3T9I1	102.10	261,677.00	2,562.95
	27	T1T4F1F4T9I1	102.60	265,331.00	2,586.07
	28	T2T3F2F3T9I1	102.70	279,203.00	2,718.63
	29	T2T4F2F4T9I1	103.20	282,857.00	2,740.86
4	30	T1T3F1F3F5T9	112.70	299,750.00	2,659.72
	31	T1T4F1F4F5T9	113.20	303,404.00	2,680.25
	32	T2T3F2F3F5T9	113.30	317,276.00	2,800.32
5	33	T1T3F1F3F5T9I1	115.60	320,026.00	2,768.39
6	34	T1T4F1F4F5T9I1	116.10	323,680.00	2,787.94
	35	T2T3F2F3F5T9I1	116.20	337,552.00	2,904.92
	36	T1T3F1F3F6T9I1	116.50	340,427.00	2,922.12
	37	T2T4F2F4F5T9I1	116.70	341,206.00	2,923.79
7	38	T1T4F1F4F6T9I1	117.00	344,081.00	2,940.86
	39	T2T3F2F3F6T9I1	117.10	357,953.00	3,056.81
8	40	T2T4F2F4F6T9I1	117.60	361,607.00	3,074.89

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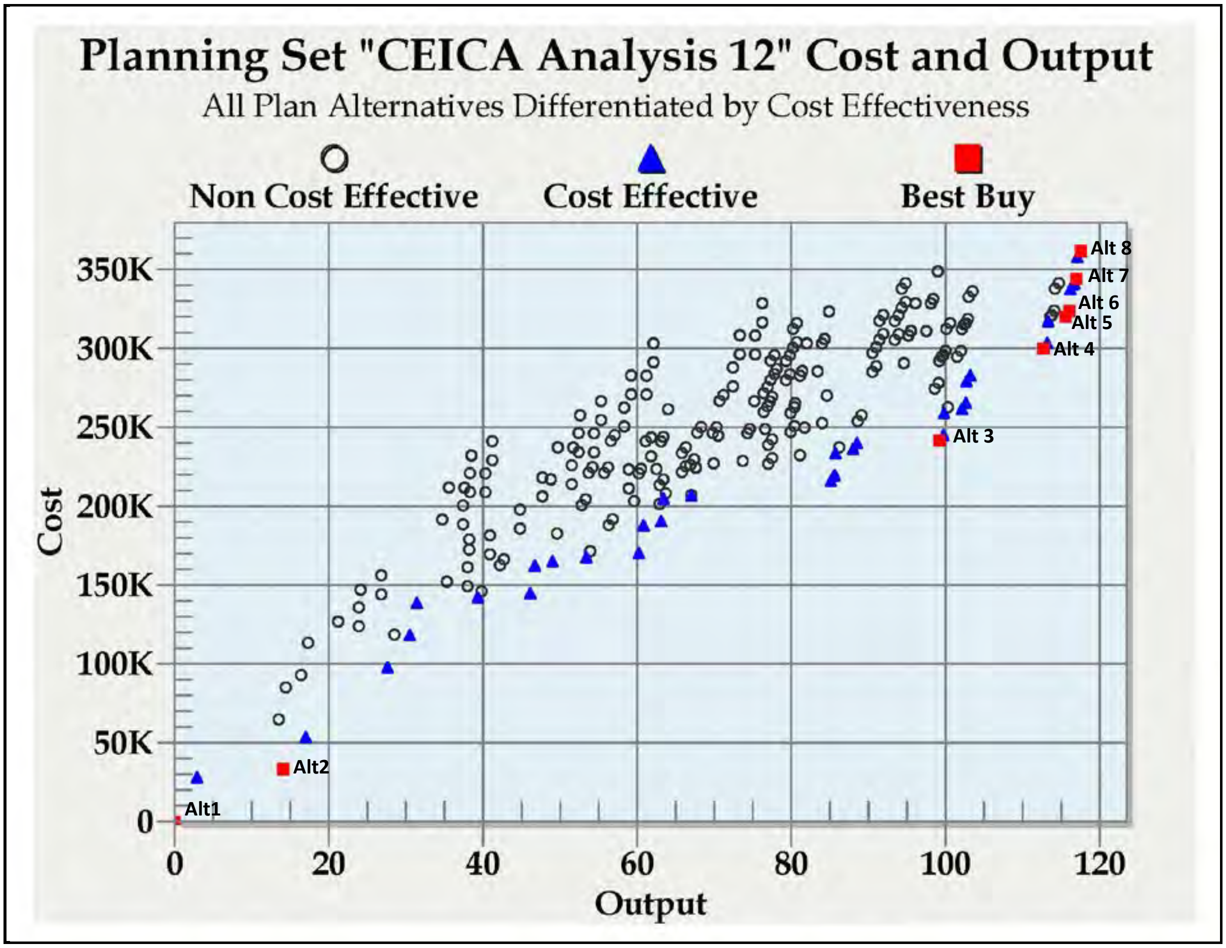

Figure 9. Cost Effectiveness of Alternatives

Table 10. "Best Buy" Combinations

Alt.#	Description	Plan	Annualized Cost ($)	Outputs (AAHU)	Average Cost ($/AAHU)	Incremental Output (AAHU)	Incremental Cost ($)	Incremental Cost/Output ($/AAHU)	First Project Costs
1	No Action Plan	No Action	0	0	0	0	0	0	0
2	Garner Closure Structure	T9	$33,311	14.1	$2,362	14.1	$33,331	$2,362	$740,575
3	Bathymetric Diversity Pool 1 (537) Bathymetric Diversity Pool 2 (537) Forest Pool 1 (537) Forest Pool 2 (537) Garner Closure Structure	T1 T3 F1 F3 T9	$241,401	99.2	$2,433	85.1	$208,090	$2,445	$5,252,555
4	Bathymetric Diversity Pool 1 (537) Bathymetric Diversity Pool 2 (537) Forest Pool 1 (537) Forest Pool 2 (537) Garner Closure Structure Forested Pad in non diverse forested area (537)	T1 T3 F1 F3 T9 F5	$299,750	112.70	$2,660	13.5	$58,349	$4,322	$6,552,275
5	Bathymetric Diversity Pool 1 (537) Bathymetric Diversity Pool 2 (537) Forest Pool 1 (537) Forest Pool 2 (537) Garner Closure Structure Forested Pad in non diverse forested area (537) Islands	T1 T3 F1 F3 T9 F5 I1	$320,026	115.6	$2,768	2.9	$20,276	$6,992	$6,935,115
6	Bathymetric Diversity Pool 1 (537) Bathymetric Diversity Pool 2 (539) Forest Pool 1 (537) Forest Pool 2 (539) Garner Closure Structure Forested Pad in non diverse forested area (537) Islands	T1 T4 F1 F4 T9 F5 I1	$323,680	116.1	$2,788	.5	$3,654	$7,308	$7,017,092
7	Bathymetric Diversity Pool 1 (537) Bathymetric Diversity Pool 2 (539) Forest Pool 1 (537) Forest Pool 2 (539) Garner Closure Structure Forested Pad in non diverse forested area (537) Islands	T1 T4 F1 F4 T9 F6 I1	$344,081	117.0	$2,941	.9	$20,401	$22,668	$7,474,782
8	Bathymetric Diversity Pool 1 (539) Bathymetric Diversity Pool 2 (539) Forest Pool 1 (539) Forest Pool 2 (539) Garner Closure Structure Forested Pad in non diverse forested area (539) Islands	T2 T4 F2 F4 T9 F6 I1	$361,607	117.6	$3,075	.6	$17,526	$29,210	$7,867,976

[1] Costs were prepared using October 2012 price levels and are based on a 50-year project life, 3.75 percent interest rate
[2] Annualized costs include O&M costs

E. Selection of the Recommended Plan

The team reviewed all eight best buy plans (table 10 and figure 10) and determined that the cost to implement the first iteration of best buy plans above the no action plan, Alternative 2, was worth the incremental investment above the no action plan since it provides an acceptable level of restoration for an acceptable cost. It provides 14.1 habitat units over the no action plan at an incremental cost per unit of output of $2,362. This alternative consists of the Garner chute closure structure (T9) which would decrease flows and provide optimal overwintering habitat.

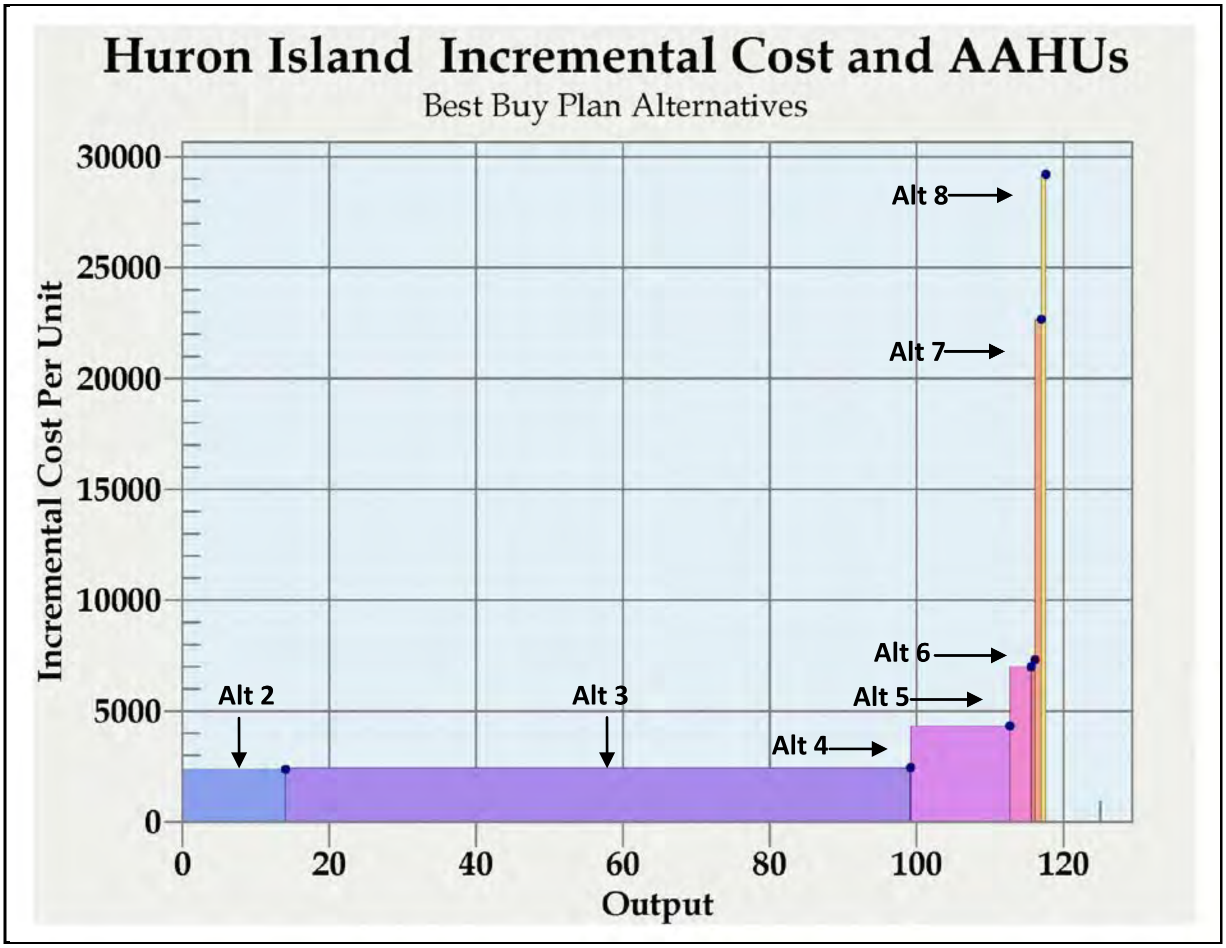

Figure 10. Huron Island “Best Buy” Plans

The PDT determined that the next plan, Alternative 3, T1T3F1F3T9 was also worth the incremental investment. This alternative includes the Garner chute closure structure, restoration of bathymetric diversity as well as aquatic vegetation planted transitionally in two Huron Island backwaters, Goose Lake Pool 1 and Pool 2, restoration of topographic diversity to elevation 537 adjacent to the two backwater areas, and plantings of forested wetland scrub/shrub and tree species. Its incremental investment of 85.1 units at an incremental cost of $2,445 is considered worth it because it helps optimize the net average annual habitat units while only minimally increasing the incremental cost.

Alternative 4, the next incremental plan, T1T3F1F3T9F5 differs from the above alternative by the inclusion of a forested pad to elevation 537 using excavated material from the back water areas and existing soil, in a monotypical forested area adjacent to Goose Lake backwaters. While the incremental cost per AAHHU is significantly more, the overall average cost per AAHU is only increased by approximately $227.00. This incremental investment of 13.5 net average annual habitat units per incremental cost of $4,322 is worth the investment since there is concern about the lack of species diversity and forest regeneration due to the increased water inundation and duration seen at Huron Island. Even the existing extensive stands of even-aged mature silver maple are a concern because their inevitable mortality (old age or flood induced) creating openings in the canopy.

Incremental best buy plan Alternative 5, T1T3F1F3 F5T9I1, includes erosion protection; in the form of riprap, at the head of two small islands in Huron Chute. This incremental investment of 2.9 net average annual habitat units per incremental cost of $6,991 is worth the investment since protection of island habitat in the UMRS is critical to the overall structure and function of the aquatic community. Not only do islands function to facilitate hydrogeomorphic processes (i.e., sediment transport, flow diversity), islands also serve a critical role in providing unique and diverse habitat. Shallow sandbar habitat at the tail-end of islands serve as critical spawning, rearing, foraging, and loafing habitat for a wide variety of fish (e.g., sturgeon, darter, sucker species), migratory bird species (e.g., waterfowl, shorebirds), and benthic invertebrates. Islands create unique macrohabitat through flow gradients (e.g., eddies, flow deflection, feeding lanes) important for fish and waterfowl. As mentioned earlier, researchers have hypothesized islands function similarly to riffle-pool complexes in smaller streams. Thus, providing the structure and processes to support fish assemblages not found within other aquatic habitat cover types. The addition of this measure has the potential to meet project objective *to maintain side channel riverine hydrodynamic, sediment transport and geomorphic processes in Huron Chute*. Alternative 5 is within the planning constraints, it is at the most upper limit without exceeding floodplain impacts.

The next best buy increment, Alternative 6, T1T4F1F4 F5T9I1, differs from Alternative Five, by increasing the topographic elevation at Goose Lake Pool 2 from elevation 537 to elevation 539 as well as increasing the area of bathymetric diversity in Goose Lake Pool 2. The team determined that although there would be additional benefits, Alternative 6 would not be considered further since it surpasses the planning constraints and exceeds floodplain impacts.

Alternative 7, T1T4F1F4T9F5I1, differs from Alternative Six, by increasing the elevation of the forested pad in a non-diverse forested area from elevation 537 to 539. The team determined that although there would be additional benefits, the extra incremental investment of .9 net average annual habitat units per incremental cost of $22,668 was not worth the cost of investment. Alternative 7 surpasses the planning constraints and exceeds floodplain impacts.

The greatest best buy plan, Alternative 8, T2T4F2F4 F6T9I1, differs from Alternative, by increasing the topographic elevation at Goose Lake Pool 1 from elevation 537 to elevation 539 and increasing the area of bathymetric diversity in Goose Lake Pool 1. The team determined that although there would be additional benefits, the extra incremental investment of .6 net average annual habitat units per incremental cost of $29,210 was not worth the cost of investment. Alternative 8 surpasses the planning constraints and exceeds floodplain impacts.

Further evaluation of the final array of alternatives (1-5) that the PDT and stakeholders determined were worth the cost of investment occurred to aide in the selection of the Recommended Plan. Alternatives 6, 7 and 8 were not acceptable alternatives since they exceed floodplain impacts and surpass the Projects planning constraints. Federal planning for water resources development was conducted in accordance with the requirements of P&G.

> *"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 U.S. Water Resources Council (completeness, effectiveness, efficiency, and acceptability, defined below) was 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.

Based on table 11, all of the alternatives listed are complete, acceptable and efficient. However, Alternative Five, T1T3F1F3F5T9I1, showed to be more effective than the other four alternatives since it addresses all four of the Project's objectives. Therefore the PDT and stakeholders concluded that Alternative Five is the Recommended Plan and the NER plan since it reasonably maximizes ecosystem restoration benefits at an acceptable incremental cost.

Table 11. Comparison of Alternatives

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Plan Description	No Action	T9	T1T3F1F3T9	T1T3F1F3T9F5	T1T3F1F3T9F5I1
Completeness	There are no actions for this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.
Acceptability	This alternative is ***ACCEPTABLE*** to Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.
Effectiveness	This plan ***DOES NOT*** address any project objectives.	This plan ***DOES NOT*** address all project objectives. This plan addresses objectives 1, 2, and 3.	This plan ***DOES NOT*** address all project objectives. This plan addresses objectives 1, 2, and 3.	This plan ***DOES NOT*** address all project objectives. This plan addresses objectives 1, 2, and 3.	This plan ***DOES*** address all four project objectives.
Efficiency	***No*** net benefits are realized.	This plan ***IS*** cost effective.	This plan ***IS*** cost effective.	This plan ***IS*** cost effective.	This plan ***IS*** cost effective.

The Recommended Plan includes the following components:

- Excavating Goose Lake Pool 1and Pool 2 to restore bathymetric diversity
- Shaping of excavated placement material to increase topographic diversity to elevation 537feet
- Planting of submerged, emergent, wetland, and floodplain forest species
- Increase of topographic diversity in non-diverse forest area to elevation 537 feet using existing soil and excavated placement material
- Placement of rock closure structure in Garner Chute between Garner and Huron Island
- Placement of riprap at the head of two small islands located in Huron Chute

The Recommended Plan is important to Huron Island and surrounding ecosystem. The project is unique in that the components are interconnected to restore, not just certain habitat types, but the natural system processes at Huron Island. The current structure is one of relatively homogenous elevation absent of mast tree production, aquatic vegetation, and deep water fish habitat. The Project no longer functions as a mosaic of interconnected habitat types and no longer offers the habitat diversity which was once prominent. The purpose of the Huron Island Project is to restore the missing distinguishing features which collaboratively restore the transitional gradient of habitats characteristic of lacustrine and riverine systems.

The locations and designs of the Recommended Plan serve to restore the missing habitat structure needed for a fully functioning wetland system. Beginning at the lowest elevation (permanently inundated wetland) deep water habitat will be restored for critical overwintering fish habitat. Adjacent to this are shallow water permanently inundated to intermittently exposed flats where restoration of aquatic vegetation (i.e. submerged and floating-leaved to emergent) will provide immediate access to spawning, foraging, and nursery habitat for fish and waterfowl. As the elevation increases on the placement site, the habitat transitions from semi permanently inundated to seasonally inundated emergent and scrub-shrub wetland. Finally, temporarily inundated forested wetland with mast trees is incorporated.

The transitional structure between one habitat type to another functions to provide overall habitat is broken at Huron Island. The habitat gap in the Huron Island system has had an effect on everything from overwintering fish to mast tree production. The restoration of the missing distinguishing characteristics provides overarching habitat at the ecosystem level benefitting fish, migratory birds, and everything in between.

F. Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made with some knowledge of the degree of reliability of the estimated benefits and costs of alternative plans. Risk is defined as the probability or likelihood for an outcome. Uncertainty refers to a lack of knowledge. Uncertainty concern the likelihood for an outcome results from a lack of knowledge about critical elements or processes contributing 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 the EMP HREPs and the EMP 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 habitats. Significant risk would be avoided by proper design, appropriate selection, and correct seasonal timing of applications. Unforeseen temporary perturbations during habitat establishment would be addressed by making allowances for replanting during the biotic establishment period. The dynamic and complex nature of riverine environmental processes is a principal source of uncertainty. Post-construction monitoring and adaptive management plans would be used to address unplanned outcomes in all Recommended Plan components.

Success of persistent aquatic vegetation was identified as being the measure with the highest degree of uncertainty. To optimize plant survival the team determined that planting on a gentle slope would minimize water level fluctuation concerns. The team felt that consulting with aquatic plant specialists at ERDC to create an aquatic vegetation design would also increase the potential for success. The adaptive management plan for aquatic vegetation includes monitoring, analysis, replacement of exclosures, and replanting of successful aquatic vegetation species.

Success of floodplain forest planting was identified having some level of risk and uncertainty. The team tried to mitigate this risk by determining the optimal elevation for success without requiring mitigation. The floodplain forest planting design tries to decrease the risk and uncertainty of success by planting a variety of species with varying circumference size on two different elevations. This experimental design will not only increase survivability but also lead to a better understanding of the needs of trees on the Mississippi River floodplain. Exclosures were also included to decrease risk and uncertainty due to herbivory. The adaptive management plan for the floodplain forest includes monitoring, analysis, and replacement of exclosures.

The Garner Island rock closure has the potential to decrease flows in Garner Chute. This could impact the dissolved oxygen levels and have severe negative impacts on the aquatic habitat in the Project Area. Based on current water quality data and hydrologic modeling it is unlikely to occur. Since there is uncertainty in the implementation of the Project, for the adaptive management plan the cost to introduce more flow by creating a notch in the closure structure is included.

The Garner Island rock closure has the potential to decrease flows in Goose Lake Pool 1 and Goose Lake Pool 2. This could impact the dissolved oxygen levels and have severe negative impacts on the aquatic habitat in these two pools. Based on current water quality data and hydrologic modeling it is unlikely to occur. Since there is uncertainty in the implementation of the Project, for the adaptive management plan the cost to introduce more flow into these backwaters by creating an opening to Gun Slough was included.

Several features were not evaluated further to reduce the potential to impact the floodplain. A hydraulic model determined there were no floodplain impacts due to rock placement. As a result of low risk and uncertainty for bank stabilization, no other opportunities for adaptive management have been identified at this time.

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 sea level on the UMRS includes a potential increase in sedimentation that from increased aggradation and flooding.

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

The Recommended Plan for the Huron Island Project includes increasing bathymetric diversity in Pools 1 and Pool 2 of the Goose Lake backwater area (T1 and T3), improving forest topographic diversity adjacent to Pool 1 and Pool 2 by increasing the elevation to 537 feet (F1 and F3) and planting floodplain forest species, construction of a closure structure in Garner Chute (T9), island bankline protection (I1), and increasing forest diversity in non-diverse forested areas by increasing the elevation to 537 feet (F5). The details of the Recommended Plan are described in Sections A through H and illustrated on Plate 13 (C-104).

A. Bathymetric Diversity of Goose Lake Backwater Area Pool 1 to Elevation 537 Feet (T1) (photograph 1).

Photograph 1. Goose Lake (June 2011)

This measure involves mechanically dredging material in Goose Lake Pool 1, side casting the material, and planting various aquatic species. Plates 14 (C-105); 17 (C-108); 19 (C-110); 20 (C-301); and 21 (C-302) provide information regarding the excavation associated with this measure. The quantities of the items to be constructed under this measure are included in table 13.

The pool would be excavated to a minimum depth of 520 feet MSL, which is approximately 8 feet below flat pool for a length of 2,402 feet. The bottom elevation is optimal to address sedimentation over the life of the Project, while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute.

To meet the volume of material required for Measure F1, a bottom width of 75 feet was selected. In addition to the deep excavation site, a 20 foot shelf will be excavated to a depth of 2 feet below flat pool along the bank. The shelf will be planted with submerged and emergent aquatic vegetation to increase foraging, spawning, and nursery aquatic habitat, and promote sediment stabilization. The shelf is critical to the establishment and sustainability of aquatic vegetation, and provides immediate access to critical fish habitat. Refer to Section IX, *Environmental Effects*.

The materials in Pool 1 contain material which is difficult to hydraulically excavate with sufficient efficiency. The pool has significant woody debris and mature trees overhanging portions of the proposed excavation site. Therefore, mechanical dredging is proposed in these areas. An environmental mechanical dredging project from the Lake Odessa HREP (2010) used similar mechanical dredging methods as those expected to be observed at Huron Island (photograph 2).

Photograph 2. Lake Odessa Stage IIB HREP Mechanical Dredging (2010)

The proposed placement sites are adjacent to the excavation site and consist of an upper site extending 1,002 feet and a lower site extending 1,163 feet. The area will be generally cleared of trees, although some trees will remain as outlined in Section IX. Cleared trees will be used for the Huron Island shoreline protection and others will be used for habitat to increase cover and foraging habitat for fish. The remaining cleared trees will be offered for sale to the public. Any trees not used for habitat or sold will be disposed of off-site.

Vegetation planting is scheduled at various elevations. Some of these elevations will overlap. Refer to plates 26 (L-102) and 35 (L-602). Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation (table12) will be planted transitionally from the excavation site to the base of the placement site. Plantings will incorporate a stratified planting design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation. Plant life stages include mature containerized plants, tubers (i.e., fleshy underground root of a plant bearing buds from which new plants develop), and existing seed bank. Plant life stages will be planted at densities ranging from 20 – 80 containerized plants per acre to 1000 -2000 tubers per acre. Exclosures will be installed for approximately half of the plots to protect against herbivory and destruction from common carp. Finally, the plots described will be planted along a stratified elevation gradient to discern potential differences in survival and growth as a function of water depth, light penetration, and flow.

Shallow marsh seasonally inundated emergent wetland vegetation (table 12) will be planted at slightly higher elevations on the side slope of the placement site. The planting design to be incorporated for scrub/shrub species is similar to that proposed for the submerged and emergent aquatic vegetation. Photographs 3 through 7 shows various aspects of aquatic vegetation restoration anticipated to be used at Huron Island.

Table 12. Quantities of Items To Be Constructed Under Measure T1

Topographic Diversity Quantities						
Goose Lake Backwater Pool 1			**Dredging**	**Clearing**	**Seed Mix**	
			69,900 cubic yards	13 acres	2.0 acres	
Wetland Vegetation Planting Quantities						
El.	**Habitat Type**	**Common Name**	**Scientific Name**	**# Tubers**	**Container Plants**	**Exclosure**
526-529'	Permanently Inundated Aquatic Bed - SAV	Illinois Pondweed	*Potamageton illinoisensis*	792	X	X
		Sago Pondweed	*P. pectinatus*	792	X	X
		American Wild Celery	*Vallisneria americana*	792	X	X
		Coontail	*Ceratophyllum demersum*	792	X	X
		American Elodea	*Elodea canadensis*	792	X	X
529-532'	Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed	Waterwillow	*Justicia americana*	544	X	X
		Arrowhead	*Sagitarria latifolia*	544	X	X
		Pickerelweed	*Pontederia cordata*	544	X	X
		Smartweed	*Polygonum spp.*	544	X	X
531-534'	Seasonally Inundated Emergent Wetland	Sedges	*Carex spp.*	544	X	
		Bulrush	*Scirpus spp.*	544	X	
		Blue Flag Iris	*Iris virginica*	544	X	
		Sweet Flag	*Acorus calamus*	544	X	
533-535'	Seasonally Inundated Scrub/Shrub Wetland	Hibiscus	*Hibiscus lasiocarpos*		X	
		Common Elderberry	*Sambucus canadensis*		X	
		Buttonbush	*Cephalanthus occidentalis*		X	
		Dogwood	*Cornus stolonifera*		X	
		Sandbar Willow	*Salix interior*		X	

Photograph 3. Common Arrowhead *Sagittaria latifolia* Cultures Taken From the Plant Nursery at the Lewisville Aquatic Ecosystem Research Facility (LAERF) in Lewisville, TX

Photograph 4. LAERF Staff Planting Native Aquatic Plant Species Grown at the Nursery

Photograph 5. LAERF Staff Installing Native Aquatic Plants and Protective Enclosures Within a Turbid Backwater

Photograph 6. Aquatic Plant Restoration Plot Containing Common Arrowhead, American lotus, and Pondweed spp

Photograph 7. Newly Planted Restoration Site

Note the protective enclosures and spacing of plots. Within one growing season each plot has the potential to expand its diameter to 20-feet creating a connected aquatic vegetation bed.

B. Bathymetric Diversity of Goose Lake Backwater Area Pool 2 at Elevation 537 Feet (T3)

This measure involves mechanically dredging material in Goose Lake Pool 2, side casting the material, planting various aquatic species, protecting the bank line from further erosion through a combination of stone and locked logs. The following plates provide information regarding the excavation associated with this measure; Plates 13 (C-104), 14 (C-105), 18 (C-109), 20 (C-301), 21 (C-302). The quantities of the items to be constructed under this measure are included in table 13.

Table 13. Quantities of Items To Be Constructed Under Measure T3

Topographic Diversity Quantities						
Goose Lake Backwater Pool 2			**Dredging**	**Clearing**	**Seed Mix**	
			75,000 cubic yards	10.0 acres	2.0 acres	
Wetland Vegetation Planting Quantities						
El.	**Habitat Type**	**Common Name**	**Scientific Name**	**# Tubers**	**Container Plants**	**Exclosure**
526-529'	Permanently Inundated Aquatic Bed - SAV	Illinois Pondweed	*Potamageton illinoisensis*	966	X	X
		Sago Pondweed	*P. pectinatus*	966	X	X
		American Wild Celery	*Vallisneria americana*	966	X	X
		Coontail	*Ceratophyllum demersum*	966	X	X
		American Elodea	*Elodea canadensis*	966	X	X
529-532'	Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed	Waterwillow	*Justicia americana*	664	X	X
		Arrowhead	*Sagitarria latifolia*	664	X	X
		Pickerelweed	*Pontederia cordata*	664	X	X
		Smartweed	*Polygonum spp.*	664	X	X
531-534'	Seasonally Inundated Emergent Wetland	Sedges	*Carex spp.*	664	X	
		Bulrush	*Scirpus spp.*	664	X	
		Blue Flag Iris	*Iris virginica*	664	X	
		Sweet Flag	*Acorus calamus*	664	X	
533-535'	Seasonally Inundated Scrub/Shrub Wetland	Hibiscus	*Hibiscus lasiocarpos*		X	
		Common Elderberry	*Sambucus canadensis*		X	
		Buttonbush	*Cephalanthus occidentalis*		X	
		Dogwood	*Cornus stolonifera*		X	
		Sandbar Willow	*Salix interior*		X	
Bank Protection Quantities						
Bankline Near Pool 2		**Riprap**	**Bedding**	**Locked Logs**		**Clearing**
		15,4000 tons	8,400 tons	17 logs		2 acres

The excavation site extends 2,642 feet long by 50 feet wide. The placement site extends 2,642 feet. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. Other than the different lengths and width, the remaining physical characteristics, design and construction methodology of the placement sites, aquatic and wetland vegetation plantings described for measure T1 (section A) apply to this measure. Refer to plates 26 (L-102) and 35 (L-602) for aquatic and wetland vegetation planting details.

Bank protection in the form of riprap is included along the bankline of Huron Island near Goose Lake Pool 2. Refer to plates 15 (C-106) and 23 (C-304). This measure is included to reduce active erosion and protect the investment made for the excavation sites, placement sites, and aquatic vegetation. Steep banks and a building foundation which, 75 years ago, was over 100 feet from the bank line and is now hanging over the water, indicate significant erosion. The area requiring protection is shown in photograph 8, although it was taken in high water and the erosion is not visually apparent.

Photograph 8. Huron Island Bankline Protection Area. Note building foundation. (June 2011)

Riprap would be placed along 2,415 feet of bankline at a 2H:1V slope at a 24 inch thickness on 12 inches of bedding stone, with a 6 foot weighted toe. Riprap would consist of IADOT (Class A) or ILDOT (RR-5) size stone. Bedding sizes would be IADOT (No. 3) or IL DOT (RR-1). Along the bottom third of the bank protection, approximately 17 locked logs (from tree clearing) will be added to the stone protection to allow for flow to be diverted from the bank line and to provide for additional aquatic habitat. Photographs 9 and 10 were taken during the construction of a locked log project at the Missouri River, overseen by David Derrick of ERDC in 2007. The photograph is looking upstream and shows placing stone over the locked log trunk.

Photograph 9. Missouri River Locked Log Construction (2007)

Photograph 10. Missouri River Locked Log Final Placement (2007)

C. Forest Diversity Adjacent To Pools 1 to Elevation 537 Feet (F1)

This measure includes shaping the excavated material placement site associated with measure T1 to a tier and flat slope configuration which will be planted with various wetland and floodplain species. The following plates provide information regarding this measure: Plates 13 (C-104), 14 (C-105), 20 C-301), 21 (C-302), 26 (L-102), 27 (L-103), 28 (L-104), 30 (L-301), 31 (L-302), 32 (L-303), 33 (L-501), and 34 (L-601). Typical forest diversity site is shown in photograph 11.

Photograph 11. Typical Site for Forest Diversity

Material excavated for Measure T1 will have been casted aside on dry land. There will be a period of time where the material will be left alone to allow the dewatering process to take place in order to be used and reshaped later into the designed structures. Silt fences will be incorporated to the Project in order to block fines sediments from flowing away with the excess water.

The 2,165 feet long excavated material placement site contained in Measure T1 would be shaped as follows: The placement site will slope up from the shallow shelf excavation site at a 8H:1V slope to elevation 535 feet at which point a 30 foot wide tier will be constructed. An elevation of 535 was chosen using the with an exceedance probability of 50 percent. This is also the minimum elevation shown to support mast producing tree sustainability (DeJager et al. 2012). The placement site will continue to slope upward at a 3H:1V slope to elevation 537 feet. The top of the placement site will be 30 feet wide before sloping back down at a 3H:1V slope to match existing ground.

Photograph 12 from the 2009 Lake Odessa HREP shows mechanically sidecast material immediately following placement (similar to what will be expected prior to the placement site shaping at Huron).

Photograph 12. Mechanically Sidecast Placement Site at Lake Odessa HREP (2009)

The proposed placement site at Huron Island will have a greater width (about 150 feet from water edge) than that shown in this photograph (about 100 feet was allowed). This material was placed with a floating excavator called "The Duck" (photograph 13).

Photograph 13. "The Duck" Mechanical Floating Excavator

Native temporarily inundated forested wetland trees and scrub/shrub species will be planted on each of the tiers. Plantings will incorporate a stratified random planting design of three 0.5-acre plots which will include treatments of tree container size, protection, and elevation. Tree container sizes will include #3, #5, and #15 RPM containers. Exclosures will be installed to protect against herbivory. The various tree sizes described will be planted equally at each of the 535 foot and 537 foot tier elevations to discern potential species specific differences in survival, growth, and regeneration capabilities as a function of water inundation duration. Photograph 14 shows RPM planting similar to what would be expected at Huron Island.

Photograph 14. Rock Island District RPM Tree Planting at Lake Odessa (2012)

In order of increasing elevation, seasonally inundated scrub/shrub wetland species, temporarily inundated forested wetland scrub/shrub species, and temporarily inundated forested wetland trees will be planted for this measure. Also, to provide ground cover post-construction the site will be planted with an understory seed mix on the two tiers. An image of buttonbush (forested wetland scrub/shrub species) adjacent to a temporarily inundated forested wetland located several miles upstream of Huron Island is shown in photograph 15.

Photograph 15. Scrub/Shrub Wetland Between Waters Edge and Floodplain Forest (2009)

D. Forest Diversity Adjacent To Pools 2 to Elevation 537 Feet (F3)

This measure includes shaping the excavated material placement site associated with measure T3 to a tier and flat slope configuration which will be planted with various wetland and floodplain species. The following plates provide information regarding this measure: 13 (C-104), 14 (C-105), 20 (C-301), 21 (C-302), 26 (L-102), 27 (L-103), 28 (L-104), 30 (L-301), 31 (L-302), 32 (L-303), 33 (L-501), and 34 (L-601).

The 2,642 feet long excavated material placement site contained in Measure T3 would be shaped as indicated in Measure F1, table 4. Plantings will also follow the methods outlined in Measure F1.

Quantities of items to be constructed under Measure F3 are shown in table 15.

Table 14. Quantities of Items To Be Constructed Under Measure F1

Wetland Vegetation Planting Quantities						
El.	**Habitat Type**	**Common Name**	**Scientific Name**	**#3 RPM**	**#5 RPM**	**#15 RPM**
533-535'	Seasonally Inundated Scrub/Shrub Wetland	Hibiscus	*Hibiscus lasiocarpos*	10.0	1.0 acres seed mix at 10 lbs/acre	
		Common Elderberry	*Sambucus canadensis*	10.0		
		Buttonbush	*Cephalanthus occidentalis*	10.0		
		Dogwood	*Cornus stolonifera*	10.0		
		Sandbar Willow	*Salix interior*	10.0		
535-537"	Temporarily Inundated Forested Wetland Scrub/Shrub	Buttonbush	*Cephalanthus occidentalis*	30.0		
		Eastern Redbud	*Cercis canadensis*	30.0		
		Red-Osier Dogwood	*Cornus stolonifera*	30.0		
		Green Hawthorn	*Crataegus viridis*	30.0		
		Elderberry	*Sambucus canadensis*	30.0		
535-537'	Temporarily Inundated Forested Wetland	River Birch	*Betula nigra*	8.0	4.0	2.0
		Bitternut Hickory	*Carya cordiformis*	8.0	4.0	2.0
		Northern Pecan	*Carya illinoinensis*	8.0	4.0	2.0
		Shellbark Hickory	*Carya laciniosa*	8.0	4.0	2.0
		Common Hackberry	*Celtis occidentalis*	8.0	4.0	2.0
		Common Persimmon	*Diospyros virginiana*	8.0	4.0	2.0
		Honey Locust	*Gleditsia triacanthos*	8.0	4.0	2.0
		Kentucky Coffeetree	*Gymnocladus dioicus*	8.0	4.0	2.0
		Black Walnut	*Juglans nigra*	8.0	4.0	2.0
		American Sycamore	*Platanus occidentalis*	8.0	4.0	2.0
		Swamp White Oak	*Quercus bicolor*	8.0	4.0	2.0
		Bur Oak	*Quercus macrocarpa*	8.0	4.0	2.0
		Pin Oak	*Quercus palustris*	8.0	4.0	2.0
		American Basswood	*Tilia americana*	8.0	4.0	2.0
		Overcup Oak	*Quercus lyrata*	8.0	4.0	2.0
Understory Seed Mix		Virginia Wild Rye	*Elymus virginicus*	3.0 acres at a rate of 10.0 lbs/acre		
		Canada Wild Rye	*Elymus canadensis*			
		Partridge Pea	*Chamaechrista fasciculata*			
		Buttonbush	*Cephalanthus occidentalis*			
		Rice Cut Grass	*Leersia oryzoides*			
		Cardinal Flower	*Lobelia cardinalis*			
		Sneezeweed	*Helenium autumnale*			
Shape Excavation site to Desired Slope and Elevations.				**1.0 LS**		
Tree Wraps.				**210**		
Tree Exclosures.				**210**		
Herbicide Treatment.				**3.0 acres**		

Table 15. Quantities of Items To Be Constructed Under Measure F3

Wetland Vegetation Planting Quantities						
El.	**Habitat Type**	**Common Name**	**Scientific Name**	**#3 RPM**	**#5 RPM**	**#15 RPM**
533-535'	Seasonally Inundated Scrub/Shrub Wetland	Hibiscus	*Hibiscus lasiocarpos*	12.0	2.0 acres seed mix at 10 lbs/acre	
		Common Elderberry	*Sambucus canadensis*	12.0		
		Buttonbush	*Cephalanthus occidentalis*	12.0		
		Dogwood	*Cornus stolonifera*	12.0		
		Sandbar Willow	*Salix interior*	12.0		
535-537"	Temporarily Inundated Forested Wetland Scrub/Shrub	Buttonbush	*Cephalanthus occidentalis*	40.0		
		Eastern Redbud	*Cercis canadensis*	40.0		
		Red-Osier Dogwood	*Cornus stolonifera*	40.0		
		Green Hawthorn	*Crataegus viridis*	40.0		
		Elderberry	*Sambucus canadensis*	40.0		
535-537'	Temporarily Inundated Forested Wetland	River Birch	*Betula nigra*	10.0	5.0	2.0
		Bitternut Hickory	*Carya cordiformis*	10.0	5.0	2.0
		Northern Pecan	*Carya illinoinensis*	10.0	5.0	2.0
		Shellbark Hickory	*Carya laciniosa*	10.0	5.0	2.0
		Common Hackberry	*Celtis occidentalis*	10.0	5.0	2.0
		Common Persimmon	*Diospyros virginiana*	10.0	5.0	2.0
		Honey Locust	*Gleditsia triacanthos*	10.0	5.0	2.0
		Kentucky Coffeetree	*Gymnocladus dioicus*	10.0	5.0	2.0
		Black Walnut	*Juglans nigra*	10.0	5.0	2.0
		American Sycamore	*Platanus occidentalis*	10.0	5.0	2.0
		Swamp White Oak	*Quercus bicolor*	10.0	5.0	2.0
		Bur Oak	*Quercus macrocarpa*	10.0	5.0	2.0
		Pin Oak	*Quercus palustris*	10.0	5.0	2.0
		American Basswood	*Tilia americana*	10.0	5.0	2.0
		Overcup Oak	*Quercus lyrata*	10.0	5.0	2.0
Understory Seed Mix		Virginia Wild Rye	*Elymus virginicus*	4.0 acres at a rate of 10.0 lbs/acre		
		Canada Wild Rye	*Elymus canadensis*			
		Partridge Pea	*Chamaechrista fasciculata*			
		Buttonbush	*Cephalanthus occidentalis*			
		Rice Cut Grass	*Leersia oryzoides*			
		Cardinal Flower	*Lobelia cardinalis*			
		Sneezeweed	*Helenium autumnale*			
			Shape Excavation site to Desired Slope and Elevations.	**1.0 LS**		
			Tree Wraps.	**255**		
			Tree Exclosures.	**255**		
			Herbicide Treatment.	**4.0 acres**		

E. Garner Chute Closure Structure (T9)

This measure includes the construction of a rock closure structure near the upstream end of Garner Chute between Garner Island and Huron Island. The structure would be constructed of riprap and built to EL 532 feet. The top width (upstream to downstream) would be 15 feet. Upstream slopes would be 2H:1V, and downstream slopes at 3H:1V. This measure is shown on Plates 16 (C-107) and 23 (C-305). An emergent closure structure constructed at the Gardner Division HREP (2001) is similar in the proposed design to the Huron Island HREP, although the Gardner Division HREP has a notch in the center. This can be seen in photograph 16.

Photograph 16. Closure Structure at Gardner Division

Garner Chute currently has adequate depths to support year-round fish habitat, but the average flow (>3 cm/sec) is too high to support centrarchid overwintering habitat. Construction of the closure structure will reduce water velocities and provide optimal overwintering habitat. Additionally, placement of the closure structure upstream of the inlet channel the interior of the Huron Island Complex upstream of Upper Buffalo Slough should reduce the inflow of sediment to the Project. The downstream confluence of Garner Chute and Huron Chute will remain open to allow for adequate dissolved oxygen circulation and ingress and egress of fish throughout the year. Quantities of items to be constructed under Measure T9 are shown in table 17.

F. Huron Chute Diversity Island Bank Stabilization (I1)

This measure consists of stone protection along the head ends of the two small islands located in Huron Chute. These islands provide the only breakwater between Garner Island and the end of Huron Island (approximately between RM 424 and RM 422). Based on historic aerial photographs from the 1930s to 2010, both islands have lost surface area. The upstream island has degraded almost 400 linear feet with respect to the direction of flow since the 1930's. The downstream island has degraded nearly 350 feet since the 1950s. Losing almost five feet per year, the islands would not be expected to last the Project life. The outline of island loss is shown on Plate 6 (V-103). Quantities of items to be constructed under Measure I1 are shown in table 16. Islands requiring protection are shown in photograph 17.

Table 16. Quantities of Items To Be Constructed Under Measures T9 and I1

Measure	Description	Clearing	Bedding	Riprap	Shaping
T9	Garner Chute Closing Structure	1.0 acre		22,100 tons	
I1	Huron Chute Island Bank Stabilization	1.0 acre	2,100 tons	3,900 tons	1 LS

Photograph 17. Huron Chute Small Islands Looking Upstream (June 2011)

Protecting the islands will provide additional forested wetland habitat, and diversity of aquatic habitat in Huron Chute. Aquatic habitat will be provided in the form of depositional areas at the downstream portion of the island, which provides critical spawning, rearing, foraging, and resting habitat for a variety of riverine fishes Preserving islands is a necessary step in maintaining the form, function, and habitat value in the river.

Bank protection in the form of riprap is included along the head end of both the upstream and downstream islands. This measure, shown on Plate 16 (C-107) and 23 (C-305), is included to reduce active erosion and potentially allow the islands to expand on the downstream end over time. Riprap would be placed along 300 feet of bank line at both the upper and lower islands at a 2H: 1V slope at a 24 inch thickness on 12 inches of bedding stone, with a 6 foot weighted toe. Riprap would consist of IADOT (Class A) or ILDOT (RR-5) size stone. Bedding sizes would be IADOT (No. 3) or IL DOT (RR-1). Bank Protection along the Gardner Division HREP (2001), which would be similar to the design proposed for the Huron Island HREP, is shown being placed in photograph 18:

Photograph 18. Placement of Bank Protection

G. Forest Diversity in Non-Diverse Forested Area to Elevation 537 Feet (F5)

This measure includes the construction of a ridge and swale habitat and the planting of floodplain, wetland and aquatic species. The following plates provide information regarding this measure: Plates 13 (C-104), 14 (C-105), 22 (C-303), 21 (C-302), 29 (L-105), 30 (L-301), 31 (L-302), 32 (L-303), 33 (L-501), 34 (L-601), and 35 (L-602).

This measure is located upstream of Goose Lake Pool 1 and Pool 2, and in addition to providing topographic diversity for various species, it will also protect measures T1 and T3 from the impacts of overland flow. For approximately 1,000 feet, the measure will be constructed using excavated material from Goose Lake and borrow from existing soil. Geotechnical borings indicate that existing soil borrow can be obtained to a depth of 6 feet below surface. Material will be mechanically excavated from Goose Lake Pool 1 and Pool 2 to supplement the topographic diversity requirements and to limit the amount of trees which will be cleared.

Three tiers will be constructed at two separate elevations, with the highest tier being in the center at elevation 537 feet (80-foot width), and the lower two tiers on either end at elevation 535 feet (50-foot width each).

Preparation of the existing soil borrow areas and placement sites for construction of the feature would include 15 acres of clearing, grubbing and stripping within the proposed existing soil borrow sites. Similar to measures F1 and F3, native floodplain vegetation including trees, scrub/shrub wetland plants, and an understory seed mix will be incorporated in the topographic diversity design. Similar to measures T1 and T3, aquatic plantings will also be placed at the lower elevations of the slopes.

Typical forestry planting spacings can be viewed in photograph 19. Measure F5 would have several flat plateaus but would be raised, which is different than shown in photograph 19.

Photograph 19. Typical Reforestation Site

Quantities of items to be constructed under Measure F5 are shown in tables 17 and 18.

Table 17. Quantities of Wetland Vegetation To Be Constructed Under Measure F5

Wetland Vegetation Planting Quantities						
El.	**Habitat Type**	**Common Name**	**Scientific Name**	**# Tubers**	**Container Plants**	**Exclosure**
526-529'	Permanently Inundated Aquatic Bed - SAV	Illinois Pondweed	*Potamageton illinoisensis*	168	X	X
		Sago Pondweed	*P. pectinatus*	168	X	X
		American Wild Celery	*Vallisneria americana*	168	X	X
		Coontail	*Ceratophyllum demersum*	168	X	X
		American Elodea	*Elodea canadensis*	168	X	X
529-532'	Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed	Waterwillow	*Justicia americana*	72	X	X
		Arrowhead	*Sagitarria latifolia*	72	X	X
		Pickerelweed	*Pontederia cordata*	72	X	X
		Smartweed	*Polygonum spp.*	72	X	X
531-534'	Seasonally Inundated Emergent Wetland	Sedges	*Carex spp.*	105	X	1.0 acre seed mix at 10/lbs/acre
		Bulrush	*Scirpus spp.*	105	X	
		Blue Flag Iris	*Iris virginica*	105	X	
		Sweet Flag	*Acorus calamus*	105	X	

Table 18. Quantities of Forest Vegetation Diversity Items To Be Constructed Under Measure F5

Forest Diversity Planting Quantities						
El.	**Habitat Type**	**Common Name**	**Scientific Name**	**#3 RPM**	**#5 RPM**	**#15 RPM**
533-535'	Seasonally Inundated Scrub/Shrub Wetland	Hibiscus	*Hibiscus lasiocarpos*	2.0	1.0 acres seed mix at 10 lbs/acre	
		Common Elderberry	*Sambucus canadensis*	2.0		
		Buttonbush	*Cephalanthus occidentalis*	2.0		
		Dogwood	*Cornus stolonifera*	2.0		
		Sandbar Willow	*Salix interior*	2.0		
535-537'	Temporarily Inundated Forested Wetland	River Birch	*Betula nigra*	16.0	6.0	3.0
		Bitternut Hickory	*Carya cordiformis*	16.0	6.0	3.0
		Northern Pecan	*Carya illinoinensis*	16.0	6.0	3.0
		Shellbark Hickory	*Carya laciniosa*	16.0	6.0	3.0
		Common Hackberry	*Celtis occidentalis*	16.0	6.0	3.0
		Common Persimmon	*Diospyros virginiana*	16.0	6.0	3.0
		Honey Locust	*Gleditsia triacanthos*	16.0	6.0	3.0
		Kentucky Coffeetree	*Gymnocladus dioicus*	16.0	6.0	3.0
		Black Walnut	*Juglans nigra*	16.0	6.0	3.0
		American Sycamore	*Platanus occidentalis*	16.0	6.0	3.0
		Swamp White Oak	*Quercus bicolor*	16.0	6.0	3.0
		Bur Oak	*Quercus macrocarpa*	16.0	6.0	3.0
		Pin Oak	*Quercus palustris*	16.0	6.0	3.0
		American Basswood	*Tilia americana*	16.0	6.0	3.0
		Overcup Oak	*Quercus lyrata*	16.0	6.0	3.0
Understory Seed Mix		Virginia Wild Rye	*Elymus virginicus*	5.0 acres at a rate of 10.0 lbs/acre		
		Canada Wild Rye	*Elymus canadensis*			
		Partridge Pea	*Chamaechrista fasciculata*			
		Buttonbush	*Cephalanthus occidentalis*			
		Rice Cut Grass	*Leersia oryzoides*			
		Cardinal Flower	*Lobelia cardinalis*			
		Sneezeweed	*Helenium autumnale*			
Shape Excavation site to Desired Slope and Elevations.				**1.0 LS**		
Tree Cleared				**8.0 acres**		
Trees Cleared, Grubbed, and Stripped				**7.0 acres**		
Existing Soil and Excavated Material Removed and Placed				**47,100 cubic yards**		
Shape to Desired Slopes and Elevation				**1.0 LS**		
Tree Wraps				**375**		
Tree Exclosures				**375**		
Herbicide Treatment				**5.0 acres**		

H. Project Summary

Table19 summarizes Project data. The data presented was developed to a feasibility level of design and will be further refined during plans and specifications.

Table 19. Project Data

FEATURE	MEASUREMENT	UNIT OF MEASUREMENT
Measure T1. Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Feet Top)		
Clearing	13	acres
Length of Excavation site	2,402	feet
Width of Excavation site	75	feet
Bottom of Excavation site	Elevation 520	Vertical Datum is MSL 1912
Mechanical Dredging	69,900	cubic yards
Placement Site Length (Approx.)	2,164	feet
Seasonally Inundated Emergent Wetland	Elevation 531-534	Vertical Datum is MSL 1912
	2	acres
Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed	Elevation 529-532	Vertical Datum is MSL 1912
	2	acres
Permanently Inundated Aquatic Bed	Elevation 526-529	Vertical Datum is MSL 1912
	3	acres
Measure T3. Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Feet Top)		
Clearing for Placement Site	10	acres
Clearing for Bankline Protection	2	acres
Length of Excavation site	2,642	feet
Width of Excavation site	50 or 100 (see plans)	feet
Bottom of Excavation site	Elevation 520	Vertical Datum is MSL 1912
Mechanical Dredging	75,000	cubic yards
Length of Placement Site	2,642	feet
Seasonally Inundated Emergent Wetland	Elevation 531-534	Vertical Datum is MSL 1912
	2	acres
Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed	Elevation 529-532	Vertical Datum is MSL 1912
	2	acres
Permanently Inundated Aquatic Bed	Elevation 526-529	Vertical Datum is MSL 1912
	3	acres
Forested Wetland Protection (Huron Island) Bank Stabilization, Length Requiring Protection	2,415	feet
Bank Stabilization Locked Logs	15	logs
Bank Stabilization Riprap	15,400	tons
Bank Stabilization Bedding	8,400	tons
Measure F1. Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 1 (537 Feet Top)		
Length of Placement Sites	2,164	feet
Lower Shelf Width	30	feet
Lower Shelf Elevation	Elevation 535	Vertical Datum is MSL 1912
Upper Shelf Width	30	feet
Upper Shelf Elevation	Elevation 537	Vertical Datum is MSL 1912
Seasonally Inundated Scrub Shrub Wetland	Elevation 533-535	Vertical Datum is MSL 1912
	1	acres
Temporarily Inundated Forested Wetland Trees	Elevation 535 and 537 tiers	Vertical Datum is MSL 1912
	14	trees per each species (various sizes)
Temporarily Inundated Forested Wetland Shrubs	Elevation 535 and 537 tiers	Vertical Datum is MSL 1912
	3	acres
Seasonally Inundated Scrub/Shrub Wetland	Elevation 533-535	Vertical Datum is MSL 1912
	1	acres
Understory Seed Mixture	Elevation 533-535	Vertical Datum is MSL 1912
	3	acres

Table 19. Project Data

FEATURE	MEASUREMENT	UNIT OF MEASUREMENT
Measure F3. Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 Feet Top)		
Length of Placement Site	2,642	feet
Lower Shelf Width	30	feet
Lower Shelf Elevation	Elevation 535	Vertical Datum is MSL 1912
Upper Shelf Width	30	feet
Upper Shelf Elevation	Elevation 537	Vertical Datum is MSL 1912
Seasonally Inundated Scrub Shrub Wetland	Elevation 533-535	Vertical Datum is MSL 1912
	1	acres
Temporarily Inundated Forested Wetland Trees	535 and 537 tiers	Vertical Datum is MSL 1912
	17	trees per each species (various sizes)
Temporarily Inundated Forested Wetland Shrubs	Elevation 535 and 537 tiers	Vertical Datum is MSL 1912
	4	acres
Seasonally Inundated Scrub/Shrub Wetland	Elevation 533-535	Vertical Datum is MSL 1912
	1	acres
Understory Seed Mixture	Elevation 533-535	Vertical Datum is MSL 1912
	4	acres
Measure F5. Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forest Location Using Existing Soil (537 Feet Top)		
Clearing (Under Pad)	8	acres
Clear, Grub and Strip (Existing Soil Borrow)	7	acres
Length of Site	1,056	feet
Lower Shelf Width (1)	50	feet
Lower Shelf Width (2)	50	feet
Lower Shelf Elevation	Elevation 535	Vertical Datum is MSL 1912
Upper Shelf Width	80	feet
Upper Shelf Elevation	537	Vertical Datum is MSL 1912
Existing Soil Borrow	22,755	cubic yards
Excavated Material	24,300	cubic yards
Seasonally Inundated Scrub Shrub Wetland	Elevation 533-535	Vertical Datum is MSL 1912
	0	acres
Temporarily Inundated Forested Wetland Trees	Elevation 535 and 537 tiers	Vertical Datum is MSL 1912
	25	trees per each species (various sizes)
Temporarily Inundated Forested Wetland Shrubs	Elevation 535 and 537 tiers	Vertical Datum is MSL 1912
	4	acres
Seasonally Inundated Scrub/Shrub Wetland	Elevation 533-535	Vertical Datum is MSL 1912
	0	acres
Understory Seed Mixture	Elevation 533-535	Vertical Datum is MSL 1912
	4	acres
Seasonally Inundated Emergent Wetland	Elevation 531-534	Vertical Datum is MSL 1912
	0	acres
Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed	Elevation 529-532	Vertical Datum is MSL 1912
	0	acres
Permanently Inundated Aquatic Bed	Elevation 526-529	Vertical Datum is MSL 1912
	1	acres
Measure I1. Huron Chute Diversity		
Clearing	1	acres
Bankline Requiring Protection (both islands)	600	feet
Riprap	3,900	tons
Bedding Stone	2,100	tons
Measure T9. Topographic Diversity and Overwintering, Garner Chute Closure Structure		
Clearing	1	acres
Design Elevation	Elevation 532.0	Vertical Datum is MSL 1912
Structure Width (Shore to Shore)	250	feet
Riprap	22,100	tons

I. Design Considerations

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

1. Location. The Project Area is in Pool 18 between RM 421.2 and RM 425.4. Horizontal datum is state plane coordinate system IL West, NAD 83, US Survey Foot. Vertical datum is 1912. Flat pool is at EL. 528.0 feet.

2. Survey Data. Survey data obtained includes the following:

- Bathymetry data of the main channels and the backwater areas for this Project were developed using a combination of hydro survey data obtained by the Corps' Operations Division, LTRMP "GAP" hydro survey data, and single beam echo sounder data obtained by the Corps Engineering Division. Cross sections of Pool 1 and Pool 2, and survey data near the Garner Chute Closure Structure were obtained in the fall of 2011, inlet points along Huron Island were obtained in the fall of 2010, and surveys near the head end of the Huron Chute islands were obtained in March and June of 2012.
- The State of Iowa LiDAR data was obtained and used for this Project. More recent LiDAR, obtained by the Corps for the UMRR-EMP, has been obtained, but as of July 2012 was still undergoing quality control checks. This data may be used for design in plans and specifications.
- Field surveys using conventional survey methods were obtained between 2008 and 2012 and included areas adjacent to the Pool 1 and Pool 2, Huron Chute islands (2012), and bankline protection locations (2010 and 2012).
- Sediment ranges were obtained across the Mississippi River floodplain in 1938 and 2005. These are shown on Plate 5 (V-102)

It is recommended that data in areas of proposed excavation be resurveyed prior to construction in order to obtain accurate quantities for the Construction Contracts.

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, an access channel 30 feet wide and to a depth of 524 feet (4 feet below flat pool) would need to be constructed to get equipment to these sites. All other work should have sufficient water depths for conventional construction equipment. River access can be obtained from the Hawkeye Dolbee Boat Ramp located near RM 422 on the Iowa side (shown on Plate C-104). It is likely that heavy materials such as riprap or bedding stone will be transported by river from boat ramps closer to the quarries.

4. Existing Soil Borrow. Borrow will be required to construct Measure F5. Additional geotechnical borings will be required during the design phase.

5. Excavated Material. Excavated Material will be required to construct Measures F1, F3 and F5. Additional geotechnical borings will be required during the design phase.

6. Historic Properties. Historic properties are addressed in the existing conditions section of this report. The layout and design was conducted to avoid impacts to the historic properties. However, it is important that areas to avoid during construction be added to the final design plan set, and that the specifications address requirements to the contractor for what to do in case historic properties are encountered during construction.

7. Hazardous, Toxic, and Radioactive Waste. As required for all earth working projects in the Rock Island District, it is also 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, Corps would stop work and follow the steps outlined in ER 1165-2-132.

8. 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.

J. Construction Considerations

1. Permits. Laws of the United States and the State of Iowa have assigned the Corps and the IA DNR 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 of Engineers 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 IA DNR 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 point source discharges of dredged or fill material into waters of the United States.

The IA DNR is the state agency created by consolidating all previous duties of the IA DNR of Water, Air, and Waste Management; the Conservation Commission; the Energy Policy Council; and the Iowa Geological Survey. The IA DNR 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 IA DNR has authority to regulate construction on all floodplains and floodways in the state. The IA DNR'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. Any person who plans to perform or allow such floodplain construction has a duty to contact the IA DNR to determine if a floodplain construction permit is needed.

2. Water Quality Certification. IA DNR Section 401 water quality certification is mandatory for all projects requiring a Federal Section 404 permit. Section 401 water quality certification is the IA DNR's concurrence that a project is consistent with the state's water quality standards. Short and long-term impacts to water quality and water-related uses are evaluated in the Section 401 certification review.

3. Construction Permits. Pursuant to Section 114.4 of the Iowa Code, the IA DNR may authorize a person, association, or corporation to build or erect any pier, wharf, sluice, piling, wall, fence, obstruction, building or erection of any kind upon the jurisdiction of the IA DNR when it is found to be in the best interest of the public.

4. 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 AC. 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 sedimentation 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 work limits. The contractor would be required to comply with all local codes and permit requirements.

5. Construction Materials. Only common construction materials are required for this Project and can likely be obtained from local sources. Materials used for placement site and pad construction include either excavated material or existing soil borrow. Refer to the boring plates for more information. Riprap and/or bedding stone will be used for the Garner Chute closure structure, and bank stabilization features. Refer to Appendix G for information on gradation sizes. Plants and trees to be planted will be obtained through approved nurseries or Corps of Engineers' labs. Native sources will also be used.

6. Construction Schedule Constraints. Please refer to the schedule of construction (table 20) for construction details. The following information indicates various scheduling restraints and must be confirmed and evaluated during plans and specifications.

a. No clearing of trees greater than 4 inches in diameter with loose peeling bark shall be allowed between April 1 and September 30 (During the Indiana Bat Breeding and Rearing Season). Coordination with the USFWS and IA DNR prior to any tree cutting may be required.

b. Coordination with the IA DNR 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.

c. Copperbelly and diamondback water snakes emerge from hibernation in early spring (April) when temperatures reach 64 to 72 degrees F. USFWS and IA DNR personnel shall survey areas under construction for snake activity during this period as a precaution to keep these snakes from being destroyed while they are still lethargic. Construction activities within these areas of suitable snake habitat shall be restricted if such activities are identified. Heavy equipment shall be restricted from this habitat and normally be lifted within 7 to 10 days when the snakes are active enough to escape the disturbance.

d. 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 on Huron Island, 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. Coordination with the USFWS and IA DNR prior to any tree cutting may be required.

e. The placement of excavated materials and final preparation of the placement area shall be completed before seeding and planting of trees will be allowed. Trees shall be planted between October 25 and December 10 when weather and soil conditions are suitable. (air temperature between freezing and 80 degrees F.)

7. Construction Sequence. The probable construction sequence is summarized in table 20; however, no sequence will be required contractually.

Table 20. Proposed Construction Sequence

Proposed Construction Stage	Action	Measure(s)	Specific Restrictions	Purpose
I	Clear	I1, T9, forested werland protection bank stabilization (protect T1/F1, T3/F3)	Clearing operations cannot take place during the period of Apr 1through Sept 30. Must avoid environmentally sensitive zones including archeological sites, Indiana bat habitat, eagle nests, and heron rookeries.	Prepare sites for rock placements. Remove trees for Locked Log Structures.
I	Rock Placement	I1, T9, forested wetland protection bank stabilization (protect T1/F1, T3/F3)		Rock placement on the west shore of Huron island is required to prevent island loss and to protect measures T1/F1 and T3/F3. Additionally, construction of Measure T9 will reduce sediment entering the Huron Island complex before sediment is removed from Goose Lake (Measures T1/F1, T3, F3). Rock Placement associated with Measure I1 will be done at the same time to reduce costs associated with mobilization.
II	Clear, Grub, Strip	T1/F1, T3/F3, F5	Clearing operations cannot take place during the period of Apr 1through Sept 30. Must avoid environmentally sensitive zones including archeological sites, Indiana bat habitat, eagle nests, and heron rookeries.	Prepare placement sites for all measures. Trees to be reused for habitat or removed from site. Grubbing and stripping required for measure F5 only (under proposed existing soil borrow sites).
II	Excavation	T1/F1, T3/F3, F5		Use excavated material to provide materials for measures F1, F3 and F5.
II	Pad Construction	F5		Measure F5 will be constructed using a combination of adjacent soil material and excavated material from Goose Lake Pools 1 and 2.
III	Placement Site Shaping	F1, F3, F5	Shaping to occur after the site has dewatered.	Prepares sites for aquatic and floodplain plantings.
III	Plant Aquatic Vegetation	F1, F3, F5	Vegetation planting to occur after sites have been shaped.	Plant during the growing season.
III	Plant Shrubs and Trees	F1, F3, F5	Plantings to occur after the sites have been shaped.	Allow time for excavated material to dry.

K. Operational Considerations

Operation and maintenance of EMP habitat projects 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. Habitat projects 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. Annual operation costs are shown in, Section VIII, *Cost Estimates*. A complete list of operation needs will be provided in the Project's operation and maintenance manual after construction.

L. Maintenance Considerations

The proposed features have been designed to ensure low annual maintenance requirements. Maintenance will include mowing weeds around mast trees, removing vegetation and debris from rock, and replacing exclosures as needed. The estimated annual maintenance costs are presented in Section VIII, *Cost Estimates*. Maintenance requirements will be further detailed in the Project's O&M manual published after construction completion.

M. Repair, Rehabilitation and Replacement Considerations

Repair, rehabilitation and replacement considerations may extend outside of the typical 50 year period of analysis, as the Project sponsor is expected to maintain the HREP Project until it is no longer authorized. 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.

N. Value Engineering

A Value Engineering (VE) Study following the six-phase VE methodology was conducted on 18-21 June 2012 for the Huron Island Project by the St. Paul District. A copy of this report is available for review at the Rock Island District office. During the evaluation phase of the study, eight proposals were developed from the 49 generated ideas, and nine comments were developed. Additionally, 13 of the ideas were incorporated into other proposals or comments. It should be noted that all proposals that have been accepted will be given further consideration by the PDT. If the PDT determines the proposal is not feasible after looking into it further, the PDT will need to document that rationale. A list of proposals and comments are listed in table 21. The survey datum reported in the VE study differed from the datum used in this report. Any incorporation into the final plan must use the appropriate survey data.

Table 21. Value Engineering Proposals and Potential Incorporation Into the Recommended Plan

Proposal or Comment Number	Idea Number	Description	PDT Response to VE Proposals & Comments
P4	4	Eliminate Riprap/Rockfill bedding	The PDT does not concur. Based on geotechnical analysis, the riprap and bedding layer as proposed in the report are appropriate for the uses in this area. More information is available in the report and in the geotechnical appendix.
P7	7	Lower riprap El (vanes)	The PDT does not accept this proposal. The quantities to construct this feature were significantly higher than similar bankline protection features, and the size of the structures would likely have an adverse impact on the floodplain analysis.
P8	8	Reduce Dredge depth	The PDT does not accept this proposal. Based on expected sedimentation rates over the Project life, an additional 2 feet of dredging is required to maintain optimum dredge depths over 50 years.
P10	10	Change chevron shape from "C" to "Z" to direct flow away from the levee	The PDT does not accept this proposal since floodplain analysis shows adverse impacts.
P17	17	Reduce top width of structure	This proposal may be incorporated into the Recommended Plan. In Plans and Specifications, a more detailed closure structure will be designed.
P26	26	Plant on higher ground	The PDT does not accept this proposal since the only area where there is higher ground is a culturally sensitive area.
P32	32	Do more backwater dredging to create forest	This proposal has been incorporated into the Recommended Plan. The pad has been moved to incorporate dredged material with the top soil.
P46	46	Only protect toe with riprap	The PDT does not accept this proposal since survey data shows the erosion is not occurring at the toe.
C1	1	Delete forested Area (F5)	The PDT does not accept this comment since this measure helps reestablish a portion of the significant loss of forest diversity that has occurred on Huron Island.
C12	12	LWD - Large Woody Debris	This comment may be incorporated into the Recommended Plan during plans and specifications. Incorporation of woody debris will be discussed with ERDC for design and has been added to the cost of the Project. Woody debris in the form of locked logs has been added to this Project.
C18	18	Introduce flow to dredge area or monitor	This comment has been incorporated into the Recommended Plan as part of the adaptive management of the Recommended Plan

Proposal or Comment Number	Idea Number	Description	PDT Response to VE Proposals & Comments
C19	19	Rethink the need for shoreline riprap	The PDT does not accept this comment since the sponsor and PDT have noted visible erosion and recommend protection.
C27	27	More naturally shaped forest	The PDT does not accept this comment since the existing shape is a rectangle, although since the VE study was conducted, the location and orientation of the rectangle has changed. The rectangular shape was chosen to maximize areas for benefits, avoid adverse impacts to Indiana bats, and to assist with ease of construction. While it is rectangular in shape, once the site is developed and trees mature, the shape of the proposed site will not be as noticeable from the air, which would be the only way one might note that the shape is rectangular based on the remote interior location of the island. Since there is no habitat benefit to changing the shape, it will remain as shown on Plate 13 (C-104).
C47	47	Validate benefit calculations	This comment has been incorporated into the Recommended Plan. The habitat evaluation for topographic diversity was revised and corrected. The CE/ICA was updated as a result.
C48	48	Consider selection criteria	The PDT does not accept this comment since the team used ER1105-2-100 selection criteria for alternative selection.
C49	49	Consider sedimentation behind the structure	The AdH sediment transport modeling results indicate some minor changes in the sedimentation patterns within Garner Chute, however deposition of sediment throughout the 50-yr project life appears to be minimal.
C50	50	Cost Per Habitat Unit	The PDT does not accept this comment since ER1105-2-100 does not dictate a specific cost per habitat unit or justification when a $3, 000 thresh hold has been exceeded. However the PDT does concur that being aware of cost per habitat unit is an important part of project selection, since the VE a more refined cost/AAHU around $3K

VII. SCHEDULE FOR DESIGN AND CONSTRUCTION

Table 22 presents the schedule of Project completion steps.

Table 22. Project Implementation Schedule

Event	Scheduled Date
Value Engineering Study	June 2012
District Quality Control - Feasibility	September 2012
Alternative Formulation Briefing – Agency Technical Review	December 2012
Alternative Formulation Briefing	March 2013
Public Review of Draft Report	April 2013
Distribute Draft Report for Agency Review	April 2013
Submit Final Feasibility Report to Mississippi Valley Division	August 2013
Execute the Memorandum of Agreement with Sponsor	September 2013
Initiate Design	September 2013
Complete All Construction Stages	July 2017

The proposed construction schedule for three stages of construction is shown in table 23.

Table 23. Design and Construction Schedule

TASK	# OF DAYS	START DATE	END DATE
Stage I (Rock)			
Plans and Spec Start	180	09/01/13	09/28/13
35%	60	05/01/13	05/31/13
65%	60	06/30/13	07/30/13
95%	60	08/30/13	09/28/13
DQCR	45	09/29/13	11/13/13
ATR	60	11/14/13	01/13/14
BCOE	60	01/14/14	03/15/14
Blue Sheet	7	03/16/14	03/23/14
Routing Drawings for Signature	20	03/24/14	04/13/14
CT to Prepare for IFB/RFP	14	04/14/14	04/28/14
IFB/RFP	30	04/29/14	05/29/14
Bid opening	1	05/30/14	05/31/14
Award	15	06/01/14	06/16/14
Notice to Proceed	15	06/17/14	07/02/14
Finish Construction	365	07/03/14	07/03/15
As Built Drawings	30	07/04/15	08/03/15

Table 23. Design and Construction Schedule (cont)

Stage II (Dredging)			
Plans and Spec Start	360	09/29/13	09/24/14
35%	120	09/29/13	01/27/14
65%	120	01/27/14	05/27/14
95%	120	05/27/14	09/24/14
DQCR	45	09/25/14	11/09/14
ATR	60	11/10/14	01/09/15
BCOE	60	01/10/15	03/11/15
Blue Sheet	7	03/12/15	03/19/15
Routing drawings for signature	20	03/20/15	04/09/15
CT to prepare for IFB/RFP	14	04/10/15	04/24/15
IFB/RFP	30	04/25/15	05/25/15
Bid opening	1	05/26/15	05/27/15
Award	15	05/28/15	06/12/15
Notice to Proceed	15	06/13/15	06/28/15
Finish Construction	365	06/29/15	06/28/16
As Built Drawings	30	06/29/16	07/29/16

Stage III (Shaping and Planting)			
Plans and Spec Start	180	04/10/15	10/07/15
35%	60	04/10/15	06/09/15
65%	60	06/09/15	08/08/15
95%	60	08/08/15	10/07/15
DQCR	45	10/08/15	11/22/15
ATR	60	11/23/15	01/22/16
BCOE	60	01/23/16	03/23/16
Blue Sheet	7	03/24/16	03/31/16
Routing drawings for signature	20	04/01/16	04/21/16
CT to prepare for IFB/RFP	14	04/22/16	05/06/16
IFB/RFP	30	05/07/16	06/06/16
Bid opening	1	06/07/16	06/08/16
Award	15	06/09/16	06/24/16
Notice to Proceed	15	06/25/16	07/10/16
Finish Construction	365	07/11/16	07/11/17
As Built Drawings	30	07/12/17	08/11/17

VIII. COST ESTIMATES

Table 24 compares costs for the fully funded estimate (FFE) and the current work estimate (CWE) (Appendix J, *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 Project construction. The CWE is shown in a detailed estimate of Project design and construction costs as presented in table 25. Quantities and costs may vary during final design. All cost estimates are calculated using FY 2013 pricing.

Table 24. Project Design and Construction Cost Estimates

Account	Feature	(FFE)[1]	(CWE)
01	Lands and Damages	0	0
06	Fish and Wildlife Facilities	$7,920,000	$7,498,860
06	Adaptive Management	$944,000	$869,628
16	Bank Stabilization	$2,206,000	$2,134,546
22	Feasibility Studies	$1,466,000	$0
30	Planning, Engineering and Design	$1,418,000	$1,342,494
31	Construction Management	$1,085,000	$972,825
	PROJECT COSTS	**$15,039,000**	**$12,818,353**

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

Table 25. Detailed Cost Estimate of Current Working Estimate with Contingency

Acct Code	Item	Quantity	Unit	Amount	Contingency (varies)	Escalation	Total Cost w/ Cont, CWE
CONSTRUCTION COSTS							
6	Adaptive Management	1	LS	$719,176	20.92	0	$869,628
6	Mob and Demob	1	LS	$569,837	20.92	0	$689,047
6	Excavation and Shaping	1	LS	$3,705,387	20.92	0	$4,480,554
6	Aquatic Planting	1	LS	$381,790	20.92	0	$461,660
6	Closure Structure	1	LS	$1,295,405	20.92	0	$1,566,404
6	Cleared Debris Processing	1	LS	$121,659	20.92	0	$147,110
6	Shrub and Tree Planting	1	LS	$127,427	20.92	0	$154,085
16	Island Bank Stabilization	1	LS	$353,860	20.92	0	$427,888
16	Forest Wetland Bank Stab.	1	LS	$1,411,395	20.92	0	$1,706,659
						TOTAL CONSTRUCTION COSTS.	**$10,503,034**
PLANNING, ENGINEERING, & DESIGN (PED) COSTS							
30	P&S	1	LS	$956,000	10.35	0	$1,054,946
30	EDC	1	LS	$260,578	10.35	0	$287,548
						TOTAL PED COSTS.	**$1,342,494**
CONSTRUCTION MANAGEMENT COSTS							
31	Construction Management	1	LS	$868,594	12	0	$972,825
						TOTAL CONSTRUCTION MANAGEMENT COSTS.	**$972,825**
						TOTAL PROJECT COSTS.	**$12,818,353**

A. Operation and Maintenance Considerations

The proposed Project features have been designed to ensure low annual operation and maintenance requirements (table 26). Operation and maintenance includes inspections, replacing aquatic bed and tree exclosures, mowing around mast trees, and replacing riprap at bankline protection locations. Per the cooperative agreement between the USFWS and IA DNR, the IA DNR will be performing the operation and maintenance for the proposed Project. The estimated total annual operation and maintenance cost is $10,290. 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. Operation and Maintenance costs are included in the annualized costs for alternative selection but are not included in the Current Working Estimate or Fully Funded Estimate.

Table 26. Estimated Annual Operation and Maintenance Costs
(October 2012 price level - 50 year period of analysis with FY 13 discount rate 3.75)

Item	Description	Measure	Quantity	Unit	Unit Price	Total Unit Cost	Frequency and Time Span	Present Value Cost	Annualized Cost
OPERATIONS									
Inspections	**Exclosures**	F1	2	hours	$50	$100	3 times per year for first 10 years post-construction	$2,464	$110
		F3	2	hours	$50	$100		$2,464	$110
		F5	2	hours	$50	$100		$2,464	$110
		T1	2	hours	$50	$100		$2,464	$110
		T3	2	hours	$50	$100		$2,464	$110
	Cover Crop & Erosion	F1	2	hours	$50	$100	3 times per year for first 5 years post-construction	$1,345	$60
		F3	2	hours	$50	$100		$1,345	$60
		F5	2	hours	$50	$100		$1,345	$60
	Closing Structure	T9	6	hours	$50	$300	1 time per year for 50 years post-construction	$6,730	$300
	Bank Stabilization Rock	T1-T3	6	hours	$50	$300		$6,730	$300
	Island Stabilization	I1	6	hours	$50	$300		$6,730	$300
							OPERATIONS TOTAL	**$36,545**	**$1,629**
MAINTENANCE									
Replacement	**Aquatic Bed Exclosures**	T1	10	EA	$50	$500	Once per year for years 6-10 post-construction	$1,865	$83
		T3	10	EA	$50	$500		$1,865	$83
	Tree Exclosures	F1	21	EA	$50	$1,050	Every 2 years for first 10 years post-construction	$4,232	$189
		F3	26	EA	$50	$1,300		$5,240	$234
		F5	38	EA	$50	$1,900		$7,659	$341
Removal	**Debris from Rock**	T1-T3	80	hours	$50	$4,000	Every 2 years for 50 years post-construction	$44,043	$1,963
		I1	80	hours	$50	$4,000		$44,043	$1,963
Mowing	**Under Mast Trees**	F1	3	acres	$1,200	$3,600	Every 2 years for 10 years post-construction	$14,511	$647
		F3	4	acres	$1,200	$4,800		$19,348	$862
		F5	5	acres	$1,200	$6,000		$24,185	$1,078
							MAINTENANCE TOTAL	**$166,991**	**$7,443**
							Operations and Maintenance Subtotal	**$203,536**	**$9,072**
							Contingency (13.45%)	**$27,376**	**$1,220**
							TOTAL OPERATIONS AND MAINTENANCE	**$230,912**	**$10,293**

B. Repair, Rehabilitation, and Replacement Considerations

For analysis purposes, the costs presented for operation and maintenance used the 50-yr period of analysis. However, the IA DNR is expected to operate and maintain the Project until it is no longer authorized. As such, the IA DNR should expect to incur costs associated with this responsibility outside of the 50-yr period of analysis. Table 27 lists the major Project components and their associated frequencies of repair, rehabilitation, and replacement. Estimates of these costs will be included in the operation and maintenance manual.

Table 27. Repair, Rehabilitation, and Replacement Considerations

Component	Frequency
Repair Rock Closure Structure (T9)	As needed, every50 yrs
Excavate Backwater Areas (T1, T3)	As needed, every 60 yrs

C. Monitoring Considerations

Costs for monitoring and collecting data are summarized in table 28. Monitoring costs include forest inventory, sediment transects and assessment, and water quality monitoring and assessment. These costs are part of the UMRR-EMP HREP performance evaluation and are not calculated in the Project Costs. The estimated total annual monitoring cost is cost $13,670.

D. Adaptive Management Considerations

Annualized costs for adaptively managing the Project are summarized in table 29. These costs include the monitoring necessary to determine if management actions are required. These costs are included in the total Project cost. The estimated total annual adaptive management cost is cost $25,620. More information regarding adaptive management can be found in Section X, *Project Performance and Assessment Monitoring*, and Appendix K, *Adaptive Management and Monitoring.*
.

Table 28. Estimated Performance Evaluation Monitoring Costs
(October 2012 Price Level – 50 year period of analysis using 3.75 discount rate)

Measure	Item	Funding	Quantity	Unit	Unit Price	Expected Frequency	Total Cost	Present Value	Annualized Cost
F1 F3 F5	Forest Survey	USACE	1	LS	$25,000	at year 25 and year 50	$50,000	$13,927	$620
T1 T3 T9	Sedimentation Transects and Assessment	USACE	1	LS	$25,000	once every 5 years starting year 5	$225,000	$104,069	$4,640
T1 T3 T9	Water Quality Monitoring and Assessment	USACE	1	LS	$25,000	once every 5 years starting year 5	$225,000	$104,069	$4,640
T1 T3 T9	Electrofishing	IA DNR	1	LS	$10,000	once every 5 years starting year 5	$100,000	$41,628	$1,860
T1 T3	Vegetation Survey	IA DNR	1	LS	$1,000	once every 5 years starting year 5	$10,000	$4,163	$190
ALL	Public Aerial Imagery	NA	1			once every 5 years starting year 5			$-
								Subtotal	**$11,950**
								Contingency (14.35%)	**$1,715**
								TOTAL	**$13,665**

Table 29. Estimated Annual Adaptive Management Costs Including PED and Post-Construction
(October 2012 Price Level – 50 year period of analysis using 3.75 discount rate)

Objective	Work Category	Activity	PED	Post Construction		Total	Present Value	Annualized Cost
				Years 1-5	Years 5-10			
Aquatic Vegetation	Plant Production	Propagule collection Sediment bioassay Plant grow-out		$15,000		$15,000	$13,450	$600
	Materials	Protective Exclosures Grow-out materials		$10,000		$10,000	$8,967	$398
	Planting	Exclosure construction Containerized plants Tubers		$25,000		$25,000	$22,416	$999
	Monitoring & Analysis	GIS coverage mapping Water Quality LTRM Veg Protocols	$5,000	$50,000	$25,000	$80,000	$68,480	$3,052
	Reporting	Quarterly and Annual	$5,000	$35,000	$25,000	$65,000	$50,030	$2,230
				Aquatic Vegetation Subtotal		***$195,000***	***$163,343***	***$7,279***
Floodplain Forest	Plant Acquisition	New RPM trees for replanting (if needed)		$15,000	$15,000	$30,000	$24,638	$1,098
	Materials	Protective Exclosures		$10,000	$10,000	$20,000	$16,426	$732
	Planting	Exclosure construction RPM Tree Planting		$10,000	$10,000	$20,000	$16,426	$732
	Monitoring & Analysis	Prism plot surveys LTRM Forest Protocols	$5,000	$30,000	$30,000	$65,000	$54,277	$2,419
	Reporting	Quarterly and Annual	$5,000	$15,000	$15,000	$35,000	$29,638	$1,321
				Floodplain Forest Subtotal		***$170,000***	***$141,405***	***$6,302***
Aquatic Habitat	Materials	VEMCO Receivers VEMCO Transmitters Floy Tags Manual Tracking Equip Laptop Surgical supplies	$80,000	$30,000		$110,000	$106,900	$4,765
	Labor	Acoustic Array Deploy Fish Collection Surgical implantation Data Downloads Manual Tracking	$15,000	$30,000		$45,000	$41,900	$1,868
	Data Analysis	Water Quality	$1,000	$1,000		$2,000	$1,964	$88
		Fish Movements	$4,000	$9,000		$13,000	$12,070	$538
	Reports	Quarterly and Annual	$5,000	$10,000		$15,000	$13,967	$623
	AM Feature: Notch Garner Chute Closure		$34,516			$34,516	$30,907	$1,378.00
	AM Feature: Backwater Flow Introduction		$52,368			$52,368	$46,892	$2,090.00
				Aquatic Habitat Subtotal		***$271,884***	***$254,600***	***$11,350.00***

IX. ENVIRONMENTAL EFFECTS

The following sections describe the potential environmental effects the proposed Project may have on the resources addressed in Section II, *Affected Environment*. The discussion is organized by potential direct, indirect, and cumulative effects of the proposed project compared to the No Action alternative.

A. Floodplain Resources

The proposed plan would benefit over 105 acres of bottomland forested wetland habitat through an increase in floodplain elevation, hard mast tree plantings, and scrub/shrub plantings. This is highly important as floodplains are important elements of regional landscapes, controlling ecosystem processes (e.g., sedimentation, 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 that over 96 percent of Huron Island and 100 percent of the Project Area contains over-mature silver maple stands (>135 years) and an understory similar to that of a park setting (i.e., clear understory). As such, the No Action alternative would result in a conversion to a mostly grassland (i.e., scrub/shrub, reed canary grass) complex within 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), general wildlife, reptiles and amphibians, etc. The following structural and functional elements contribute to the overall habitat value and benefits of the Project site.

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). Prior to lock and dam construction, the Project site contained about 54 surface acres above the 2-year flood elevation which supported around 14 tree species. Benefits from the proposed Project result from the increased elevation of the Project site in relation to the pre-dam reference condition. The increased elevation promotes mast tree 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 6 to 15 Species. Currently, six species of native tree species occur within the footprint. In addition to increases in elevation, benefits are accrued through an increase in tree species under the proposed plan. 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 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 15 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 within the Project site. This 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 primarily moist soil species and reed canary grass which has less habitat value than a diverse floodplain forest. Migratory birds which rely on well-connected diverse forest habitat for migration, nesting, and foraging purposes will be impacted. 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 site.

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 Complex and is expected to increase over time. An increase in elevation, the resulting increase in mast tree production per year, and the operation and maintenance of the Project will limit opportunities for invasive species establishment.

6. **Increase Ephemeral Wetland Habitat**. Construction of measure F5 results in an increase in ephemeral wetland habitat in the existing soil borrow area for critical spawning, rearing, and foraging habitat for waterfowl, reptiles, amphibians, and wildlife species inhabiting the Complex.

7. **Backwater Habitat Protection.** Material placement sites serve as protection to the excavated backwaters and aquatic vegetation plantings during high water events. Benefits include a potential flow break which could result in reduced sedimentation within the backwaters (benefits include added life of Project feature), decreased turbidity (benefits include aquatic vegetation establishment, growth, and sustainability), increased water clarity (benefits include aquatic vegetation establishment, growth, and sustainability; fish foraging and spawning), and flow refuge (benefits include fish habitat; aquatic vegetation sustainability).

8. **Active Adaptive Management**. A large component of this Project is developing threshold relationships and experimental designs to evaluate the stressors and drivers which limit the growth and sustainability of diverse floodplain forests. The inclusion of treatments of tree maturity (i.e. #3, 5, and 15 RPM), species, elevation (i.e. 535 vs.537), and protection from herbivory will allow for comparisons which will discern differences in species specific growth and sustainability as a function of water inundation. Ultimately, this enables inferences to be made regarding habitat value allowing future projects to optimize project planning through cost savings, increased benefits, and efficiency. For example, using a #15 RPM at elevation 535 feet might result in the same growth and habitat value as a #15 RPM at elevation 537 feet but would require less material; thereby, reducing costs while providing the same habitat benefit.

The proposed Project construction would take place within Huron Island and the Hawkeye Dolby boat ramp, which is the staging area. 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.

The staging activities at the Hawkeye Dolby boat ramp, which is a gravel parking lot and two-lane concrete boat ramp with dock, would not result in environmental impacts or impact recreation. Minor short-term impacts in the form of dust and noise may result from increased vehicle travel to the staging and construction area.

Construction of the Project features would require up to 42 acres of tree clearing, grubbing, and stripping to enable excavated material placement site construction and bank stabilization features. Temporary disruptions to wildlife are likely to occur. This includes Indiana bats, which, based on recent surveys, use a part of the Project Area for feeding and roosting. To minimize and avoid disturbances to bats, the area designated for clearing and construction (measure F5) was moved downstream to an area that does not contain primary roost trees, primary feeding corridors, and has less bat activity. This area also reduces the total number of trees which must be removed. In another effort to minimize temporary disturbances, an average of 10 trees per acre will be left standing within the cleared area. Roughly half of these remaining trees (5/acre) will be girdled and killed to produce potential roost trees. The Corps in consultation with the USFWS anticipates no long-term adverse effects to wildlife or Indiana bats as a result of this Project.

Disruption of the habitat during tree planting would be minimal. Post-planting, periodic operation and maintenance procedures would be implemented. These include undesirable vegetation control through mowing, hand pulling, or herbicide treatments. Mowing and hand pulling activities would have little impacts on the environment. Herbicide treatments would be applied using state and federal standards, and would be applied by a licensed applicator; thus, minimizing potential localized impacts.

B. Aquatic Resources

Additional discussion of aquatic and water quality impacts is contained in Appendix B, *Clean Water Act, Section 404(b)(1) Evaluation*. The proposed plan would benefit 79.2 acres of aquatic habitat through an increase in backwater and riverine habitat structure and function. Specifically, backwater habitat is improved through increased depths, aquatic vegetation establishment, and improved water quality. Riverine habitat geomorphic processes are improved through a reduction of island erosion and restoration of sediment transport processes in Huron Chute.

Section II – Affected Environment explained that over 96 percent of the Complex backwaters are less than 4 feet deep at flat pool. In general, the backwaters are shallow and turbid, with a complete lack of aquatic vegetation. Overwintering habitat appears to be limiting as the backwaters are too shallow. Under the No Action alternative the backwaters within Huron Island would continue to experience sedimentation and result in a loss of the remaining 4 percent of overwintering habitat. Island habitat would be lost after 50-years and Garner Chute would remain unsuitable overwintering habitat. The following structural and functional elements contribute to the overall habitat value and benefits of the Project site.

1. Increased Backwater Depths. Of the 79.2 acres of improved aquatic habitat, 77.1 acres will be improved for year-round fish habitat, including overwintering habitat. This equates to a 12 percent increase in overwintering habitat in the Complex. Currently, overwintering habitat is limiting in Pool 18 and is mainly attributed to reduced depths in backwaters, which is addressed in this Project. Increased depths provide areas where higher water temperatures and dissolved oxygen can persist in the winter. Year-round habitat is improved by providing a connection between overwintering and spawning habitat. Ideally, fish prefer to have overwintering habitat near spawning habitat so the energy required to move into spawning areas is reduced. The location of the excavation sites for this Project provides direct access to adjacent spawning and rearing habitat. It also allows for ingress and egress of fish by way of Huron Chute.

2. Reduced Flow in Garner Chute for Overwintering Habitat. Approximately 22 acres or a 6 percent increase in the total overwintering habitat will be improved through construction of the Garner Chute closing structure. Garner Chute currently has adequate depth and dissolved oxygen for overwintering. However, the chute's velocity of 30 cm/sec is significantly greater than the requirement for overwintering. Installation of a closure structure within this channel reduces flows during the winter to provide optimal conditions. The location of the habitat is also significant in terms of the spacing of overwintering habitat in Pool 18. Recent studies have indicated bluegill will routinely travel up to a mile in search of overwintering habitat (Steuck and Hanson 2010). Taking this into account, a second location (in addition to Goose Lake) at the head of the Huron Complex essentially provides reachable overwintering habitat for all centrarchid species inhabiting the Complex; a hypothesis which will be evaluated through monitoring for this Project. For more details see Appendix K, *Adaptive Management and Monitoring.*

3. Aquatic Vegetation Establishment. Aquatic vegetation provides critical spawning, rearing, and foraging habitat for fish, waterfowl foraging habitat, and substrate stabilization.

For some fish species (e.g., perch, pike) vegetation is a requirement for successful reproduction because eggs are laid directly on the vegetation. For others (e.g., bluegill, largemouth bass) vegetation increases the likelihood of a successful reproduction as a result of protection from predators and immediate foraging opportunities. All of these are critical functional elements which contribute to successful fish populations.

The second functional component of aquatic vegetation is waterfowl forage and loafing habitat. Several species of aquatic vegetation are highly valuable as a food source for waterfowl. For young-of-year waterfowl, the area will be an important form of protection from predators.

Finally, aquatic vegetation has been shown to stabilize substrates and reduce the effects of sediment dislodgement produced by wind, waves, and high flows. This is important for improved water quality and for stability of fish spawning areas in the backwaters.

4. Reduced Island Erosion and Restoration of Sediment Transport Processes. Island habitat in the UMRS is highly valuable for habitat diversity, and has been steadily declining. In fact, researchers have hypothesized the habitat afforded by islands in the UMRS function similarly to riffle-pool systems in smaller streams based on the fish community present and the functions provided. Installation of island protection will reduce erosive forces and facilitate the restoration of sediment transport processes in Huron Chute. Sediment deposition at the tail-end of the islands will increase island acreage, wildlife habitat diversity, and potential tree production. The tail of the islands 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 islands will be critical low flow foraging and nursery habitat for both backwater and riverine fish species.

5. Potential Increase in Endangered Mussel Habitat. Two federally-endangered mussel species have the potential to exist within the Huron Chute portion of the Project Area. Both species have a preference for stable substrates consisting of sand to boulders. Implementation of the rock structures will stabilize erosion and begin to build additional habitat with shallow, low velocity, and stable substrate. Combined with the probable increase in fish use, it's likely the general mussel population and the likelihood of Higgins eye or spectaclecase mussel occurrence will increase.

6. Active Adaptive Management. Similar to the floodplain adaptive management, the aquatic habitat measures incorporate a substantial experimental design aimed at evaluating the stressors of aquatic vegetation establishment, overwintering fish habitat use, and meeting objectives in the most efficient manner possible. Aquatic vegetation plantings incorporate stratified planting design which will include treatments of plant life stage, density, protection (i.e., exclosures), and elevation. Plant life stages include mature containerized plants, tubers (i.e., fleshy underground root of a plant bearing buds from which new plants develop), and existing seed bank. Results will be used to optimize vegetation growth in the Project Area and future restoration projects in the UMRS. In addition, results from this Project will lead to the development of an efficient planting design which will maximize benefits, while potentially decreasing costs.

Construction activity would temporarily increase turbidity immediately downstream of the proposed excavation sites in Goose Lake, the islands in Huron Chute, bank stabilization, and Garner Chute. Material will be mechanically dredged and placed on the floodplain. Although macroinvertebrate density and diversity is low, temporary disruption and minor loss is expected to occur through excavation and rock placement. These areas should be recolonized shortly following construction.

Coordination with the IA DNR personnel will be conducted 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 to reduce potential impacts to recreationists.

C. Invasive Species

Compared to the No Action alternative, the proposed plan 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 collaborate to out-complete reed canary grass growth. Also, operation and maintenance of the Project would include non-desirable vegetation control.

The proposed project includes features which will increase off-channel habitat and may potentially be used by juvenile and adult Asian carp as described in Kolar et al. (2005). However, the benefits to native aquatic species resulting from implementation of the proposed project are expected to far exceed any potential benefits for non-native fish species.

D. Endangered and Threatened Species

The Higgins eye pearlymussel, spectaclecase mussel, and Indiana bat are federally-endangered species potentially in the Project Area, while the prairie bush clover and Western prairie fringed orchid are federally-threatened species listed in Des Moines County, Iowa. The Corps prepared a Biological Assessment and submitted it to the USFWS on July 21, 2012. Based on the information provided, the Corps determined the proposed Project ***May Affect*** but is ***Not Likely to Adversely Affect*** Indiana bats, Higgins eye pearlymussel, and spectaclecase mussel. The proposed Project will have ***No Effect*** on the prairie bush clover and Western prairie fringed orchid. The USFWS concurred with these determinations through their submittal of the Fish and Wildlife Coordination Act Report dated August 13, 2013. See Appendix A, *Correspondence.*

1. Indiana bat. The proposed Huron Island Project may directly affect the Indiana bat by reducing the amount of potential roosting and foraging habitat and creating short-term fragmented woodlands within the action area. The Project would potentially affect 42.0 acres of floodplain forest through clearing of trees for placement site construction. The overall forested habitat which exists on Huron Island proper is approximately 1,850 acres. When compared to the number of acres potentially affected by the Project, the Corps determined it to be 2.2 percent of the total.

2. Higgins eye pearlymussel. The proposed excavation of the backwaters in Huron Island should have no direct impacts to the Higgins eye pearlymussel since the backwaters do not appear to contain suitable habitat.

Within Huron Chute the Project proposes bankline stabilization through rip rap placement to reduce island erosion and bank erosion. The bank stabilization would potentially affect approximately 3,015 linear feet of substrate through rock placement. However, Higgins eye have not been collected in Huron Chute, and shifting sand and erosive forces around the island indicate a low likelihood of presence.

A closing structure is proposed to be constructed within Garner Chute. The habitat contained within the chute closely resembles Huron Chute. The construction of the structure would potentially affect a surface area of approximately 0.57 acres through rock placement.

3. Spectaclecase. The proposed excavation of the backwaters in Huron Island should have no direct impacts to the spectaclecase mussel since the backwaters do not appear to contain suitable habitat.

Within Huron Chute the Project proposes bankline stabilization through rip rap placement to reduce island erosion and bank erosion. The bank stabilization would potentially affect approximately 3,015 linear feet of substrate through rock placement. However, spectaclecase have not been collected in Huron Chute, and shifting sand and erosive forces around the island indicate a low likelihood of presence.

A closing structure is proposed to be constructed within Garner Chute. The habitat contained within the chute closely resembles Huron Chute. The construction of the structure would potentially affect a surface area of approximately 0.57 acres through rock placement.

4. Prairie bush clover. The Project should have no direct impacts to the Prairie bush clover since the Project Area does not have any Prairie bush clover habitat.

5. Western prairie fringed orchid. The Project should have no direct impacts to the Western prairie fringed orchid since the Project Area does not have any Western prairie fringed orchid habitat.

6. State Listed Species. None of the State-listed endangered or threatened species listed in Section II, *Affected Environment*, and no rare natural communities are expected to be adversely affected by the proposed Project.

7. Indirect Effects. Indirect effects, as they apply to Section 7 of the Endangered Species Act, are those effects caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur (USFWS and NMFS, 1998).

The Recommended Plan for Huron Island includes planting over 800 trees from 15 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.

E. Hazardous, Toxic, and Radioactive Waste

While there may be minimal recognized environmental conditions on target properties due to trace amounts of fertilizers, pesticides, fungicides, and herbicides because of agricultural activities, there are no physical signs, records or specialized knowledge indicating a significant environmental condition of concern for the Project. Furthermore, the implementation of this Project will not have an effect on current conditions of hazardous, toxic, and radiological waste in the Project Area (Appendix E, *HTRW*)

F. Historic and Cultural Resources

The Corps has determined there will be no historic properties affected by the proposed Project. The Corps provided this determination to the Iowa SHPO by letter dated January 7, 2011. After reviewing this information, the SHPO concurred with the Corps determination by letter dated January 14, 2011 (SHSI R&C # 110129027) (Appendix A).

While the Corps is assured that no historic properties would be affected by the preferred alternative; 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.

G. Hydrology and Hydraulics

1. Discharge and Velocity. Velocities in Garner Chute are effectively reduced by the Garner Chute closing structure (T9), thereby providing conditions suitable for overwintering. Existing velocities during low flow overwintering discharges (60,000 cfs) within Garner Chute are 1-2 ft/s. Under the Recommended Plan, overwintering velocities are decreased to less than 0.2 ft/s. The alignment of the floodplain forest diversity features (F1, F3 and F5) effectively reduces discharge into Goose Lake Pools 1 & 2 for discharge events almost as high as the 20 percent exceedance probability event.

2. Sedimentation. The Recommended Plan includes floodplain diversity placement site and pad features (F1, F3 and F5) whose alignment and design elevation deflects island inundating flows from entering Goose Lake Pool 1 and Goose Lake Pool 2. Sedimentation resulting from more frequent island-inundating events will be reduced as a result of the Project. The AdH sediment transport model results suggest that with the Recommended Plan in place average annual sedimentation rates within Goose Lake Pool 1 will decrease from 1.2 cm/yr (0.040 ft/yr) to 0.55 cm/yr (0.018 ft/yr) and from 0.68 cm/yr (0.022 ft/yr) to 0.32 cm/yr (0.011 ft/yr) within Goose Lake Pool 2.

H. Executive Order 12898 (Federal Actions To Address Environmental Justice)

This Executive Order (EO) requires the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or a socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Meaningful involvement means that:

- potentially affected community residents have an appropriate opportunity to participate in decision making about a proposed activity that could affect their environment and/or health;
- the public's contribution can influence the regulatory agency's decision;
- the concerns of all participants will be considered in the decision making process; and
- the decision makers seek out and facilitate the involvement of those potentially affected.

The District has complied with the provisions of the EO through coordination and the NEPA review process. No concerns regarding this Executive Order surfaced during this process.

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 Huron 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 restoration features will not impact community cohesion. No public opposition has been expressed, nor is any expected.

3. Displacement of People. There are no residential properties in the Project Area that would be displaced by the proposed Project.

4. Property Values and Tax Revenues. Huron Island is federally-owned land managed by the Iowa DNR and the USFWS. No change in property values or tax revenues would occur.

5. Public Facilities and Services. The proposed Project would positively impact public facilities and services by increasing habitat diversity, resulting in additional opportunities for recreational use of the area.

6. Life, Health, and Safety. The Project poses no threats to the life, health, or safety of recreationists in the area. A hazardous, toxic, and radioactive waste (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 Project 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 Project construction. The Project would not directly affect employment of the labor force in Des Moines County, Iowa.

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 Project construction, disturbing wildlife and recreationists in the area. The Project Area is rural with no significant, long-term impacts.

12. Air Quality. The project site is not in or near an air quality nonattainment area. However, minor, temporary increases to air quality due to construction activity may occur as a result of construction and transportation of materials.

13. 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 the implementation of this Project.

J. 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 18.

1. Past Actions. The most significant navigation action in Pool 18 was the authorization, construction, and operation and maintenance of the 9-foot channel project. Construction of L&D 18 raised water levels in Pool 18 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 18 has historically been one of the most heavily dredged areas in the Rock Island District. As a result, several wing dams and closure structures (including the Huron Chute closing structure and a modification to further reduce flows through a reduction of the notch) 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. Additionally, several dredged material placement sites exist including Johnson Island, Keithsburg, Snipe Island and Kingston Bar. Each of these sites were used as placement sites then planted with mast producing trees. In each case, the tree plantings failed.

A Section 1135 restoration project was conducted at Huron Island in 1995. This Project included the planting of 58 acres of mast producing trees at the existing elevation. Today over 90 percent of the trees have experienced mortality due to excessive flooding, including both frequency and duration.

Construction of the Lake Odessa (RM 434.5-441.5) was completed in 2012. The HREP was developed to reduce forest fragmentation, increase bottomland hardwood diversity, enhance migratory waterfowl habitat, restore native grasslands, and increase overwintering fish habitat.

In 2008, an EA was completed with implementation shortly after for construction of a chevron dike field near Oquawka, Illinois. The chevrons were constructed as part of the operation and maintenance of the 9-foot channel as an attempt to improve sediment transport and reduce dredging in the area. The chevrons had minor impacts on the substrate and benthic communities in the footprint of the structure. The chevrons also provide fish habitat and improved macroinvertebrate habitat.

2. Present and Foreseeable Actions. The Corps continues the operation and maintenance of the 9-foot navigational channel project. This includes continuation of dredging, placement of material, and dike construction (i.e., chevrons, closing structures, and wing dams).

The Corps was developing a plan to construct an additional wing dam at the entrance to Huron Chute until model results showed no increase in elevation. Other potential structures could affect Huron Chute directly through rock placement and reduced flows into Huron Chute.

Foresters with the Corps continue to implement timber stand improvements measures at locations within Huron Island and Lake Odessa. 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 estimated approximately 100 acres of active timber stand improvements strategies will be implemented in the next 20 years on Huron Island.

It is anticipated within the next 10 years the Keithsburg Division and Boston Bay HREPs will commence planning efforts for implementation. These projects would be similar to Huron 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. The potential for significant cumulative impacts is lessened by the ecosystem restoration efforts in Pool 18. This Project, in concert with Lake Odessa, Keithsburg Division, and Boston Bay, should counter some of the past, current, and foreseeable actions described earlier. In total, 54 HREPs have been completed benefiting nearly 100,000 acres on the UMRS. Six projects are in construction, and 30 additional projects are in various stages of planning, engineering, or design.

3. Probable Adverse Impacts Which Cannot Be Avoided. A minor unavoidable adverse impact would include the clearing of vegetation for construction of Project features. The placement sites will require approximately 42 acres of clearing to accommodate the features footprints, grading and shaping, and access. All of the clearing will be located near Goose Lakes 1 and 2. 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 USFWS and the IA DNR for protection of threatened and endangered species.

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

K. 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, establishment of submerged, emergent and wetland vegetation and providing more dependable reproduction, foraging and resting areas for migratory, 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 of the Complex. Negative long-term impacts are expected to be minimal on all ecosystems associated with the Project.

L. Irreversible or Irretrievable Resource Commitments

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

M. 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.

N. Compliance with Environmental Statutes

Table 30 provides a list of environmental protection statutes and other environmental requirements which were considered during development of this report. The table reports the applicability or compliance of the Recommended Plan as it relates to each statute and requirement.

Table 30. Relationship of the Recommended Plan 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 U.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. 4321, et seq.	Full Compliance
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.

X. PROJECT PERFORMANCE ASSESSMENT MONITORING

This section summarizes the monitoring and data collection aspects of the Project which are not associated with Adaptive Management. The primary Project objectives have been summarized elsewhere in this document, and the performance assessment is designed to gauge progress toward meeting these objectives. Appendix K further discusses Adaptive Management and Monitoring.

Table 31 presents overall types, purposes, and responsibilities of monitoring and data collection; table 32 presents actual monitoring and data parameters grouped by Project phase, as well as data collection intervals; table 33 presents the post-construction evaluation plan, which displays the specific parameters and the levels of enhancement that the Project hopes to achieve.

Table 31. 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 features.	Sponsor	Sponsor	Sponsor
	Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field Station or Sponsor through Cooperative Agreements or Corps	HREP/Sponsor
Design	Data Collection for Design	Include quantification of Project objectives, design of Project, and development of performance evaluation plan.	Corps	Corps	HREP
Construction	Construction Monitoring	Assess construction impacts; assures permit conditions are met.	Corps	Corps	HREP
Post-Construction	Performance Evaluation Monitoring	Determine success of Project as related to objectives.	Corps (quantitative) Sponsor (field observations)	Field Station or Sponsor through Cooperative Agreement, Sponsor thru O&M, or Corps	HREP/Sponsor
	Biological Response Monitoring	Use performance monitoring and Adaptive Management and Monitoring results to evaluate predictions and assumptions of the habitat benefit evaluation. Study beyond scope of performance evaluation.	Corps	Corps	HREP

Table 32. Resource Monitoring and Data Collection Summary [1]

	WATER QUALITY DATA					**ENGINEERING DATA**			**NATURAL RESOURCE DATA**				
	Pre-Project Phase		**Design Phase**		**Post-Const. Phase**	**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**								**Agency**	**Remarks**
Point Measurements													
Water Quality Stations [2]												Corps	
Air Temperature	2W	6W	2W	6W	5Y								
Wind Direction	2W	6W	2W	6W	5Y								
Wind Velocity	2W	6W	2W	6W	5Y								
Percent Cloud Cover	2W	6W	2W	6W	5Y								
Wave Height	2W	6W	2W	6W	5Y								
Water Depth	2W	6W	2W	6W	5Y								
Velocity	2W	6W	2W	6W	5Y								
Dissolved Oxygen	2W	6W	2W	6W	5Y								
Water Temperature	2W	6W	2W	6W	5Y								
PH	2W	6W	2W	6W	5Y								
Specific Conductance	2W	6W	2W	6W	5Y								
Total Alkalinity	2W	6W	2W	6W	5Y								
Secchi Disk Transparency	2W	6W	2W	6W	5Y								
Turbidity	2W	6W	2W	6W	5Y								
Suspended Solids	2W	6W	2W	6W	5Y								
Chlorophyll	2W	6W	2W	6W	5Y								
Ice Thickness		6W		6W	5Y								
Snow Depth		6W		6W	5Y								
Boring Stations [3]													
Geotechnical Borings						1	1					Corps	
Fish Stations													

Table 32. Resource Monitoring and Data Collection Summary [1]

	WATER QUALITY DATA					ENGINEERING DATA			NATURAL RESOURCE DATA				
	Pre-Project Phase		**Design Phase**		**Post-Const. Phase**	**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**								**Agency**	**Remarks**
Electrofishing/Seining[4]									Y		Y	IA DNR	
Transect Measurements													
Vegetation Survey[5]											5 Y	IA DNR	
Mast Tree Survey[6]											25Y	Corps	
Sediment Transects/Bathymetry								5Y				Corps	
Mapping													
Aerial Imagery[7]						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 37 (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 36 (O-101): W-M422.2G, W-M422.3I, W-M422.4E, W-M422.5B, W-M422.5C, W-M422.7E and W-M422.7F .

Post-Construction water quality stations are shown on Plate 37 (O-102): W-M422.4E, W-M422.5B, W-M422.5C and W-M422.7E. Some of the water quality locations changed based on measure development.

[3] See Plate 7 (B-101) for geotechnical boring locations and Plates 8 and 9 (B-301 and B-302) for boring logs and dates.

[4] Fish sampling data by the Sponsor will begin at year 6 following Adaptive Management and Monitoring. It will be used to evaluate project effectiveness and results obtained from Adaptive Management and Monitoring activities.

[5] Vegetation Transects will begin at year 11 following Adaptive Management and Monitoring to determine the effectiveness of planting measures following construction.

[6] Mast Tree surveys will be conducted similar to the past 2 surveys on the Huron Island complex, or as best determined by foresters 25 years into the Project to determine tree planting effectiveness.

[7] Aerial imagery will be obtained at no cost from GIS resources such as National Agriculture Imagery Program (NAIP). A review of the aerial imagery will assist with determining overall project effectiveness.

Table 33. Post Construction Evaluation Plan [1]

Enhancement Features	Measurement	Unit	Year 0 w/o Alt	Year 1 w/ Alt	Year 25 w/ Alt	Year 50 Target w/ Alt	Feature Measurement	Annual Field Observations by Mgr.
Bathymetric Diversity of Goose Lake Backwater Area Pool 1 to Elevation 537 (T1).	Aquatic Habitat (deep water (>4 ft), low velocity (<1 cm/sec), high dissolved oxygen concentrations (> 5.0 mg/L), and increased water temperature (>4.0°C).	% Backwater	4%	80%	65%	50%	Water Quality Stations, Electrofishing, and sediment transects/bathymetry	Presence of fish during overwintering, spawning, rearing, and foraging seasons.
Bathymetric Diversity of Goose Lake Backwater Area Pool 2 at Elevation 537 (T3).	Coverage of Aquatic Vegetation	% Backwater	0%	[2]	70%	70%	Vegetation Transects	Visual presence during the growing season
Forest Diversity Adjacent to Pools 1 to Elevation 537 (F1)	Diverse Tree Population	% Trees	0%	[2]	75%	50%	Mast Tree Survey	Visual Observations
Forest Diversity Adjacent to Pools 2 to Elevation 537(F3)	Coverage of Emergent Aquatic Vegetation and Scrub Shrub Wetland Species	% Area Covered	0%	[2]	70%	70%	Vegetation Transects	Visual presence during the growing season
Forest Diversity in Non-Diverse Forested Area to Elevation 537 (F5).	Diverse Tree Population	% Trees	0%	[2]	75%	50%	Mast Tree Survey	Visual Observations
	Coverage of Emergent Aquatic Vegetation and Scrub Shrub Wetland Species	% Area Covered	0%		70%	70%	Vegetation Transects	Visual presence during the growing season
Garner Chute Closure Structure (T9)	Aquatic Habitat (deep water (>4 ft), low velocity (<1 cm/sec), high dissolved oxygen concentrations (> 5.0 mg/L), and increased water temperature (>4.0°C).	% Garner Chute	4%	95%	65%	50%	Water Quality Stations, Electrofishing, and sediment transects/bathymetry	Presence of fish during overwintering, spawning, rearing, and foraging seasons.
Side Channel Island Chevrons (I2)	Length of Existing Island Remaining	Length of Upper Island (ft)	400	400	450	515	Bathymetry and Aerial Photos	Visual Observations
		Length of Lower Island (ft)	200	200	275	365	Bathymetry and Aerial Photos	Visual Observations

[1] Refer to Section III, *Development of Project Objectives,* of this report for relationships between enhancement features and project goals and objectives.

[2] Refer to Adaptive Management Plan

XI. REAL ESTATE REQUIREMENTS

The Huron Island HREP is a part of the UMRR – EMP authorized by Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended. The Project is located on the Mississippi River in Pool 18 between RM 421.2 and 425.4.

All Project lands are presently owned by the United States and are under the control of the Corps. The USFWS manages these lands under a cooperative agreement between the USFWS and the Corps, dated January 19, 1961 and an amended cooperative agreement dated July 31, 2001. IA DNR manages these lands from USFWS under a cooperative agreement between USFWS and IA DNR for management of Corps general plan lands dated October 11, 1963 and amended March 22, 2012.

The USFWS is a Federal participant in the Project. The Project would be a100 percent Federal cost. A map showing the Project Area is included on Plate13 (C-104) 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 Huron Island.

Access to the Project would be by water (Mississippi River) from Hawkeye-Dolbee Boat Ramp (Appendix J).

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

A draft Memorandum of Agreement (MOA) between the USFWS and the Corps is included as Appendix C. The Real Estate Plan is included as Appendix J. Estimated operation and maintenance costs can be found in table 8-3.

XII. IMPLEMENTATION RESPONSIBILITIES AND VIEWS

A. U.S. Army Corps of Engineers

The Corps is responsible for Project management and coordination with the USFWS, the State of Iowa, and other affected agencies. The Corps will submit the subject DPR; 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(3) of WRDA 1986 states that the first cost funding for enhancement features will be 100 percent Federal cost because Project features will be located on federally-owned land that is managed by the USFWS as a national wildlife refuge. The Corps has agreed to support this HREP's monitoring and data collection needs as outlined in tables 32 and 33.

B. U.S. Fish and Wildlife Service

The USFWS is a Federal participant in the Project and has provided final comments for this Project pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.)

and the Endangered Species Act of 1973, as amended (Appendix A). The USFWS has agreed to support this HREP's monitoring and data collection needs as outlined in tables 32 and 33.

C. Iowa Department of Natural Resources

The IA DNR is a Project proponent and has provided technical and other advisory assistance during all phases of the Project and would continue to provide assistance during Project implementation. The Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) of the Project is the responsibility of the IA DNR in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. The annual OMRR&R costs are estimated at $10,293. These functions will be further specified in the Project O&M Manual to be provided by the Corps prior to final acceptance of the Project by the USFWS sponsor. Through a sponsor support letter (Appendix A, *Correspondence)*, the IA DNR has agreed to support this HREP's monitoring and data collection needs as outlined in tables 32 and 33.

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
Iowa State Historic Preservation Office
U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency

A. Coordination Meetings

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

- November 22, 2006. meeting with Corps, USFWS, ILDNR, IA DNR. Team discussed habitat sustainability
- August 2, 2007. meeting with Corps, USFWS, ILDNR,, IA DNR, University of AZ, University of IA. Team discussed flow levels, Project schedule, historic conditions, desired conditions
- February18, 2010. General scoping meeting with Corps, USFWS, and IA DNR
- December 2, 2011. visit with Corps, USFWS, and IA DNR
- December 19, 2011. Feasibility Scoping Meeting with Corps, USFWS, and IA DNR to review existing and future without Project conditions
- February 20, 2011 meeting with Corps, USFWS, and IA DNR to project future without Project conditions and future with Project conditions for use quantifying habitat benefits
- January 9-10, 2012. meeting with Corps, USFWS, and IA DNR to create a diagram and discuss potential measures
- July 10, 2012. visit with ERDC Corps, USFWS, and IA DNR to discuss potential aquatic vegetation plan

B. Coordination by Correspondence

- Letter dated April 24, 2006 from the MVD Director of Programs to the Rock Island District Commander approving the Huron Island and Beaver Island HREP fact sheets.

- Letter dated January 14, 2011 from the State Historical Society of Iowa to The Corps stating they concur with the Corps determination of no historic properties affected provided additional information is supplied.

- Letter dated September 01, 2011 from the Rock Island District to the Commander, USACE Headquarters requesting exclusion from Independent External Peer Review (IEPR) for the Huron Island HREP.

- Memorandum for Record dated September 09, 2011, which provides a summary of the discussions resulting from the Huron Island HREP NEPA scoping meeting.

- Letter dated September 28, 2011 from the USACE Mississippi Valley Division Commander to USACE Headquarters concurring with the recommendation of the Rock Island District Engineer and supporting the decision for exclusion from IEPR.

- Memorandum for Record dated December 19, 2011, which provides a summary of the discussions resulting from the Huron Island HREP feasibility scoping meeting held with the Mississippi Valley Division.

- Memorandum for Record dated January 12, 2012, which provides a summary of the discussions from the Planning Charette held with the Huron Island PDT, project sponsor, stakeholders, and other consulting parties.

- Scope of work dated February 02, 2012 provided to ERDC describing the work to be accomplished in support of the AdH sediment transport modeling for the Huron Island HREP study.

- Letter dated July 20, 2012 from the Rock Island District to the US Fish and Wildlife Service 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 7, 2013 from the US Fish and Wildlife Service to the Rock Island District transmitting the draft Fish and Wildlife Coordination Act (FWCA) for the Huron Island HREP.

- Email dated May 6, 2013 from the EPA Region 7 to the Rock Island District transmitting comments on the Public Review Draft DPR and Environmental Assessment.

- Public Review After Action Report dated June 26, 2013 documenting the open house held April 18, 2013, and the comments received from the public.

- Letter dated July 16, 2013 from the IADNR to the Rock Island District demonstrating their support of the Huron Island HREP for ecosystem restoration and their understanding and intent to support the operation and maintenance of the project.

- Email dated July 30, 2013 from the Rock Island District to the EPA Region 7 transmitting the District's responses to comments made on the Draft DPR and Environmental Assessment.

- Letter dated August 13, 2013 from the USFWS to the Rock Island District transmitting the final Fish and Wildlife Coordination Act Report and concurrence on determinations made by the District regarding federally endangered or threatened species listed under the Endangered Species Act.

C. Public Views and Comments

The *Draft DPR with Integrated Environmental Assessment* was distributed for a 30-day public, state, and agency review on April 9, 2013. During the public review we received comments from the IADNR (editorial in nature) and the EPA. Comments from the EPA were generally positive and included suggestions for clarifying document text, design, and improving readability. See Appendix A for more details on the comments received from EPA and the response from the Corps to the EPA.

During the public review period an open house was held (April 18, 2013) in Mediapolis, Illinois, to discuss the draft recommended plan with interested members of the public and to gather public input. Representatives from the Corps, USFWS, and IADNR were present to talk one-on-one with attendees. Maps of the recommended plan and copies of the report were arranged around the room. In addition, hand-outs of the Executive Summary, a project map, and a comment sheet were available for each attendee. Forty-seven members of the public attended the evening session. Eighteen comment sheets were returned. Respondents indicated they used the area for recreation, fishing, boating, and hunting. Some respondents owned cabins and land in the area. Generally, the most common response from the open house was uncertainty regarding the potential for increased bank erosion near the island protection features. Cabin owners and representatives from the Two Rivers Levee and Drainage Association are concerned that rock placement on the upstream point of the Huron Chute islands will result in increased river flow along the right descending bank in Huron Chute. The District conducted additional hydraulic modeling of Huron Chute to assess the Drainage District's concerns regarding the potential impacts. Various flows were modeled to compare changes in velocity under the existing condition, with-project condition, and complete removal of the islands. Based on the modeling efforts, there were no significant changes observed in the velocity, magnitude, or direction along the right descending bank under each scenario.

XIV. CONCLUSIONS

Full realization of the potential habitat value in Huron Island has been hindered by the sedimentation of off-channel areas and changed flow regimes due to impoundment which has led to the loss of diverse bottomland forests and deep-water, off-channel habitats. Establishing off-channel areas containing reliable aquatic/wetland habitat and establishing floodplain areas that would support survival and regeneration of hard mast-producing trees would allow the Project Area to realize the highest benefit to fish and migratory birds

The Recommended Plans restoration features for Huron Island (mechanically excavation sites, aquatic plantings, Garner Island closure structure, floodplain forest plantings, bank stabilization) are designed to meet the Project's objectives of restoring and protecting aquatic habitat and restoring floodplain forest habitat.

Assessment of the future with-Project scenario shows definite increases in total habitat units over the 50-year project life for the target species, as well as a majority of other aquatic and wetland dwelling species. These increases represent quantification of the Projected outputs: improved habitat quality and increased preferred habitat quantity.

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

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-19PR)

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

RECOMMENDATIONS

I have weighed the outputs to be obtained from the full implementation of the Huron 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 Project to include excavating backwaters, constructing topographic diversity, establishing floodplain forest, establishing aquatic vegetation, and bank stabilization of Huron Chute islands.

The current estimated Federal construction cost of this Project is $10,503,034. The total Federal estimated Project cost, including general design and construction management, is $12,818,353.

November 13 2013

Date

Mark J. Deschenes

Mark J. Deschenes
Colonel, U.S. Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-19PR)

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

FINDING OF NO SIGNIFICANT IMPACT

I have reviewed the information provided within this Definite Project Report with Integrated Environmental Assessment, along with data obtained from Federal and State agencies having jurisdiction by law or special expertise, and from the interested public. I find that the proposed habitat enhancement project in Pool 18, Des Moines 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.

An array of management measures were considered from which alternatives were derived. The measures include:

1. excavating within Huron Island backwaters;
2. constructing topographic diversity next to select excavation sites;
3. establishing native floodplain forest species on floodplain placement sites;
4. establishing native aquatic vegetation on excavated sites; and
5. constructing bank stabilization on Huron Chute small islands.

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

1. The Project is anticipated to improve the habitat value of Huron 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 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.

11-13-13

Date

Mark J. Deschenes
Colonel, U.S. Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX A

PERTINENT CORRESPONDENCE

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

REPLY TO
ATTENTION OF:

CEMVD-PD-SP 24 April 2006

MEMORANDUM FOR Commander, Rock Island District, ATTN: CEMVR-PM-M

SUBJECT: Upper Mississippi River Restoration (UMRR) - Fact Sheet Approval for the Huron Island, Des Moines County, Iowa, and Beaver Island, Clinton County, Iowa, Habitat Rehabilitation and Enhancement Projects (HREP)

1. Reference memorandum, CEMVR-PM-M, 21 March 2006, subject: Revised Appendix A-Project Study Issue Checklist for the Upper Mississippi River Restoration (UMRR) and Fact Sheet Approval for the Huron Island, Des Moines County, Iowa, and Beaver Island, Clinton County, Iowa, Habitat Rehabilitation and Enhancement Projects (HREP).

2. Subject fact sheets, as revised, are approved for continued HREP planning (encl).

Encl

MICHAEL B. ROGERS, P.E.
Director of Programs

CF:
CEMVD-PD-SP

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BEAVER ISLAND COMPLEX

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

Pool 14
Upper Mississippi River Mile
513.0 – 515.5

Clinton County, Iowa
Rock Island District

LOCATION:
The Beaver Island Complex project area is located along the right descending bank of the Upper Mississippi River near Clinton, Iowa. The 270-acre Beaver Island Complex represents 16% of Pool 14 backwater habitat. Project lands are federally owned by the Corps of Engineers and the U.S. Fish and Wildlife Service (USFWS). All the federally owned lands are managed by USFWS as part of the Upper Mississippi River National Wildlife and Fish Refuge, Savanna District. Upstream portions of the island are privately owned, but are not included in the project area.

RESOURCE PROBLEM:
The complex of backwaters and wetlands has historically provided spawning, nursery, and overwintering habitat for fish and feeding and resting habitat for migratory water birds. Excessive sedimentation has negatively affected the habitat quality and wetland functions of this valuable backwater complex.

PROJECT FEATURES:

* Dredge backwaters and connecting sloughs using a combination of hydraulic and/or mechanical dredging.
* Create nesting islands.
* Construct berms (using dredged material) to deflect sediment.
* Plant mast-producing trees on berms.
* Create isolated wetlands (potholes).
* Install a manual control structure or high water diversion gate on the upper end of the complex to reduce sediment loading, while introducing oxygen rich water into the complex when needed.

PROJECT OUTPUTS:
Dredging backwaters and connecting sloughs would provide critically important overwintering habitat for fish, such as bass, crappie, and bluegill. Isolated wetlands would restore feeding habitat for resident and migratory waterfowl, shorebirds, and wading birds. Mast tree plantings would increase species diversity and improve the existing timber stand. The project would maintain the quality and diversity of habitat in the largest backwater complex in Pool 14.

FINANCIAL DATA:
General design and construction costs are estimated at $600,000 and $4,000,000, respectively. A detailed construction cost estimate will be included in the draft Definite Project Report (DPR). Annual costs for operation, maintenance, and repair will be the responsibility of the U.S. Fish and Wildlife Service. The Iowa Department of Natural Resources is the project proponent.

STATUS:
General design of the project has begun. A draft DPR is scheduled for completion in 2007.

Revised 21 April 2006

HURON ISLAND COMPLEX

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

Pool 18
Upper Mississippi River Mile
421.2 - 425.4

Des Moines County, Iowa
Rock Island District

LOCATION:
The Huron Island Complex project area is located along the right descending bank of the Upper Mississippi River in the northern portion of Des Moines County, Iowa (RM 421.2 to 425.4). The 2,000 acre project area includes Huron Chute. The project lands are federally owned by the Corps of Engineers and are part of the Mark Twain National Wildlife Refuge Complex. The U.S. Fish and Wildlife Service has granted management of the project area to the Iowa Department of Natural Resources through a cooperative agreement.

RESOURCE PROBLEM:
The Huron Island Complex is a heavily forested island complex. The project includes 164 acres of backwater areas and 500 acres of secondary channels. Sedimentation in these areas has negatively affected fish and wildlife habitat by decreasing depth and reducing water clarity when fine sediments are resuspended by waves. Bankline sloughing in the upper portion of Huron Chute has caused degradation in near-shore habitat.

PROJECT FEATURES:

* Dredge backwaters and connecting sloughs using a combination of hydraulic and/or mechanical dredging.
* Construct berms at the upstream end of the island to deflect sediment-laden floodwaters.
* Plant mast-producing trees on berms.
* Create isolated wetlands (potholes)
* Protect banklines in Huron Chute

PROJECT OUTPUTS:
Dredging connecting channels and backwater lakes would provide important off-channel deep water habitat for fish. Shallow depression wetlands would provide feeding areas for resident and migratory waterfowl, shorebirds, and wading birds. Mast tree plantings would increase species diversity and improve the existing timber stand. The project would improve the quality and diversity of habitat in a major backwater complex in Pool 18.

FINANCIAL DATA:
General design and construction costs are estimated at $600,000 and $5,000,000, respectively. A detailed construction cost estimate will be included in the draft Definite Project Report (DPR). Annual costs for operation, maintenance, and repair will be the responsibility of the U.S. Fish and Wildlife Service. The Iowa Department of Natural Resources is the project proponent.

STATUS:
General design of the project has been initiated. A draft DPR is scheduled for completion in 2007.

STATE HISTORICAL SOCIETY *of* IOWA

A Division of the Iowa Department of Cultural Affairs

January 14, 2011

In reference to R & C#: 110129027

Mr. Brant Vollman
Economic and Environmental Analysis Branch
Corps of Engineers – Rock Island District
Clock Tower Building P.O. Box 2004
Rock Island, IL 61204-2004

RE: COE – DES MOINES COUNTY – W012EK-08-D-0002 – ROCK ISLAND DISTRICT – HURON ISLAND COMPLEX HABITAT REHABILITATION/ENHANCEMENT PROJECT – SECS. 3, 9, 10, 14-16, 21-23, AND 27, T72N-R1W – PHASE I ARCHAEOLOGICAL SURVEY [BCA 1710]

Dear Mr. Vollman,

We have received the Corps' January 7, 2011 letter and copy of the report entitled *Phase I Archeological and Geomorphological Survey f o0r the Huron Island Complex Habitat Rehabilitation and enhancement project, Huron Township, Des Moines County, Iowa [BCA #1710]* prepared by Messrs. David W. Benn and Lowell Blikre of Bear Creek Archeology, Cresco, Iowa. We provide the following review based upon the results of this investigation and in accordance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470 *et seq.*) and its implementing regulations 36 CFR Part 800 (revised, effective August 5, 2004).

Preliminary records review, pedestrian and shoreline reconnaissance, and subsurface sampling identified three (3) archaeological sites. One (13DM1305) is located within the revetment and confined spoil placement location that was subject to intensive phase I survey activities. This site is an abandoned boat landing comprised of an above-ground cinder block foundation and a low-density scatter of modern artifacts. Sites 13DM1306 and 13DM1156 are located outside of the revetment/spoil survey area, but within the larger Huron Island Complex study area. Respectively, these sites are a scatter of historic artifacts, and the unconfirmed location of a GLO map feature dating to the late 1830s.

The consulting archaeologist has recommended that sites 13DM1305 and 13DM1306 be considered ineligible for listing in the National Register of Historic Places. We agree with this assessment citing limited research potential, lack of antiquity, and site redundancy.

The consultant has also made recommendations regarding the archaeological potential for the larger study area based on their geomorphologic evaluation of the Huron Island Complex study area. We are in agreement with these recommendations with the caveat that a map is prepared and submitted to our office detailing those areas that possess archaeological potential and are to remain subject to future survey and those areas that are judged to be too recent to possess archaeological potential.

Based on the results of this investigation, and provided that the additional information is supplied, the Iowa SHPO is prepared to concur with the Corps' determination of 'no historic properties affected.'

If design changes are made for this project which would involve undisturbed new rights-of-way or easements, please forward additional information to our office for further comment along with the Agency Official's determination of effect. If project activities uncover an item(s) that might be of archeological, historical or architectural interest, or if important new archeological, historical or architectural data should be encountered in the project APE, the applicant should make reasonable efforts to avoid further impacts to the property until an assessment can be made by a qualified archaeologist.

600 EAST LOCUST STREET, DES MOINES, IA 50319-0290 P: (515) 281-5111

You may reach me at (515) 281-8744 or by email at Daniel.higginbottom@iowa.gov if you have any questions or require further assistance in this matter.

Sincerely,

Dan Higginbottom

Daniel K. Higginbottom, Archaeologist
Iowa State Historic Preservation Office

Cc: David Stanley, Project Manager, Bear Creek Archeology

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING - P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

SEP 01 2011

REPLY TO
ATTENTION OF
CEMVR-PM-M

MEMORANDUM THRU Commander, US Army Engineer Division, Mississippi Valley (CEMVD-PD-SP/Fred Ragan), P.O. Box 80, 1400 Walnut Street, Vicksburg, Mississippi 39181-0080

FOR Commander, U.S. Army Corps of Engineers, Headquarters (CECW-P/Tab Brown), 441 G. Street, NW, Washington, DC 20314-1000

SUBJECT: Request for Exclusion from Independent External Peer Review (IEPR) for the Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) Huron Island Habitat Rehabilitation and Enhancement Project (Project).

1. References:

a. Engineering Regulation 1105-2-100, Appendix F, dated 22 Apr 2000, Subject: Planning Guidance Notebook

b. Engineer Circular 1165-2-209, Appendix D, dated 31 Jan 2010, Subject: Civil Works Review Policy

2. Project Background and Implementation Guidance: The UMRR – EMP was authorized by Section 1103 of Water Resources Development Act, Public Law 99-662 as enacted on November 17, 1986.

> "(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 change of such association or agency to the Congress for approval within 90 days of the receipt of such comments or recommended changes.

(e)(1) The Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, is authorized to undertake, as identified in the master plan-- (A) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement; (B) implementation of a long -term resource monitoring program; and (C) implementation of a computerized inventory and analysis system.
(2) Each program referred to in paragraph (1) shall be carried out for ten years. Before the last day of such ten-year period, the Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall conduct an evaluation of such programs and submit a report on the results of such evaluation to Congress.
Such evaluation shall determine each such program's effectiveness, strengths, and weaknesses and contain recommendations for the modification and continuance or termination of such program.
(3) For purposes of carrying out paragraph (1)(A) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $8,200,000 for the first fiscal year beginning after the date of enactment of this Act, not to exceed $12,400,000 for the second fiscal year beginning after the date of enactment of this Act, and not to exceed $13,000,000 per fiscal year for each of the succeeding eight fiscal years.
(4) For purposes of carrying out paragraph (1)(B) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $7,680,000 for the first fiscal year beginning after the date of enactment of this Act and not to exceed $5,080,000 per fiscal year for each of the succeeding nine fiscal years.
(5) For purposes of carrying out paragraph (1)(C) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $40,000 for the first fiscal year beginning after the date of enactment of this Act, not to exceed $280,000 for the second fiscal year beginning after the date of enactment of this Act, not to exceed $1,220,000 for the third fiscal year beginning after the date of enactment of this Act, and not to exceed $875,000 per fiscal year for each of the succeeding seven fiscal years.

(1) in subsection (e)(7)—
(A) in subparagraph (A), by striking ''(1)(A)'' and inserting ''(1)(A)(i)''; and
(B) in subparagraph (B), by striking ''paragraphs (1)(B) and (1)(C)'' and inserting ''paragraph (1)(A)(ii)''; and (2) in subsection (f)(2)—
(A) by striking ''(2)(A)'' and inserting ''(2)''; and
(B) by striking subparagraph (B).

3. The Review Plan, prepared by CEMVR, conducted a risk informed decision process that concluded that the Project does not meet any of the criteria for IEPR and that it would not benefit from an IEPR.

4. According to Reference 1b, any of the following factors requires IEPR:

a. The Project area is currently utilized for environmental habitat and poses no risk to human life; the recommended features will not change that condition.

b. Total cost of an Environmental Management Program project is greater than $45 million: The estimated total Project cost is $8,000,000.

c. Where the Governor of an affected State requests a peer review by independent experts: There has been no request for IEPR by the Governor of the State of Iowa.

d. Request of IEPR by a state or Federal agency: The State of Iowa and the Fish and Wildlife Service, which are participating in the development of the Project features, have not requested IEPR of the Project nor has any Federal Agency.

e. Controversy due to significant public dispute over the size, nature, or effects of the Project or the economic/ environmental costs or benefits of the Project: No controversy exists for this Project and none is expected to since the Project footprint is small in nature, does not impact individual landowners and is more environmentally beneficial than the current habitat.

f. Methods are novel or complex. The Project does not involve novel or complex design or construction techniques. The proposed types of environmental features have been constructed by CEMVR for the UMRR–EMP for 25 years and can be found in the UMRR-EMP Handbook.

g. Chief of Engineers determines IEPR is necessary. To date, the Chief of Engineers has not determined that IEPR is necessary.

h. When a decision document does not trigger a mandatory Type I IEPR, it is appropriate to make a risk-informed decision. The subject Project is very limited in scope, cost and risk such that it would not significantly benefit from IEPR.

5. Additional Review Efforts: Reference 1b establishes a comprehensive life-cycle review strategy for Civil Works products by providing a seamless process for review of all Civil Works projects from initial planning through design, construction, and Operation, Maintenance, Repair, Replacement and Rehabilitation. Reference 1b specifies the procedures for ensuring the quality

and credibility of USACE decision, implementation,.and operations and maintenance documents and work products. It presents a framework for establishing the appropriate level of independence of reviews as well as detailed requirements, including documentation and dissemination. In addition, Reference 1b achieves the stated purpose through three primary mechanisms: the previously discussed IEPR (when required); District Quality Control (DQC)/Quality Assurance (QA); and Agency Technical Review (ATR). The DQC/QA and ATR are discussed as follows in relation to the subject Project along with the model certification.

a. The Project is undergoing rigorous DQC during development of the objectives, features and report. The Technical and Policy Compliance Checklist, Certification of Legal Review by District Counsel and the Finding of No Significant Impact will provide documentation at the completion of the major DQC milestones.

b. A comprehensive ATR of the feasibility package will be conducted in 2012. Reviewers included experts in the following disciplines:

- Planning and Policy
- Environmental and NEPA Compliance
- Socio-Economic Resources
- Civil Engineering
- Hydrology and Hydraulic Engineering
- Cost Engineering
- Geotechnical Engineering
- Real Estate

6. Other Issues: The Project continues to be a high priority ecosystem restoration project for the Sponsor.

7. For reference, see the endorsement signed by the Chief of Engineering and Construction Division (Encl 1) and draft Review Plan (Encl 2).

8. Recommendation: The CEMVR recommends to the Chief of Engineers that exclusion be granted from conducting an IEPR on any phase of the UMRR-EMP Huron Island Habitat Rehabilitation and Enhancement Project.

9. The point of contact for this action is Mr. Steve Rumple, UMRR-EMP CEMVR Project Manager, (309) 794-5565 or e-mail: stephen.t.rumple@usace.army.mil.

SHAWN P. MCGINLEY
COL, EN
Commanding

2 Encls
as

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING - P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

MEMORANDUM FOR RECORD

SUBJECT: Engineering and Construction Chiefs Endorsement of Exclusion from Independent External Peer Review (IEPR) for the Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) Huron Island Habitat Rehabilitation and Enhancement Project.

I have reviewed the UMRR-EMP Huron Island Habitat Rehabilitation and Enhancement Project and determined it does not contain risks that would require an IEPR in accordance with EC 1165-2-209. A Safety Assurance Review is also not required for this Project. The scope of the Project is small and includes measures that have been used consistently in ecosystem restoration projects. The Project will not pose a significant threat to human life; the cost is approximately $8,000,000; the Governor does not request an IEPR; the Project study is not controversial and does not have significant economic or environmental costs or benefits.

The Project is not likely to have a significant adverse impact on environmental, cultural, or other resources; does not include an Environmental Impact Statement; is not controversial; has negligible impact on scarce or unique tribal, cultural, or historic resources; has no substantial adverse impacts on fish and wildlife habitat; and has negligible adverse impact on threatened and endangered species.

Denny A. Lundberg
Chief of Engineering and Construction

ENCLOSURE 1

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MVD CAP Review Plan Checklist

Date:	06 SEP 2011
Originating District:	MVR
Project/Study Title:	Huron Island Complex
P2# and AMSCO#:	134085
District POC:	Steve Rumple
MSC Reviewer:	
CAP Authority:	N/A
Other Program Directed to follow CAP Processes: Environmental Management Program (EMP)	

Please fill out this checklist and submit with the draft Review Plan when coordinating with the MSC. Any evaluation boxes checked "No" may indicate the project may not be able to use the MVD Model Review Plan. Further explanation may be needed or a project specific review plan may be required. Additional coordination and issue resolution may be required prior to MSC approval of the Review Plan. Checklist may be limited to Section I or Section II or Both, depending on content of review plan (or subsequent amendments).

Section I - Decision Documents

REQUIREMENT	EVALUATION
1. Is the Review Plan (RP) for a Continuing Authorities Project? **Or Other Program Directed to follow CAP Processes?**	Yes ☐ No ☒ Yes ☒ No ☐
a. Does it include a cover page identifying it as following the Model RP and listing the project/study title, originating district or office, and date of the plan?	a. Yes ☒ No ☐
b. Does it include a table of contents?	b. Yes ☒ No ☐
c. Is the purpose of the RP clearly stated?	c. Yes ☒ No ☐
d. Does it reference the Project Management Plan (PMP) of which the RP is a component?	d. Yes ☒ No ☐
e. Does it succinctly describe the levels of review: District Quality Control (DQC), Agency Technical Review (ATR), and Independent External Peer Review (IEPR) if applicable for Sec 103 or Sec 205?	e. Yes ☒ No ☐
f. Does it include a paragraph stating the title, subject, and purpose of the decision document to be reviewed?	f. Yes ☒ No ☐
g. Does it list the names and disciplines of the Project Delivery Team (PDT)?* **Note: It is highly recommended to put all team member names and contact information in an appendix for easy updating as team members change or the RP is updated.* **Comments:**	g. Yes ☒ No ☐

ENCLOSURE 2

2. Is the RP detailed enough to assess the necessary level and focus of the reviews?	Yes ☒ No ☐
3. Does the RP define the appropriate level of review for the project/study?	Yes ☒ No ☐
a. Does it state that DQC will be managed by the home district in accordance with the MVD and district Quality Management Plans? b. Does it state that ATR will be managed by MVD? c. Does it state whether IEPR will be performed? For Sec 103 and Sec 205, see additional questions in 5. below. **Comments:**	a. Yes ☒ No ☐ b. Yes ☒ No ☐ c. Yes ☒ No ☐
4. Does the RP explain how ATR will be accomplished?	Yes ☒ No ☐
a. Does it identify the anticipated number of reviewers? b. Does it provide a succinct description of the primary disciplines or expertise needed for the review (not simply a list of disciplines)? c. Does it indicate that ATR team members will be from outside the home district? d. Does it indicate where the ATR team leader will be from? e. If the reviewers are listed by name, does the RP describe the qualifications and years of relevant experience of the ATR team members?* **Note: It is highly recommended to put all team member names and contact information in an appendix for easy updating as team members change or the RP is updated.* **Comments:** Anwer to question e. is NA since names of ATR team are not included	a. Yes ☒ No ☐ b. Yes ☒ No ☐ c. Yes ☒ No ☐ d. Yes ☒ No ☐ e. Yes ☐ No ☐
5. For Sec 103 and Sec 205 projects, does the RP explain how IEPR will be accomplished?	Yes ☐ No ☐ n/a ☒
a. Is an exclusion being requested, requiring CG approval? b. Does it provide a defensible rationale for the decision on IEPR? c. If IEPR is required, does it state that IEPR will be managed by an Outside Eligible Organization, external to the Corps of Engineers? d. If IEPR is required, does the RP indicate which PCX will manage the IEPR and whether any coordination with the PCX has occurred? **Comments:**	a. Yes ☐ No ☐ b. Yes ☐ No ☐ c. Yes ☐ No ☐ d. Yes ☐ No ☐
6. Does the RP address review of sponsor in-kind contributions?	Yes ☒ No ☐

7. Does the RP address how the review will be documented?	Yes ☒ No ☐
a. Does the RP address the requirement to document ATR and IEPR comments using Dr Checks? b. Does the RP explain how the IEPR will be documented in a Review Report? c. Does the RP document how written responses to the IEPR Review Report will be prepared? c. Does the RP detail how the district will disseminate the final IEPR Review Report, USACE response, and all other materials related to the IEPR on the internet and include them in the applicable decision document? **Comments:**	a. Yes ☒ No ☐ b. Yes ☐ No ☐ n/a ☒ c. Yes ☐ No ☐ n/a ☒ d. Yes ☐ No ☐ n/a ☒
8. Does the RP address Policy Compliance and Legal Review?	Yes ☒ No ☐
9. Does the RP present the tasks, timing and sequence (including deferrals), and costs of reviews?	Yes ☒ No ☐
a. Does it provide a schedule for ATR including review of the Alternative Formulation Briefing (AFB) materials and final report? b. Does it present the timing and sequencing for IEPR? c. Does it include cost estimates for the reviews?	a. Yes ☒ No ☐ b. Yes ☐ No ☐ n/a ☒ c. Yes ☒ No ☐
10. Does the RP indicate the study will address Safety Assurance factors? Factors to be considered include: • Where failure leads to significant threat to human life • Novel methods\complexity\ precedent-setting models\policy changing conclusions • Innovative materials or techniques • Design lacks redundancy, resiliency of robustness • Unique construction sequence or acquisition plans • Reduced\overlapping design construction schedule	Yes ☐ No ☐ n/a ☒ **Comments:**
11. Does the RP address opportunities for public participation?	Yes ☒ No ☐
12. Does the RP indicate ATR of cost estimates will be conducted by pre-certified district cost personnel who will coordinate with the Walla Walla Cost DX?	Yes ☒ No ☐
13. Has the approval memorandum been prepared and does it accompany the RP?	Yes ☒ No ☐

Section II - Implementation Documents

Please fill out this checklist and submit with the draft Review Plan or subsequent Review Plan amendments when coordinating with the MSC. For DQC, the District is the RMO; for ATR and Type II IEPR, MVD is the RMO. Any evaluation boxes checked "No" indicate the RP possibly may not comply with MVD Model Review Plan and should be explained. Additional coordination and issue resolution may be required prior to MVD approval of the Review Plan.

REQUIREMENT	EVALUATION
1. Are the implementation documents/products described in the review or subsequent amendments?	Yes ☒ No ☐
2. Does the RP contain documentation of risk-informed decisions on which levels of review are appropriate?	Yes ☒ No ☐
3. Does the RP present the tasks, timing, and sequence of the reviews (including deferrals)?	Yes ☒ No ☐
a. Does it provide an overall review schedule that shows timing and sequence of all reviews? b. Does the review plan establish a milestone schedule aligned with the critical features of the project design and construction?	a. Yes ☒ No ☐ b. Yes ☒ No ☐
4. Does the RP address engineering model review requirements?	Yes ☒ No ☐
a. Does it list the models and data anticipated to be used in developing recommendations? b. Does the RP identify any areas of risk and uncertainty associated with the use of the proposed models? c. Does it indicate the certification/approval status of those models and if review of any model(s) will be needed? d. If needed, does the RP propose the appropriate level of review for the model(s) and how it will be accomplished?	a. Yes ☒ No ☐ b. Yes ☒ No ☐ c. Yes ☒ No ☐ d. Yes ☐ No ☐ NA
5. Does the RP explain how and when there will be opportunities for the public to comment on the study or project to be reviewed?	Yes ☒ No ☐
6. Does the RP address expected in-kind contributions to be provided by the sponsor? If expected in-kind contributions are to be provided by the sponsor, does the RP list the expected in-kind contributions to be provided by the sponsor?	Yes ☐ No ☒ Yes ☐ No ☐ NA

7. Does the RP explain how the reviews will be documented?	Yes ☒ No ☐
a. Does the RP address the requirement to document ATR comments using Dr Checks and Type II IEPR published comments and responses pertaining to the design and construction activities summarized in a report reviewed and approved by the MSC and posted on the home district website? b. Does the RP explain how the Type II IEPR will be documented in a Review Report? c. Does the RP document how written responses to the Type II IEPR Review Report will be prepared? d. Does the RP detail how the district/MVD will disseminate the final Type II IEPR Review Report, USACE response, and all other materials related to the Type II IEPR on the internet?	a. Yes ☒ No ☐ b. Yes ☐ No ☐ NA c. Yes ☐ No ☐ NA d. Yes ☐ No ☐ NA
8. Has the approval memorandum been prepared and does it accompany the RP?	Yes ☒ No ☐

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MODEL REVIEW PLAN

Using the MVD Model Review Plan

for the

Upper Mississippi River Restoration -Environmental Management Program (UMRR-EMP)

and

Referencing the UMRR-EMP Programmatic Review Plan

Huron Island Complex Des Moines County, Iowa – Mississippi River, Pool 18, River Mile 421-2-425.4

Rock Island District

MSC Approval Date: *Pending*
Last Revision Date: *None*

US Army Corps
of Engineers ®

ENCLOSURE 2

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Review Plan
Using the MVD Model Review Plan

Huron Island Complex Des Moines County, Iowa – Mississippi River, Pool 18, River Mile 421-2-425.4

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REVIEW PLAN

Huron Island Complex Des Moines County, Iowa – Mississippi River, Pool 18, River Mile 421-2-425.4

1. Purpose and Requirements

a. Purpose

This Review Plan defines the scope and level of peer review for the *Huron Island Complex Des Moines County, Iowa – Mississippi River, Pool 18, River Mile 421-2-425.4*. *Products included for review are an environmental and cultural assessment; plan formulation; cost estimate; incremental cost analysis; hydraulic and hydrologic analysis; geotechnical analysis; real estate plan; and drawings and specifications. This Review Plan is for decision documents and implementation documents. This review plan is a component of the project manamgement plan located on projectwise at* Huron Island_Approved_PMP_134805_2010-07-22.pdf

The Environmental Management Program (EMP) study and construction authority is contained in the EMP Programmatic Review Plan (EMP PRP), Section IV.

b. Applicability

This review plan is based on the MVD Model Review Plan, which is applicable to projects that do not require Independent External Peer Review (IEPR), as defined by the mandatory Type I IEPR triggers contained in EC 1165-2-209, Civil Works Review Policy.

Tha applicability regarding the EMP is contained in the EMP PRP, Section II.

c. References

Reference materials are shown in the EMP PRP.

2. Review Management Organization (RMO) Coordination

RMO coordination will be in accordance with the MP PRP, Sections I, III, VI, and VIII.

3. Project Information

a. Decision and Implementation document

The *Huron Island Complex Des Moines County, Iowa – Mississippi River, Pool 18, River Mile 421-2-425.4* decision document *and implementation document* will be prepared in accordance with ER 1105-2-100, Appendix F, Amendment #2. The approval level of the decision document (if policy compliant) is MVD. An Environmental Assessment (EA) will be prepared along with the decision document. *An implementation document (Plans and Specifications), will also be prepared for implementation of the project and will undergoDQC and ATR review.*

b. Study/Project Description

Huron Island Complex is a 2,000 acre area federally owned by the Corps of Engineers and managed by the US Fish and Wildlife Service. The US Fish and Wildlife Service has granted management of the project area to the Iowa Department of Natural Resource through a cooperative agreement. The project includes 164 acres of backwater areas and 500 acres of secondary channels. Sedimentation in these areas has negatively affected fish and wildlife habitat by decreasing depth and reducing water clarity when fine sediments are resuspended by waves. The Huron Island Complex is a heavily forested island complex. The forested area has declined from a diverse forested wetland to a mono-typical silver maple *complex. The forested area has declined from a diverse forested wetland to a mono-typical silver maple forested wetland. Potential project features to address these problems are dredging (mechanical or hydraulic), water control structures, berm, potholes, J-hooks, tree plantings, and vanes. Based off of the project features currently used in the EMP handbook the associated costs are estimated around $8 mil. There are no existing or anticipated policy waiver requests.*

c. Factors Affecting the Scope and Level of Review

The factors affecting the scope and level of review are discussed in the EMP PRP, Section V.

d. In-Kind Contributions

Products and analyses provided by non-Federal sponsors as in-kind services are subject to District Quality Control (DQC) and ATR, similar to any products developed by USACE. *No in-kind products are anticipated.*

4. District Quality Control (DQC)

District Quality Control (DQC) will be conducted in accordance with the EMP PRP, Section III.A.

5. Agency Technical Review (ATR)

The Agency Technical Review (ATR) will be conducted in accordance with the EMP PRP, Sections III.B and VI.C.

6. Policy and Legal Compliance Review

The Policy and Legal Compliance Reviews will be conducted in accordance with the EMP PRP, Section III.D.

7. Cost Engineering Directory of Expertise (DX) Review and Certification

Cost Engineering Directory of Expertise (DX) Review and Certification will be conducted in accordance with the EMP PRP, Section VIII.D.

8. Model Certification and Approval

Approval of planning and engineering models used in EMP projects will be in accordance with the EMP PRP, Section III.E, and Section VII.

Table 1. Planning Models That May Be Used in the Development of Huron Island Complex

Model Name and Version	Brief Description of the Model and How It Will Be Applied in the Study	Certification / Approval Status
IWR-Plan	The IWR-Plan was developed by Institute of Water Resources as accounting software to compare habitat benefits among alternatives. This model will be used to determine best buy plans and incremental cost analysis of alternatives	Certified
Wildlife Habitat Appraisal Guide (WHAG)	The WHAG model is a field evaluation procedure, originally developed by the Missouri Department of Conservation, NRCS and USACE, designed to measure the quality of habitat for 12 select, representative avian and wildlife species. These indicator species were chosen to represent the needs of a wider variety of species and habitat requirements. Results of the WHAG model are used to evaluate among potential species-specific or aggregate habitat improvements or detriments associated with proposed project alternatives as part of the overall USACE ecosystem restoration planning process. This model may be used to determine the floodplain habitat units of Huron Island's existing conditions, future without project conditions and alternative plans.	Review In Process
Aquatic Habitat Appraisal Guide (AHAG)	The AHAG model is a field evaluation procedure, originally developed by the Engineer Research and Development Center (ERDC) and Rock Island District, designed to measure the quality of habitat for 11 select, representative fish species. These indicator species were chosen to represent the needs of a wider variety of species and habitat requirements. Results of the AHAG model are used to evaluate among potential species-specific or aggregate habitat improvements or detriments associated with proposed project alternatives as part of the overall USACE ecosystem restoration planning process. This Model may be used to determine the aquatic habitat units of Huron Island's existing conditions, future without project conditions and alternative plans.	Review In Process
USFWS Habitat Suitability Index Models for other species (HEP or Bluebooks)	Habitat Evaluation Procedure (HEP) is a species-habitat approach to impact assessment and habitat quality for selected evaluation species document with an index, the Habitat Stability Index (HIS). This value is derived from an evaluation of the ability of key habitat components to compare existing habitat conditions and optimum habitat conditions for the species of interest. There are currently 166 models for invertebrates, fish, amphibians, reptiles, birds, mammals, and communities. Since the review process is not complete on WHAG and AHAG the HEP procedure is an alternative model choice to determine the wetland and aquatic habitat units associated with the project. As the project progresses a determination will be made as to which model is more appropriate.	Approved, pending certification of spreadsheets or other accounting software

Table 2. Engineering Models That Are Being Used in the Development of EMP Projects

Model Name and Version	*Brief Description of the Model and How It Will Be Applied in the Study*
ADH 2-dimensional hydraulic model	*Adaptive Hydraulics Modeling (ADH) system developed by the Coastal and Hydraulics Laboratory, ERDC, USACE (and is capable of handling both saturated and unsaturated groundwater, overland flow, three-dimensional Navier-Stokes flow, and two- or three-dimensional shallow water problems. One of the major benefits of ADH is its use of adaptive numerical meshes that can be employed to improve model accuracy without sacrificing efficiency. It also allows for the rapid convergence of flows to steady state solutions. ADH contains other essential features such as wetting and drying, completely coupled sediment transport, and wind effects.* *ADH will be used to simulate a 2-dimensional (longitudinal and lateral) variation in water surface elevation, flow velocity, and flow direction in project areas. Model results for existing conditions, future without, and alternatives will be compared to determine whether project objectives are being achieved. Sediment transport simulations will be done.*

9. Review Schedules and Costs

a. DQC Schedule and Cost.

(1) *DQC Estimated Schedule*

Event	*Kick-off*	*Reviewer Comments End*	*PDT Evaluation*	*Back Check*	*Complete*
Feasibility	*03/10/12*	*03/24/12*	*04/01/12*	*04/10/12*	*04/16/12*
P&S DQC	*04/08/13*	*04/22/13*	*04/30/13*	*05/10/13*	*05/17/13*

(2) *DQC Estimated Cost*

Reviewer	*Feasibility*	*P&S*	*Total Cost*
Planner	*$1,000*		*$1,000*
Engineer	*$1,000*	*$2,000*	*$3,000*
Natural Resources	*$1,000*		*$1,000*
Cost Estimate	*$1,500*	*$2,000*	*$3,500*
Real Estate	*$1,000*		*$1,000*
Geotech	*$1,000*	*$2,000*	*$3,000*
H&H	*$1,500*	*$2,000*	*$3,500*
TOTAL	*$8,000*	*$8,000*	*$16,000*

b. ATR Schedule and Cost

(1) *ATR Estimated Schedule*

Event	Kick-off	Reviewer Comments End	PDT Evaluation	Back Check	Complete
Pre AFB ATR	04/17/12	05/04/12	05/18/12	06/02/12	06/12/12
AFB Conference	06/13/12	NA	NA	NA	07/13/12
Pre Final DPR ATR	07/14/12	NA	NA	NA	07/30/12
P&S ATR	05/20/13	06/15/13	06/30/13	07/19/13	08/13/13

(2) *ATR Estimated Cost*

Reviewer	ATR Pre AFB	ATR Feasibility	ATR P&S	Cost
ATR Lead (AFB review included)	$2,000	$1,000	$2,000	$5,000
Planner	$2,000	$1,000		$3,000
Engineer	$2,000	$1,000	$2,000	$5,000
Natural Resources	$2,000	$1,000		$3,000
Cost Estimate	$2,500	$500	$2,500	$5,500
Real Estate	$2,000	$500	$2,000	$4,500
Geotech	$2,000	$500	$2,000	$4,500
H&H	$3,000	$500	$3,000	$6,500
TOTAL	$17,500	$6,000	$13,500	$37,000

10. Public Participation

Public review will be in accordance with the EMP PRP, Section VI.F

11. Review Plan Approval and Updates

The Review Plan approval process will be in accordance with the EMP PRP, Section VIII.B.

12. Review Plan Points Of Contact

Public questions and/or comments on this review plan can be directed to the following points of contact:

- *Steve Rumple, Rock Island District Program Manager, (309)794-5565 - MVR*
- *Monique Savage, Rock Island District Plan Formulator, (309) 794-5342 - MVR*
- *Fred Ragan, Rock Island District Support Team Chief, (601) 634-5310 -MVD*

Attachment 1: Team Rosters

PRODUCT DELIVERY TEAM ROSTER - 2011

Name	*Title*	*Contact Information*
Kathy Henry	*Sponsor- FWS Service*	*319-523-6982*
Bernie Schonhoff	*Proponent - IA DNR*	*563-263-5062*
Mike Griffin	*Proponent - IA DNR*	*563-872-5700*
Marv Hubbell	*Regional Program Manager*	*Marvin.E.Hubbell@usace.army.mil*
Steve Rumple	*Program Manager*	*Stephen.T.Rumple@usace.army.mil*
Monique Savage	*Plan Formulator*	*Monique.E.Savage@usace.army.mil*
Heather anderson	*Senior Project Engineer*	*Heather.L.anderson@usace.army.mil*
Kara Mitvalsky	*Project Engineer*	*Kara.N.Mitvalsky@usace.army.mil*
Lucie Sawyer	*Hydraulic & Hydrologic Engineer*	*Lucie.M.Sawyer@usace.army.mil*
Felix Castro-Calderon	*Geotechnical Engineer*	*Felix.R.Castro-Calderon@usace.army.mil*
Mike Cummings	*Cost Engineer*	*Michael.R.Cummings@usace.army.mil*
Nate Richards	*NEPA Compliance Specialist*	*Nathan.S.Richards@usace.army.mil*
Brant Vollman	*Cultural Resources Specialist*	*Brant.J.Vollman@usace.army.mil*
Jason Appel	*Real Estate Specialist*	*Jason.C.Appel@usace.army.mil*
Mark Pratt	*Construction POC*	*Mark.R.PRatt@usace.army.mil*
Allen Giger	*Survey Engineer*	*Allen.Giger@usace.army.mil*
Tom Minear	*District Counsel*	*Thomas.B.Minear@usace.army.mil*
LaShell Harper	*Lead Technician*	*LaShell.L.Harper@usace.army.mil*
Emily Johnson	*Support Technician*	*Emily.J.Johnson@usace.army.mil*
Donna Jones	*Regulatory*	*Donna.M.Jones@usace.army.mil*

DISTRICT QUALITY CONTROL ROSTER - 2011

Name	*Title*	*Email*
Darron Niles	*Senior Plan Formulator*	*Darron.L.Niles@usace.army.mil*
Ken Barr	*Senior Environmental Specialist*	*Kenneth.A.Barr@usace.army.mil*
Ken Barr	*Senior Cultural Resource Specialist*	*Kenneth.A.Barr@usace.army.mil*
Rachel Fellman	*Senior Environmental Engineer*	*Rachel.C.Fellman@usace.army.mil*
Tom Kirkeeng	*Senior H&H Engineer*	*Thomas.A.Kirkeeng@usace.army.mil*
Jotham Povich	*Senior Geotechnical Engineer*	*Jotham.K.Povich@usace.army.mil*
Charlie Van Laarhoven	*Senior Cost Estimator*	*Charles.R.VanLaarhoven@usace.army.mil*
Debra VanOpdorp	*Senior Real Estate Specialist*	*Debra.J.VanOpdorp@usace.army.mil*

AGENCY TECHNICAL REVIEW ROSTER - 2011

Name	Title	Email
John Grothaus	ATR Team Leader	John.J.Grothaus@usace.amy.mil
TBD	Senior Plan Formulator	TBD
TBD	Senior Environmental Specialist	TBD
TBD	Senior Cultural Resource Specialist	TBD
TBD	Senior Environmental Engineer	TBD
TBD	Senior H&H Engineer	TBD
TBD	Senior Geotechnical Engineer	TBD
TBD	Senior Cost Estimator	TBD
TBD	Senior Real Estate Specialist	TBD

MAJOR SUBORDINATE COMMAND ROSTER - 2011

Name	Title	Email
Fred Ragan, MVD	DST Planner	Fredrick.Ragan@usace.army.mil
Renee Turner, MVD	Program Manager	Renee.N.Turner@usace.army.mil

Attachment 2: Review Plan Revisions

Revision Date	Description of Change	Page/Paragraph Number

CEMVR-PD-F **09 SEP 2011**

MEMORANDUM FOR RECORD

SUBJECT: Huron Island HREP NEPA Scoping Meeting

1. The subject meeting was held on 09 SEP 2011 at the Iowa Department of Natural Resources (IA DNR) Wapello Field Office. The following representatives from the Rock Island District (CEMVR), U.S. Fish and Wildlife, and IA DNR were in attendance:

Monique Savage	USACE	monique.e.savage@usace.army.mil
Kara Mitvalsky	USACE	kara.n.mitvalsky@usace.army.mil
Nate Richards	USACE	nathan.s.richards@usace.army.mil
Steve Rumple	USACE	stephen.t.rumple@usace.army.mil
Jon Schultz	USACE	jon.r.schultz@usace.army.mil
Mike Griffin	IA DNR	michael.griffin@dnr.iowa.gov
Bill Ohde	IA DNR	bill.ohde@dnr.iowa.gov
Andy Robbins	IA DNR	andy.robbins@dnr.iowa.gov
Cathy Henry	FWS	cathy_henry@fws.gov
Jon Duyvejonck	FWS	jon_duyvejonck@fws.gov
Bob Clevenstine	FWS	robert_clevenstine@fws.gov

2. Meeting Agenda
   1) Overview of existing conditions collected by USACE
   2) Forest History and existing conditions
   3) Present day forest conditions and potential data inventory
   4) Present day forest stand mapping/potential project features
   5) Eagles Nests
   6) Heron/Egret Rookeries
   7) Identify waterfowl and migratory game bird hunting areas
   8) Wildlife
   9) Monitoring
   10) Future without project conditions
   11) Aquatic component potential features
   12) Soils and borings
   13) Measures
   14) Engineering and Design

3. Meeting Summary
   Meeting started with an overview of the agenda. Next team discussed the existing conditions and data USACE PDT has collected to date and what the draft objectives for the project are. Next we discussed in depth the forestry, aquatic, bird, herps, mammals, bugs that are affected by the different habitats associated with Huron Island. A main point made at the meeting was that diversity of habitat is a key component of the Huron Island Complex project, whether we were discussing forest age and composition diversity, or the diversity in fish species and their seasonal

habitat needs. At the meeting we also discussed the benefits of a phased planning approach so that we can monitor and adapt the project to meet the needs of this very dynamic system. Sponsor and team discussed narrowing the focus of the aquatic habitat needs to the SW area of the island. We also brainstormed over the measures that could be used to meet the objectives. The meeting was concluded by discussing the next meeting time and the timeline for the FSM.

Opportunities: Discuss existing conditions.

4. Summary of Agenda Items Discussed

   a. **Overview of existing conditions collected by USACE.** To date, the Corps has assembled the following data for the site:
      i. Phase I Archeological Study
      ii. Phase I Environmental Site Assessment (for Hazardous, Toxic, and Radioactive Waste)
      iii. Bathymetric Survey of interior channels and Huron Chute
      iv. LIDAR data for the island (obtained by the State of Iowa)
      v. 1982 Forest Inventory
      vi. Water Quality Data of Interior Channels
      vii. Geotechnical Borings of Interior Channels
      viii. Rough quantity calculations for extensive dredging as described in the sponsors fact sheet
      ix. Initial hydraulic modeling of the island

   b. **Monitoring.** Forestry surveys, additional bathymetric surveys and water quality data will be obtained in the project area.

   c. **Wildlife.** Fish and wildlife use in this area is extensive and includes waterfowl, neotropical migrants, shorebirds, bats, mammals and reptiles/amphibians. Snake use may be limited to water snakes in this area. More detail of existing wildlife should be included in our report.

   d. **Forest History and existing conditions.** Jon Schulz went into detailed discussions of the forest history. Huron Island was under an 80-100 year harvest rotation. Previous treatments included a thinning and clearcuts in 1985, and clearcuts in 1990-91. Leave trees (seed trees) were left within the cuts to assist with seed dispersal for regeneration purposes. Competitive herbaceous vegetation and frequent flood inundation has limited the success of natural regeneration in some of these harvest areas. Other harvest areas responded well and early succession tree species have started the process over again. Prescriptions were designed to promote diversity of age classes within the unit. There was a mutual agreement amongst Corps foresters and partnering managing agency IA DNR to reduce forest fragmentation through timber harvest on Huron Island due to the threat of reed canary grass (*Phalaris arundinacea*) filling in canopy voids. If timber harvest were to occur, we need to ensure there is follow-up active management within these areas to ensure success of volunteer or planted trees. This is among the most diverse forested island in the Upper Mississippi River, but the age of the trees is such that there is concern that the diversity could soon be lost. Based on 1982 forest inventory data, silver maple was the dominant canopy tree species on ¾ of Huron Island. Pin oak was the dominant canopy tree on approximately 200 acres. A contract will soon be awarded to obtain forest inventory on 690 acres including 380 acres of diverse stands and 310 acres of typical stands. This data will be compared to the 1982 data to assess forest health and diversity. In order for a healthy forest to sustain itself, it's very important to have diversity amongst tree species and differing age classes that occupy the various canopy classes (overstory, midstory, and understory). Updated forest inventory will assist in answering some of these questions.

e. **Potential project features to increase forest health and tree species diversity**

   i. Features including trees removal were: Timber Stand Improvement (Crop tree release); Shelterwood thinning; Harvest areas.
   ii. Features including tree planting were: Underplantings and plantings in canapy openings. Both hard and soft mast trees would be planted to address various habitat needs. For example, song birds just need a nice place to rest, and the soft mast trees can provide this. Planting for vertical and crown structure with eastern cottonwood and sycamore will also be considered. For example, trees with a complex structure could create a future heron rookery.
   iii. Manipulate elevations to increase diversity. This could occur through moving dirt within the existing island to create ridges, or could be created by placing adequate dredged material to increase elevations for tree plantings. The objective would be to make ridges and ephemeral wetlands for forestry. Mike Griffin has a copy of a report indicating what trees survive at various elevations and he will provide that to the PDT. This report can be used to ensure that the elevations and plantings are manipulated appropriately.
   iv. Invasive species and weed control must be managed after plantings. Many plantings are unsuccessult without some type of weed control or ongoing maintenance.

f. **Eagles Nests, Heron/Egret Rookeries, and waterfowl and migratory game bird hunting areas** were identified on the available drawings. Jon will update the drawings and share with the team.

g. **Soils and sediment.** Soil data has indicated that the material will not be conducive to hydraulic dredging (which also means no geotubes). Therefore, focusing measures on mechanical dredging is imperitive. Sedimentation has occurred across the island since inundation as evidenced by various transects across the island, although the sediment appears somewhat uniform. Channel boring indicate that the softer sediment layer is narrower in faster moving interior channels (often flushed out?) and if thicker in slower moving interior channels (not as often flushed and has time to settle into itself a bit).

h. Aquatic component potential features. It was recommended that these features be focused on the southwest portion of the island and within Huron Chute. Considerations included:

   i. Chevrons located near small islands in Huron Chute to protect these islands and to create deep holes before them for fish habitat.
   ii. Create in channel structures to create deep water habitat for fish in Huron Chute. We need to ensure that the Iowa bankline is not impacted due to cabins and a levee district being located along Huron Chute.

i. Future without project conditions. Generally, sedimentation could continue, trees could age and die, and the interior channels could fill in over time.

5. Meeting Minutes

- Monique Savage – Handed out last PDT meeting minutes and Draft Huron Island objectives
    - Increase native species diversity in the floodplain forest in areas above elevation xxx and below elevation xxx (for emerged aquatic vegetation). Target is xx percent increase in number of species present in these areas.
    - Increase aerial coverage in acres of native hard-mast producing trees in floodplain forest above elevation xxx. Target is xx percent increase in acres from existing conditions.
    - Maintain and increase depth diversity in backwaters of project area
    - Increase year round flowing side channel habitat areas at least 6 feet deep within the project area to provide habitat for fish and other aquatic species
    - Decrease streambank erosion in Huron Chute caused by flows over xx elevation to reduce amount of floodplain forest lost.

- Nate Richards - Main Focus of meeting is Existing Conditions
    - Anything we need to address or data availability
        - Habitat Available
        - Anything we need to address
        - Endangered Species
        - Migratory Birds
        - Heron Rookeries
- Jon Schultz-
    - Last tree inventory was 1982
        - Looked over inventory map, tree diversity map, age
        - 3/4 of island is silver maple
        - 2/3 of Huron island stand are 110-150 years old
            - Shelf life of Silver Maple is 80-100 years old
    - 1993 flood is believed to have changed tree diversity and created a relatively monotypical silver maple forest
    - Forest Diversity, Species and Age are all major components of forest
        - Kara Mitvalsky asked what is the turn over if you don't harvest – do all trees die off at once if the forest is a %100 mature-over mature
        - Jon responded yes that it can quickly and that you need diversity in age so there is regeneration
        - Huron was on an 80 yr cutting rotation – was not a lot of regeneration with seed trees and RPM tree plantings didn't take that is why its necessary to do several years of follow up for successful tree plantings – plant less stems per acre but do more follow up maintenance
        - timber buyers are interested in the mature trees either that or we have to pay for the trees to be hauled away
        - If we aren't careful that eventually Huron Island will look like Pool 9 with Reed Canary
        - Mike Griffin stated that Huron Island has better tree diversity than most areas on the Mississippi and that we need to keep what we have

        - Green Ash will be extinct in a 100 yrs
        - The problem is that Huron Island was higher before the L&D's were put in. Not that the elevation has changed but that the water level (Table) has increased so that the roots of the trees are inundated with water a higher percentage of the time
    - Going to look at what was already inventoried in 1982; 380 acres of diverse forest and 310 acres of what was silver maple single class
    - May have monies left over to do more, Jon has areas selected if that occurs
    - Jon believes cottonwood will be the #2 dominant species
    - Hackberry has become absent from floodplain forest would like to see it reinstated
    - Some areas of Huron are conducive to soft mass and some to hard; should plant accordingly
    - Worst case with a monotypical forest if something that impacts silver maple (flood, draught, disease) happens the impacts would be devastating to the neotropical birds as well as others in the habitat
    - Potential timber stand improvement
        - Reduce canopy by a 1/3
        - Will that impact duckblinds
        - Are there specific areas that need it
    - Persimmon progressing north due to change in climate- should we plant here
    - Take into effect climate change effects on elevation of trees for future
    - Hardly any buttonbush left at Huron

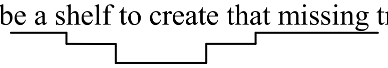
- Nate Richards - what about other wildlife concerns
    - Jon- are there different habitats at the different elevations
    - Kara Mitvalsky- Ridge and swale in the internal part of island instead of dredge material
        - Is the material good for trees
    - Monique Savage – will there be an issue with the 404 permit for wetland
    - Kara Mitvalsky– For Odessa elevation couldn't be over 540
    - Bob Clevenstine– Don't let that be a deterrent. Can still get permit but will have to get project permit, will not fall under a nation or regional.
    - Mike Griffin & Bob Clevenstine – discussion about hydraulic analysis by river mile of elevation needed for tree survival. Done with noting where certain trees where at that time. Mike will send Kara and Monique the model
- Nate Richards - what about neotropical and other bird concerns
    - There are local and nesting bird surveys out there for April, May August, September
    - No known specific bird areas to stay away from
    - Bill Ohde and Andy Robbins show Jon where there are known Eagle Nests and Heron Rookeries
    - Have Heron Rookeries increased or decreased at South End of Cody Chute
        - Bill Ohde-don't have survey data but can say visually its maintained its size, can tell its not abandoned since the birds are there in the spring
        - Heron's like open canopy – cottonwood and Sycamore since grow taller
        - Waterfowl use has decreased tremendously since the 80's, believe its due to the lack of aquatic vegetation

- Nate Richards - Indian bats
    - Bob Clevenstine – They're there but we don't have surveys for Huron Island

  - Indiana bats were found at Army Depot

- Snakes-
  - Water regime isn't conducive to copperbelly snake

- Mike Griffin – Most important but hardest to quantify and habitat to keep is the aquatic-terrestrial transition zone
  - Everyone uses it bugs, birds, herps, aquatic mammals, wading and shore birds
  - John Duyvejonck- need to use more than one model because of the mix of habitat
    - AHAG
    - WHAG
    - Bluebooks
    - May try to certify Jon tree model
  - No known data on herps and aquatic mammals
  - Island used to be used for trapping but not as much anymore
    - Muskrat have left since there is no emergent vegetation
  - Maybe a shelf to create that missing transition zone



  - Or draining a backwater to create an MSU for emergent vegetation
- Sedimentation
  - Kara Mitvalsky - Transect at River Mile 424 looks like sedimentation is uniform
  - Jon – need silty clay loam, less than 25% sand for it to be used for tree plantings
  - Bob Clevenstine, are geotubes a possibility for containing sediment?
    - Used in hydraulic, may not have enough loose material to justify
  - Huron Island is one of the most diverse islands in the area – need to keep what is good and not lose anymore
  - Diversity is a high priority- challenge to figure out what the best mix of habitat mosaic is

- Nate Richards – Aquatic needs
  - Would like to have all seasons for fish in Huron Island – general agreement
  - Data indicates that fish will come from 6 miles to use areas – don't need large area need good habitat
  - Bass master elite series 3 out of 4 top winners were in Huron

- Dredge cut into backwater area from Huron Island may not be a good idea. IADNR/FWS tried a similar thing across the River at Burnt Pocket to try to flush a backwater to keep it self scouring but instead it sedimented the backwater in instead.

- PDT meetings changed to twice a month
  - Monique will send out meeting time and call in number

6. POC for this memorandum is Monique Savage at (309) 794-5342

7. Attendees' comments were incorporated and minutes finalized on 20 Sept 2011.

Monique Savage
Plan Formulation Branch

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

REPLY TO
ATTENTION OF:

28 Sep 2011

CEMVD-PD-SP

MEMORANDUM FOR HQUSACE (CECW-MVD), WASH DC 20314-1000

SUBJECT: Request for Exclusion from Independent External Peer Review (IEPR) for the Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) Huron Island Habitat Rehabilitation and Enhancement Project (Project)

1. References:

a. Memorandum, CEMVR-PM-M, 1 September 2011, subject as above (encl).

b. EC 1165-2-209, Civil Works Review Policy, CECW-CP, 31 January 2010.

2. Endorsed for your approval is the recommendation of the Rock Island District that an exclusion be granted from conducting IEPR on the UMRR-EMP, Huron Island Habitat Rehabilitation and Enhancement Project. I concur in the recommendation of the Rock Island District Engineer and support this waiver.

3. The MVD point of contact is Mr. Fredrick Ragan, CEMVD-PD-SP, at (601) 634-5926.

Encl

MICHAEL J. WALSH
Major General, USA
Commanding

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CEMVR-PD-F **19DEC2011**

MEMORANDUM FOR RECORD

SUBJECT: Huron Island FSM

1. The subject meeting was held on 19 DEC 2011 by teleconference. The following representatives were in attendance:

Bob Clevenstine	FWS	robert_clevenstine@fws.gov
Jon Duyvejonck	FWS	jon_duyvejonck@fws.gov
Mike Griffin	IA DNR	michael.griffin@dnr.iowa.gov
Bernie Schonhoff	IA DNR	bernard.schonhoff@dnr.iowa.gov
Susan Smith	USACE	susan.k.smith@usace.army.mil
Renee Turner	USACE	renee.n.turner@usace.army.mil
Fred Ragan	USACE	fred.ragan@usace.army.mil
Robin Broil-Cox	USACE	robin.d.broil-cox @usace.army.mil
Frankie Griggs	USACE	frankie.e.griggs@usace.army.mil
Lexine Cool	USACE	lexine.t.cool@usace.army.mil
Monique Savage	USACE	monique.e.savage@usace.army.mil
Kara Mitvalsky	USACE	kara.n.mitvalsky@usace.army.mil
Lucie Sawyer	USACE	lucie.m.sawyer@usace.army.mil
Nate Richards	USACE	nathan.s.richards@usace.army.mil
Jon Schultz	USACE	jon.r.schultz@usace.army.mil
Dave Bierl	USACE	david.p.bierl@usace.army.mil
Marvin Hubbell	USACE	marvin.e.hubbell@usace.army.mil
Camie Knollenberg	USACE	camie.a.knollenberg@usace.army.mil
Darron Niles	USACE	darron.l.niles@usace.army.mil

2. Meeting Agenda
   1) Attendance
   2) Background information
   3) Problems & opportunities
   4) Goals, objectives, and potential measures
   5) Schedule
   6) Work Completed
   7) Future Work
   8) Considerations
   9) Comments/Questions
   10) Adjournment

3.
   Meeting Summary
   - MVD- Clearly identify in FWOP conditions CARS wing dam impacts such as OMR&R, depth diversity etc.

    - MVR Response – concur that the impact of the wingdam needs to be included in the report. Based on operations input that the wingdam is an absolute the team is modeling all of our measures with the wingdam in place.
- MVD – Provide more information on the type of aquatic vegetation that has historically been in Pool 18 and now is not present
    - MVR- Concurs – will add the types of aquatic vegetation that were historically present in Huron Island in the problems and opportunities section. More information on Macrophytes can be found in section 2.5.3
- MVD – Island erosion and measures to address that
    - Quantities are unclear – MVR Concurs, will add the quantities to the report and address that it is erosion not migration
    - Is it possible to deflect and aggregate sediment to build islands – Twin Island NESP project. MVR will look at report and see if there are measures we can include. Chevrons and J-Hooks were dual purpose of island protection and fish habitat
- MVD – Where is the Huron Review Plan – MVR has routed the RP and sent it MVD, an electronic copy will be sent to Renee and Fred.
- FWS – Cautions about the schedule due to the probability of Indian Bat habitat on Huron Island. Survey can't be done until June. MVR- concurs – Once the forest inventory is complete and area of survey is determined we can work on SOW and schedule

4. POC for this memorandum is Monique Savage at (309) 794-5342

5. Attendees' comments were incorporated and minutes finalized on

Monique Savage
Plan Formulation Branch

CEMVR-PD-F **12JAN2012**

MEMORANDUM FOR RECORD

SUBJECT: Huron Island 2 Day Planning Charette

1. The subject meeting was held on 9 and 10 JAN 2012 at LACMRERS. The following representatives were in attendance:

Monique Savage	USACE	Darron Niles	USACE
Lucie Sawyer	USACE	Bernie Schonhoff	IA DNR
Nate Richards	USACE	Adam Thiese	IA DNR
Jon Schultz	USACE	Andy Robbins	IA DNR
Kara Mitvalsky	USACE	Bob Clevestine	FWS
Amanda Geddes	USACE	Marshall Plumley	USACE
Dave Bierl	USACE	Cathy Henry	FWS
Steve Rumple	USACE	Jon Duyvejonck	FWS

2. Meeting Agenda

DAY 1
8-830 Intro
830-930 Review of measures
930-945 Break
945-1130 Discuss measures 1-3
1130-1230 Lunch
1230-200 Discuss measures 4-7
200-215 Break
215-400 Discuss measures 8-11

Day 2
8-9 Review Day 1
9-1130 Discuss parameters (min. – max.) of measures
1130 -1230 Lunch
1230-400 Tentatively discuss habitat units of measures

3. Meeting Summary

   Opportunities: Discuss the path forward for the Huron Island project

- Closure structures –
  - Gun Slough South Channel river training structures: Discussion ensued about the ability to produce enough velocity to self scour. Previous meetings suggested it was not possible. Average flows in Gun Slough are 11 m/s. Team determined we will run

several features (overbank flow alterations – trees planted on either side of bank and river training structures – vanes) in the model and analyze the results

- o Pool 1 and 2 closure structures were determined to be only gated structures and it was decided as a group that while oxygen is not a problem it has the slight potential to become once the project is implemented. The team determined that these structures should be added in as part of our risk and uncertainty then put in as part of our adaptive management plan.

- o Closure Structure at inlet of NW Corner of Huron Island - 2
  - ▪ see FAST diagram for feature discussion
  - ▪ This is a main channel but the team is not sure if this is adding enough sediment to warrant a closing structure. The team determined to use the H&H model to determine if a closing structure is necessary to reduce sedimentation
- o Closure structure in Garner Chute – 1
  - ▪ see FAST diagram for feature discussion
  - ▪ Creates overwintering habitat

- Topographic Diversity - Team discussed the outputs of the EFM used to determine minimum elevations needed for tree plantings. The minimum elevation (50% exceed. prob.) for the minimally tolerant species is 535.2. Maximum elevation we can go prior to impacting wetlands is 537. Experience from other plantings show that narrow berms have a high mortality rate during flood events – ie. Ted Shanks. The team would like to create a gradual increase in elevation over a wide area to minimize the risks of tree mortality. The team would like to plant trees on two elevations to do monitoring and comparisons of survival. The elevation for the 25% exceedance is 536.6 for the minimally tolerant trees. At a minimum team would like to compare the difference between the 25% exceedance and 50% exceedance elevation. For ICA compare the cost between going up 536.6 and 537.
  - o Ridge and swale Pad – The tree inventory determined the location of a 100 acre plot containing no species diversity and no understory growth. An area was found North of Gooselake, engineering had already created drawings showing this 100 acre area. From both an engineering and forestry standpoint the location of the feature "PAD" is appropriate. The material for this pad will be analyzed for both earthen material and dredged material.
  - o Ridge and Swale behind diverse tree area near NW corner of Huron Island- The tree inventory shows that there is a diverse area of trees in the NW corner of Huron Island. A discussion was had about the potential benefits of increasing this forest. It can be either dredged material from garner chute or earthen material.
  - o Dredge material placement – The team discussed the difference between doing tiers or a 30 on 1 gradual slope and determined that a couple of tiers and a gradual slope met the requirements for all team members
    - ▪ Tiers let the tree have two separate flat elevations to grow on and monitor

        - Gradual Slope let the potential aquatic vegetation grow at different elevations based on varying water levels
        - A discussion ensued on the meaning of scrub-shrub. Team still needs to come up with species list for scrub-shrub besides button-bush.

- Bathymetric diversity -Based on existing borings the team ruled out the viability of hydraulic dredging.
    - Mechanical Dredging - Discussion occurred whether we were dredging to a certain amount or if we need a certain amount for planting. The team agreed that it was the latter but that there is a minimum of 8 ft deep and 50 ft wide for the dredge. Kara ran the number and to achieve a 535.2 elevation over a gradual slope/tier a minimum of a 50 ft wide dredge is needed. The criteria for our dredge/placement site were an area with minimal diverse forest, achieve beneficial overwintering habitat and were in close enough proximity we could manually dredge without double handling. Goose lake Pool 1 and 2 met all three of these criteria. The team would like to dredge both pools but will leave it to the ICA to determine if it's the best buy plan.
- Aquatic Vegetation – Team discussed whether there should be an increase in both SAV and emergent or just focus on one. Consensus was that there is a problem with both but that SAV was more critical since it wasn't found in the seed bank. Emergent has the potential to grow after placement of dredged material as long as it placed at the correct elevation. Since there is little to no seedbank of SAV plantings are necessary. We can either harvest or purchase (purchase may be better). The team would like to implement different sectors to gain some information on planting success – no plantings, no protection, enclosures, etc. There is a moderate risk to increasing aquatic vegetation since there may be other factors outside of known constraints impacting SAV survival in Pools 16-23(?) ie algae. Sponsors are going to look into historical information available to them so we can make as accurate depiction as possible as to historic conditions.
- Woody debris was discussed at length as an independent measure and as a construction material for vanes and chevrons. The material for the vanes etc will be determined by cost and environmental impacts.
- River training structures and shoreline protection was discussed as a needed measure to protect Pool 1 & 2 since the bank erosion is occurring adjacent to those backwater areas. There are significant aquatic benefits to using vanes and chevrons. Research by MVS shows that chevrons create a unique riffle like habitat. There may be impacts to putting in chevrons, closing dam or vanes on adjacent land owners and levee district. Will run 2D model to determine impacts and make decisions accordingly.
- Ephemeral pools.
    - The ridge and swale will also be analyzed using ICA to include ephemeral pools.
    - Team discussed the viability of creating ephemeral pools where existing reed canary grass is located to curb invasive species migration.

- Tree stand improvement. Approximately 100-300 acres. Cottonwood is aligned with old agriculture sites. Sedimentation rates and tree diversity are correlated with each other. Timber harvest in 80’s reduced canopy by 30% (didn’t work well, grew back reed canary grass) Soils may play a role in survival rates. Need to have floodplain borings to determine soil types prior to planting.
    - Selective harvest – focuses on multiple age classes
        - Can be cutting or prescribed burns
        - Focus on small areas with decent seed trees, 5-10 acre plots to increase potential tree recruitment
    - Crop tree release – focuses on species
        - Cut 10 ft radius around specified trees to allow for potential growth
    - Plantings
        - The team decided that there should also be some variation in the age of trees planted for survivability analysis. The ICA will be used to determine the best mix of #3 (108 per acre), #5 (45 per acre) and #15 (27 per acre) to be used. Still need to determine the quantity and species of trees to plant and analyze in ICA.
        - Clearings will be need for the plantings. Trees will be girdled for Indian bat habitat. Coordination with FWS is necessary

4. Items to be discussed at next meeting
    1) Biologists determine list of SAV and scrub-shrub plantings
    2) Hydraulic model needs
    3) Reduce list of measures through criteria
    4) Discuss forest model – need model to show benefits other than elevation
    5) Discuss forest inventory
    6) Discuss H&H model
    7) Determine needs and completion date for changes to report
    8) Existing conditions/problems of Herps for ephemeral pools measure
    9) Need to discuss J-hook as a potential feature
    10) Need to determine whether scrub shrub is an issue that needs to be discussed in our problems and opportunities.

5. POC for this memorandum is Monique Savage at (309) 794-5342

6. Attendees’ comments were incorporated and minutes finalized on 19 Jan 2012.

Monique Savage
Plan Formulation Branch

Scope of Work

For

Huron Island
AdH Sediment Transport Modeling

02 Feb 2012

1. General. The work to be accomplished with this funding is in support of the AdH sediment transport modeling for the Huron Island Habitat Rehabilitation and Enhancement Project Feasibility Study. The Rock Island District is soliciting the expertise of ERDC to assist in calibration of an existing condition model and evaluation of one alternative.

2. Work to be Accomplished. The objectives include the calibration of the existing conditions model and simulation of the selected plan alternative. Calibration will be based on the model's ability to generally reproduce depositional distribution trends as illustrated by channel maintenance dredging records.

3. MVR Provided Materials. MVR will provide all input files (.3dm, .bc and .hot) for the existing conditions and selected plan models. A shapefile with the historical dredging locations and any other supplemental information will be provided as needed.

4. ERDC Provided Materials. ERDC will facilitate the application of the AdH sediment transport model to meet the needs of the Huron Island Feasibility Study, providing brief documentation of any necessary model changes and the quality of calibration.

5. Funding. A cross charge labor code (1C96C5) has been established for the Estuaries Branch (Org code U430530) in the amount of $5K.

6. Schedule. Following calibration of the existing conditions model, MVR will provide ERDC with the selected plan input files. Simulation of the selected plan must be completed within 10 calendar days of input file receipt. All work must be accomplished by September 24, 2012.

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING - PO BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

July 20, 2012

T:\HANCKS FILES\RICHARDS2012LTRS/20JUL2012/Huron Island BA/mer/5286

Regional Planning and Environmental
Division North (RPEDN)

Mr. Richard Nelson
USFWS, Rock Island Field Office
1511 - 47th Avenue
Moline, Illinois 61265

Dear Mr. Nelson:

The U.S. Army Corps of Engineers, Rock Island District (District), is providing the enclosed Biological Assessment (BA) titled *Huron Island Habitat Rehabilitation and Enhancement Project, Des Moines County, Iowa*. Upon distribution of this BA, the District is requesting the initiation of Formal Consultation among our agencies on this project.

The District proposes to rehabilitate and enhance the Huron Island Complex 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 the Complex.

The USFWS identified the Indiana bat *Myotis sodalis*, prairie bush clover *Lespedeza leptostachya*, Western prairie fringed orchid *Platanthera praeclara*, higgins eye pearlymussel *Lampsilis higginsii,* and spectaclecase mussel Cumberlandia monodonta as federally-endangered or threatened species that have the potential to occur within Des Moines County in Iowa.

Based on the information provided, the District determines the proposed project ***may affect*** but is ***not likely to adversely affect*** Indiana bats, Higgins eye pearlymussel, and spectaclecase mussel. The proposed project will have ***no effect*** on the prairie bush clover and Western prairie fringed orchid.

I am forwarding a copy of this correspondence with enclosure to:

Jon Duyvejonck, USFWS
Rock Island Field Office
1511 - 47th Avenue
Moline IL 61265

Bob Clevenstine, USFWS
Rock Island Field Office
1511 - 47th Avenue
Moline IL 61265

Cathy Henry, USFWS
Port Louisa National Wildlife Refuge
10728 County Road X61
Wapello IA 52653

Michael Griffin
Iowa Department of Natural Resources
206 Rose Street
Bellevue IA 52031

Andy Robbins
Iowa Department of Natural Resources
260 Mulberry, Suite 3
Wapello IA 52653

The point of contact for this action is Mr. Nathan Richards of our Environmental Planning Branch at (309)794-5286 or e-mail: nathan.s.richards@usace.army.mil or write to our address above, ATTN: Environmental Compliance Branch (Nathan Richards).

Sincerely,

ORIGINAL SIGNED BY

Kenneth A. Barr
Chief, Environmental Planning Branch, RPEDN

Enclosure

CF: w/out
PM-M (w/ encl)
PD-P (Richards w/out encl)

7/20/12
RODKEY
PM-M

NR
RICHARDS 7-20-12
PD-D

BARR
PD-P KB
7/20/12

FWS/RIFO

February 7, 2013

Colonel Mark J. Deschenes
District Engineer
U.S. Army Corps of Engineers
Rock Island District
Attn: Mr. Ken Barr, Chief, Planning
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Deschenes:

This document transmits our draft Fish and Wildlife Coordination Act (FWCA) for the Huron Island Environmental Management Program (EMP) in Mississippi River Pool 18, Des Moines County, Iowa. The U.S. Army Corps of Engineers, Rock Island District proposes to rehabilitate and enhance the Huron Island Complex 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 the Complex.

The Corps' recommended plan and action area for the Huron Island Complex includes increasing bathymetric diversity in Pools 1 and 2 of the Goose Lake backwater area, improving forest topographic diversity adjacent to Pools 1 and 2 by increasing the elevation to 537 and planting 15 mast tree species, construction of a closure structure in Garner Chute, and increasing forest diversity in non-diverse forested areas by increasing the elevation to 537.

By letter dated July 20, 2012 we have received the Biological Assessment (BA) for the Huron Island project. The BA concludes that there will be no effect on the prairie bush clover, and the Western prairie fringed orchid. We concur with that conclusion.

The BA concludes that the project ***May Affect***, but is ***Not Likely to Adversely Affect*** Indiana bat because:

1. No effects to any designated critical habitat or known swarming habitat associated with the project area will occur as a result of the proposed project.

2. Suitable habitat exists within the action area for the project; however, the District would remove trees located here during the period when Indiana bats are not using those trees (September 15 – April 14). Therefore, the project will not harm, harass, displace, injure, or kill bats.
3. Identified potential roost trees, trees within 150-meters of foraging corridors, or trees within 200-meters of capture sites will not be removed or disturbed within the project site (click to see map

of identified trees and areas with buffer).

4. An average of 10 trees per acre within the clearing area will be left standing to prevent complete tree loss. Additionally, roughly half of them will be girdled and killed to produce potential roost trees for the future.

5. Greater than 800 mast trees will be planted in the project site, including those which produce exfoliating bark (i.e., hickory spp.). This should result in a positive long-term benefit for potential roost tree production, foraging habitat, and habitat diversity.

6. Clearing areas and measure F5 construction will be moved further south near the backwater to reduce tree clearing requirements and minimize effects to Indiana bat habitat disturbance.

7. The project should not diminish the overall quantity or quality of habitat on a scale resulting in jeopardy to the species because the amount of potential Indiana bat habitat the project would affect (42 acres) represents 2.2 percent of the total acreage of forested habitat located within the Huron Island Complex.

We concur that these actions will not adversely affect the Indiana bat. The documentation of Indiana bats near the project site presents a unique opportunity to investigate this species use of floodplain forests. Given the tendency of some bats to utilize multiple roost tees, the installation of artificial roosting structures provides on opportunity to investigate if Indiana bats will use them and whether such structures could potentially serve as mitigation for impacted roost trees. The Rock Island Field Office will work with Rock Island District COE biologists regarding the design and placement of the structures. Following installation, the Service will also work with COE biologists to design and implement a monitoring plan.

The BA concludes that, ***May Affect***, but is ***Not Likely to Adversely Affect Higgins Eye Pearlymussel*** based on the following reasons and proposed conservation measures:

1. No effects to designated critical habitat or essential habitat areas will occur as a result of this project.

2. Surveys completed in and around the Huron Island Complex did not result in the collection of Higgins eye Pearlymussel.

3. The overall area for the construction of the chevrons and closing structure is relatively small and affects habitat generally considered to be sub-optimal for Higgins eye Pearlymussel.

4. Prior to construction, the District, in cooperation with the USFWS, will conduct preliminary surveys of the impact area to determine potential changes in habitat and the likelihood of Higgins eye presence.

We concur that these actions will not adversely affect the Higgins Eye Pearly Mussel. Should additional information, or the project be modified, this determination may be reconsidered.

The BA concludes that the project ***May Affect***, but is ***Not Likely to Adversely Affect Spectaclecase Mussel*** based on the following reasons and proposed conservation measures:

1. No effects to designated critical habitat or essential habitat areas will occur as a result of this project.Surveys completed in and around the Huron Island Complex did not result in the collection of spectaclecase mussels.

2. The overall area for the construction of the chevrons and closing structure is relatively small and affects habitat generally considered to be sub-optimal for spectaclecase mussel.

3. Prior to construction, the District, in cooperation with the USFWS, will conduct preliminary surveys of the impact area to determine potential changes in habitat and the likelihood of spectaclecase presence.

We concur that the proposed auction will not adversely affect the Spectaclecase mussel since there is no suitable habitat in the project area.

Additionally, the Service removed bald eagles from protection under the Endangered Species Act on August 8, 2007. However, they remain protected today under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act of 1940 (Eagle Act). The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). Disturb is defined in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

The bald eagle (*Haliaeetus leucocephalus*) is also recorded for Des Moines County. Should any active bald eagle nests be observed near the project area, please contact our office for technical assistance regarding actions necessary to minimize impacts.

Upper Mississippi River (UMR) floodplain forests are generally dominated by over mature stands of silver maple which provide little wildlife value compared to mast producing tree species. According to a report[1] published by the Upper Mississippi River Conservation Committee (UMRCC), hard mast species (e.g. oak and hickory) comprise less than 10% of the floodplain forest and are still declining. The recently published "Upper Mississippi River Systemic forest Stewardship Plan[2]" emphasizes the continuing UMR system-wide decline in forests and that "…within 50-70 years… this will result in open conditions and promote undesirable species such as reed canary grass that make it difficult for floodplain forest trees to regenerate." Such changes will result in declines of wildlife species dependent upon a productive and diverse floodplain forest.

Implementation of forest restoration projects, such as Huron Island, is critical if management agencies are to even maintain current forest conditions, let alone reverse the decline. Forest managers have gained considerable knowledge in recent years concerning actions needed to assure the success of floodplain forest projects. Two common causes for poor tree survival have been flooding and the lack of sustained attention to tree maintenance. Flood impacts will be minimized by the elevated berms where trees will be

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[1] Urich, R., G. Swenson, and E. Nelson, editors. 2002. Upper Mississippi and Illinois River Floodplain Forests. Desired Future and Recommended Actions. Upper Mississippi River Conservation Committee.

[2] Guyon, L. et. al. Upper Mississippi River Systemic Forest Stewardship Plan. August 2012. US Army Corps of Engineers. 124 pp.

planted. In order to assure successful tree planting however, a maintenance crew (responsible for tree care) should routinely attend to plantings during the growing season for two to four years following construction.

In addition to forestry management objectives, the proposed project seeks to improve Huron Island fishery resources by creating deep water, off-channel habitat to enhance fish survival over the winter. Compared to the forestry objectives, where mast tree habitat can exceed 100 years of productivity, off-channel fishery will most likely not reach fifty. However, as indicated in the draft report, calculating an optimum acreage of overwintering backwater habitat is extremely difficult given our current knowledge of UMR fishery resources. Despite this uncertainty, any dredged material will add to island elevation which will increase desirable bottom land hardwood understory plant species.

It is our understanding that up 42 acres of forest may be cleared to allow for berm construction. Any of the cleared land that is not planted with mast trees, or other ground cover, is at high risk of succeeding to reed canary grass and other undesirable species. It is recommended that any of the cleared construction corridor that is not already covered by a planting regime, should be planted with aggressive native species that can compete with reed canary grass in particular. Desirable species for planting include wet prairie grasses such as cordgrass, red osier dogwood, button bush, and blue indigo (*Amorpha fruticosa*).

Bank stabilization in Huron chute is part of the proposed project. We understand that this stabilization will consist primarily of quarry rock. The Service recommends that trees cleared during construction be used in stabilizing some section of the bank was well as stone in order to compare the relative effectiveness of stone versus woody debris. In addition, woody debris may provide better cavity diversity for a variety of aquatic and semi-aquatic animals compared to stone. Excess trees should also be used to construct woody debris shelters used by a variety of wildlife rather than disposing of them.

This letter provides comments under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); and the Endangered Species Act of 1973, as amended. Questions concerning this letter and attached FWCA report should be directed to Mr. Jon Duyvejonck (telephone 309.757-5800, ext. 207).

Sincerely,

Richard C. Nelson
Field Supervisor

Environmental Management Program (EMP) Huron Island Habitat Rehabilitation and Enhancement Project April 18, 2013

1. Introduction. This document serves as the after-action report for the Huron Island open house 18 April 2013.

2. Open House Objective. The objective of the public meeting was to discuss and gather comments from the public on the draft report findings.

3. Open House Location. The public meeting was held at the Mediapolis City Hall at 510 Main Street, Mediapolis, IA.

4. Medium. An announcement was mailed to approximately 102 addressees including congressional interests, federal, state and local governmental agencies; businesses, environmental organizations, media and the general public inviting them to attend. The Public Affairs Office also sent a news release to area television and radio stations and newspapers.

5. Public Meeting Format.

a. Date/Time: The open house was held on April 18, 2013 from 5:00pm-7:00pm.

b. Corps and project sponsor representatives were present to talk one-to-one with the attendees during the open house and to answer any questions. The representatives were:

Rock Island/St. Paul District.

Darron Niles – PD-F (St. Paul)
Nate Richards – PD-P (St. Paul)
Marsha Dolan – PD-E (St. Paul)
Kara Mitvalsky– EC-DN (Rock Island)
Jon Schultz -- OD-MN (Rock Island)

Project Sponsors:

Mike Griffin – Iowa DNR
Bill Ohde – Iowa DNR
Andy Robbins -- Iowa DNR
Bernie Schonhoff – Iowa DNR
Cathy Henry -- USFWS

c. Displays. Maps of the study area and proposed project were on display.

6. Attendance. There were approximately 47 attendees which included two newspaper reporters and five project sponsors. The attendees were offered a comment sheet and a copy of the executive summary of the draft report. Results of the returned comments are shown in paragraph 7 below.

7. Public Comments. Public meeting attendees were asked to fill out a comment sheet. A total of 18 comments sheets were received. (Should we discuss the results of questions 1-5 on the comment sheets here?)

Summary of Additional Responses: The comment sheet also provided space for additional participant comments.

Questions 1-6	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**	**Totals**
This open house and public meeting provided an opportunity to gain information and a better understanding of Huron Island Complex Habitat Rehabilitation and Enhancement Project	55.6%	44.4%	0	0	100%
This open house provided an opportunity For everyone to offer comments about the project	61.1%	38.9%	0	0	100%
The display/material provided were informative	52.9%	47.1%	0	0	100%
I had a chance to talk to a study team member	82.4%	11.8%	0	5.9%	100%
This open house was worth my time	72.2%	16.7%	11.1%	0	100%
Whole Group Percentage	64.2%	32.5%	2.2%	1.1%	100%

Comments regarding the project:

Question 6: Do you have other comments or concerns regarding this project:

- Rip rap the west bank also
- Costs too much
- Cabin owners have done their part to try to prevent erosion. Hope cabins will be protected.
- If you intend to armor the two small islands in Huron Chute, it would be beneficial to include armoring of the bank on the mainland to prevent any further damage to the levee system where it is eroding away. The Corps has been monitoring this area for at least 10 years. It should be included in the project.
- After discussion with the study team I am still not convinced that fortifying the small islands in Huron Chute and raising elevation on the east side of Huron Chute is not going to divert more water and cause more erosion on the west bank below Mediapolis cabins. If you are going to armor the small and large islands in the chute please armor the west bank also as part of the project.
- Waste of tax money.
- The fact that the Corps studies projects like this and does nothing for the concerns of the levee districts is appalling. We have asked for revetment on the levee side of the shore for decades and been told no. To think that this is more wasteful spending on Huron Island is even considered is borderline crazy. Have you heard of the fiscal situation?

Are you really going to spend money to do something this stupid? You only have to look at the past failures to know this won't work. Burnt Pocket comes to mind as a failure that you don't consider flood control tells us of your slant.

- We need rock on yes it is needed bad south of Mediapolis cabins.
- What a waste of money!! When we are trillions in debt, how can you sleep at night spending our money this way? Fix the levees and keep them up instead.
- The access dredging needs to be deeper to allow barges to float the crane. This project requires rehandling dredge spoil using mechanical equipment this will be slow, expensive, and complex.
- The Corps should save the money for necessary work. The country is in 16 trillion or more in debt. Use what funds you have to do essential work. So much is needed on the locks and dams and levee system.
- You need to provide revetment on the west side of the Huron Chute just north of the northern most island to protect it from erosion that will be caused by the planned alternatives project is too costly for benefits.
- I am concerned about wave action due to the 2 islands on NW side of project. The potential that current will be diverted into the levee system seems probable. I suggest the removal of both islands and/or riprap (revetment) of the levee west of the islands. I am concerned that long term wave action will deteriorate levee.
- I have no objections to the goals of this project. But I am disappointed that for $12.8 million there will not be more dredging on Huron Island. Also with the trends of higher crests I don't believe the hardwoods are elevated to ensure a good chance of survivability. My other concerns are these: that Garner Chute does not silt in below the closure, that the added water on the west side of Garner does not cut out the bank more below the riprapped areas, and that the riprapping at the northern island does not lead to cutting more on the very eroded banks to the west of it. I grew up and now own a farm adjacent to Huron Island. We are very alarmed at the rate that the river bank is disappearing especially in the last 20 years or so. We also hold the lease on the southern most cottage across from the island. We love this area, the river, and hope this project achieves all the goals intended for it. Thank you for the open house and the chance to give our input.

8. Summary. The open house met the objective of providing information on the proposed project. The discussion between the study team personnel and the public was informative. Attendees were generally supportive of the open house format. This report is being distributed to the study team members for their consideration and analysis.

MARSHA DOLAN
Public Involvement Specialist
Economic & Environmental Analysis Branch

CF:
PD-F (D. NILES)
PD-F (M. SAVAGE)
PD-E (M. DOLAN)

ENVIRONMENTAL MANAGEMENT PROGRAM (EMP)
HURON ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT
APRIL 18, 2013

	Strongly Agree		Agree			Disagree			Strongly Disagree	
(1) This open house and public meeting provided an opportunity to gain information and a better understanding of the Huron Island Habitat Rehabilitation and Enhancement Project………………..	1	2	3	4	5	6	7	8	9	10
(2) This open house provided an opportunity for everyone to offer comments about the project…	1	2	3	4	5	6	7	8	9	10
(3) The displays/materials provided were informative………………………………….	1	2	3	4	5	6	7	8	9	10
(4) I had a chance to talk to a study team member………………………………….	1	2	3	4	5	6	7	8	9	10
(5) This open house was worth my time	1	2	3	4	5	6	7	8	9	10

(6) Do you have other comments regarding this project?

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(7) Would you like a CD of the Final Report mailed to you? ____ Yes ____ No

(Optional) Name ____

Address ____

____

THANK YOU FOR ATTENDING THIS OPEN HOUSE AND PROVIDING YOUR COMMENTS!

Richards, Nathan S MVR

From: Shepard, Larry [Shepard.Larry@epa.gov]
Sent: Monday, May 06, 2013 4:27 PM
To: Richards, Nathan S MVR
Cc: Kowal, Kathleen; Medley, Leah
Subject: EPA Region 7 Comments on the Public Review Draft of the DPR/EA for Huron Island HREP

Thank you for the opportunity to review the public review draft of the Definite Project Report (DPR) with Integrated Environmental Assessment (EA) for the Huron Island, Iowa, Habitat Rehabilitation and Enhancement Project (HREP). The project is located in Des Moines County, Iowa, along the right descending bank of the Mississippi River in Pool 18 between River Miles 425 and 421. Through this project, the Corps proposes to rehabilitate and enhance Huron Island through construction measures which will improve over-wintering habitat for the fish community, increase island forest vegetation diversity, restore areas of aquatic vegetation and maintain side channel habitat and bathymetry.

General Comments

This is a very detailed and well-constructed document. It is very well-done. There is typically a great deal of detail associated with Corps PIRs and DPRs and when integrated with the NEPA compliance document, in this case the EA, that detail can create a very complex and potentially confusing NEPA document. It is often difficult to 'see the forest for the trees' with regard to the overall project development process and the alternatives comparison. Specifically, the detailed descriptions of many multiple measures integrated into separate alternatives make for some confusion. This being the very nature of Corps rehabilitation projects and difficult to avoid, I suggest that all the Districts consider similar formats for HREP projects with a stronger reliance on mapping and tables within the main document to aid in reader understanding and interpretation. A document which relies heavily on references to plates, photos and tables in the appendices or distant from the text itself can be confusing and overwhelming, particularly given the variety of measures evaluated. Please consider the following document design suggestions:

· Photo depiction of both measures retained for additional evaluation and those measures eliminated from further evaluation. It would be helpful to see photos and figures (e.g., Figure ES-1) with the locations of each measure within the project footprint. ES-1 is the only project map with features identified in the whole body of the document. More detailed figures are referenced within the text to other sections of the document.

· Figure 2 lacks sufficient clarity and detail, using the document link version, to discern chutes, channels, islands and lakes/backwaters. The text describing measures and project features would be much easier to understand and place in context with the overall site and each other with clear, appropriately sized project figures and maps.

· References to plates, figures or other pieces remote from the text should include page numbers. In a document such as this, some references are almost clandestine (e.g., C-102). Although it is the way these assessments will be made available for public or other agency review into the future, electronic versions of documents do make 'document search' more challenging. Sometimes review agencies are forced to print the entire document just to get a sense of content and arrangement.

Introduction

The purpose and need descriptions are excellent and clearly describe the problem to which the Corps is responding and the project objectives.

Affected Environment

Water Quality: Although the inclusion of water quality data in tabular form, as with Table 4 and Appendix F, is necessary to any such report, the narrative supporting the data is most critical, i.e., what are the data saying and why is it important? I would caution that the rationale supporting what, where, when and how often water quality is sampled is very critical to the incorporation of this data into project planning and adaptive management. It is important to determine which indicators of water quality are most relevant to measuring project success and where they should be measured. It is also important to establish a baseline of water quality condition in locations where one is looking for response. Monitoring in both chutes, baseline and response, would seem to be important. You might consider a characterization of the nutrient profile in lotic and lentic waters within the project area, baseline and response.

Climate/Hydrologic Changes: The document did not provide any information about how drought or high water events have affected the project site or this pool. How stable have water levels been at this site and within this pool over the past almost 80 years and in recent years of record high flows. Is this reach more or less vulnerable to extreme weather and flows? How vulnerable is project success to possible changes in hydrology, particularly extremes?

Potential Project Features

This chapter is very detailed, as it should be, and provides the first 'cut' on the evaluation of the suitability of individual measures which could be incorporated into alternatives. Given the detail, a map/figure showing the location of these measures would facilitate reader integration.

Some of the rationale supporting the elimination of several measures from further consideration is clear and self-explanatory, but some of it is not. Specifically, it is not clear what is meant when a measure is eliminated because it "would likely have an adverse impact on the floodplain analysis" (e.g., E.5.b) or "floodplain heights" (e.g., E.5.e). Alternative assembling and the selection of the recommended plan in Section V, page 63, includes similar references for the elimination of Alternatives 6, 7 and 8, i.e., "surpasses the planning constraints and exceeds floodplain impacts." The same vagueness is associated with the statement "does not meet the objectives set forth by this study" (e.g., F.2). The document would be improved if these conclusions were more clearly elucidated.

The discussion supporting the treatment of the role of Best Management Practices (BMPs) in the design of this project under "Non-Structural Methods" is very revealing of what EPA has always believed is a flaw in HREP design and will most likely be unnoticed by most project participants and the public. The DPR/EA discusses the significance of the project's location downstream from the Iowa River, the effect of watershed land management on both Iowa River and Pool 18 water quality and the significant dredging requirements for Pool 18. In G.1 of this section, the DPR/EA simply references that the application of BMPs is "outside of Corps authority" and eliminates the importance of this measure from further evaluation. NEPA requires the evaluation of all reasonable alternatives, even those "not within the jurisdiction of the lead agency" (40 CFR 1502.14(c)). A weakness not limited to this project, the overall HREP has historically been limited in its overall effect on mainstem ecological health by its reluctance to integrate Clean Water Act programs, administered by State environmental management agencies and largely operating outside of the main channel Mississippi River, into its assessments and planning. In many reaches along the UMR, the potential for restoration success and the sustainability of HREP projects is severely reduced by the counterproductive impacts of tributary watersheds. Nutrient and sediment loading from major tributaries not only contribute significantly to the original loss of function and habitat in the mainstem river, in addition to pool construction, but the degradation of confluence areas themselves results in the loss of important reproductive and feeding habitat for big river fish species. State agency partners to the EMP and the Corps have the authority to operate land use and management programs in UMR watersheds (e.g., CWA 404 and 303 and state and local controls) in such a manner that mainstem restoration projects will be more successful and sustainable. This concept has long been acknowledge by the Corps and assorted partner groups within the UMRS, but it has yet to be integrated into reach- or pool-specific restoration efforts. Regardless of the Corps' limits in authority, this and all EMP NEPA compliance documents should more fully characterize 1) the connection between watershed management/tributary water quality and the ecological problems in the mainstem UMR to which the EMP is responding, 2) the association between tributary/watershed contributions of sediment and nutrients and the sustainability of HREP projects and 3) the actions necessary in the watershed to sustain improvements made within reaches through HREP at least to the extent that they affect individual projects. This later component would clarify what actions outside the mainstem are necessary to improve the condition of the river and sustain the improvements made under EMP. In this instance, it would not be unreasonable to assume that without improvements to water quality in the Iowa River, this project might not achieve its objectives.

Somewhere within the DPR/EA there should be a discussion of the sustainability of the project. The document references a 50-year life for the project, but I could not locate any significant discussion of the basis for this projection or how sustainable these habitat improvements are and under what conditions. Consistent with my comment above, it would also be informative for the public and other agencies to understand what conditions, both within and outside the river corridor, are necessary to the sustained success of this project.

I greatly appreciate the opportunity to review and provide comment on this document. It is a well-conceived project and thoroughly supported by the information in the document. If you have any questions about these comments, please contact me.

Larry Shepard

NEPA Team

U.S. Environmental Protection Agency

Region 7

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July 16, 2013

Gary R. Meden
Deputy for Programs and Project Management
US Army Engineer District, Rock Island
Clock Tower Building
P.O. Box 2004
Rock Island IL, 61204-2004

Dear Mr. Meden:

The Iowa Department of Natural Resources (IDNR) supports the U.S. Army Corps of Engineers' (USACE) Huron Island Habitat Rehabilitation and Enhancement Project for ecosystem restoration in Des Moines County, Iowa.

The project will enhance the wildlife and fisheries of Pool 18 of the Upper Mississippi River System as well as Huron Island. Huron Island was one of the most diverse island complexes on the Mississippi River and the completion of this project will again fill that role.

The IDNR understands as the non federal partner with management authority for the project operation and maintenance, at an estimated average annual cost of $10,293 would be the IDNR's costs at 100% as referenced in the Cooperative Agreement for Management of USACE General Plan Lands, dated March 22, 2012, between the U.S. Fish and Wildlife Service and the IDNR, if and when funds are available.

For additional information, please contact Mr. Michael Griffin of my staff at 563-872-5700 or Michael.Griffin@dnr.iowa.gov.

The IDNR supports and looks forward to the timely completion of this project.

Sincerely,

Chuck Gipp
Director

cc: Mike Griffin

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Richards, Nathan S MVR

From:	Richards, Nathan S MVR
Sent:	Tuesday, July 30, 2013 10:49 PM
To:	Shepard, Larry
Cc:	Kowal, Kathleen; Medley, Leah; Richards, Nathan S MVR; Savage, Monique E MVR
Subject:	RE: EPA Region 7 Comments on the Public Review Draft of the DPR/EA for Huron Island HREP (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Larry --

The Rock Island District appreciates your time and diligence in reviewing the Huron Island Definite Project Report with Integrated EA. I have reviewed your feedback and comments. In general your feedback provides for a more coherent and complete document for the Huron Island DPR and future DPRs drafted under the Environmental Management Program (EMP). I wanted to take a few moments to share our evaluation of a few of your comments.

1) Photo depictions - I agree photos and clear figures are important in describing the features, designs, and locations of project alternatives. Although we attempted to maximize our visual interpretation, we were unable to secure visuals for all features and locations. Design drawings in the appendix provide great detail; however, as you note it requires the reader to flip back and forth between sections of the report. Future DPR preparations will certainly include more maps, figures, and photos within the body of the main report to enhance the reader's visual interpretations.

2) Water Quality - critical water quality parameters for this project include velocity (Huron Chute and Goose Lakes), D.O. (winter conditions; Garner Chute and Goose Lakes), and temperature (winter conditions; Garner Chute and Goose Lakes). Although this may not be as apparent within the water quality section, it is directly addressed in the Adaptive Management and Monitoring Appendix. Furthermore, our water quality data includes nutrient profiles within Goose Lakes (lentic) and Huron Chute (lotic), which allows for comparisons between with- and without-project conditions.

3) Climate/Hydrologic Conditions - Unfortunately, with a large document drafted by an interdisciplinary project team details sometimes get diluted within the main report, figures/tables, and appendices. I did want to take some time to further address your comments. Although they are addressed in various levels of detail within the report, apparently they are not deliberate. First, hydrology is a major stressor within the project area. Completion of L&D 18 increased water elevations more than 7 feet in most spots. Essentially, this inundated most of the low lying backwaters and side channels. Additionally, what was only flooded during a 25-year event pre-dam is now under water during a 2-year event, which inundates hard mast trees more frequently and for longer durations. A large portion of our analysis included the evaluation of various potential berm elevations based on water inundation and duration. This analysis used only the last ~25 years of river gage information as this is apparently more appropriate given recent years of higher flows. We also incorporated risk and uncertainty in our evaluation by including berm heights which correspond to the 2-year, 5-year, and 10-year flood frequency intervals (remember the critical threshold for mast tree survival and growth is approximately between the 2-5 year flood event). Plantings at each elevation allows us the ability to compare vegetation survival, growth, and regeneration under various hydrological events over the planning horizon of the project (i.e., 50 years).

4) Floodplain Impacts - document text was revised to provide a more coherent and complete description of the constraints associated with securing a floodplain construction permit, which states water elevations may not exceed State of Iowa standards as a result of project features. This is also described in detail within the H&H Appendix

5) Project Life and Sustainability - The document used a 50-year project planning horizon which is standard for all USACE ecosystem restoration projects. Sustainability is included within the habitat benefit evaluation appendix in which we describe the future with project conditions at various target years ending at year 50. In this evaluation we estimate various parameters of the aquatic and floodplain habitat conditions over time. This includes habitat features, sedimentation rates, depth, and sustainability over time. The evaluation also includes our assumptions and predictions which are the underlying basis for projecting project success and sustainability.

Again, thank you for taking the time to provide feedback and contributing to the Huron Island DPR and future DPRs prepared within EMP. Continued success of this project and EMP depends heavily on our partners to ensure our restoration efforts continue to meet the needs of the UMRS, and that our compliance documents meet the needs of the public.

If you have any additional questions or concerns please feel free to let me know.

Nate

Nathan S. Richards
Biologist
U.S. Army Corps of Engineers
Rock Island, IL
309-794-5286

-----Original Message-----
From: Shepard, Larry [mailto:Shepard.Larry@epa.gov]
Sent: Monday, May 06, 2013 4:27 PM
To: Richards, Nathan S MVR
Cc: Kowal, Kathleen; Medley, Leah
Subject: EPA Region 7 Comments on the Public Review Draft of the DPR/EA for Huron Island HREP

Thank you for the opportunity to review the public review draft of the Definite Project Report (DPR) with Integrated Environmental Assessment (EA) for the Huron Island, Iowa, Habitat Rehabilitation and Enhancement Project (HREP). The project is located in Des Moines County, Iowa, along the right descending bank of the Mississippi River in Pool 18 between River Miles 425 and 421. Through this project, the Corps proposes to rehabilitate and enhance Huron Island through construction measures which will improve over-wintering habitat for the fish community, increase island forest vegetation diversity, restore areas of aquatic vegetation and maintain side channel habitat and bathymetry.

General Comments

This is a very detailed and well-constructed document. It is very well-done. There is typically a great deal of detail associated with Corps PIRs and DPRs and when integrated with the NEPA compliance document, in this case the EA, that detail can create a very complex and potentially confusing NEPA document. It is often difficult to 'see the forest for the trees' with regard to the overall project development process and the alternatives comparison. Specifically, the detailed descriptions of many multiple measures integrated into separate alternatives make for some confusion. This being the very nature of Corps rehabilitation projects and difficult to avoid, I suggest that all the Districts consider similar formats for HREP projects with a stronger reliance on mapping and tables within the main document to aid in reader understanding and interpretation. A document which relies heavily on references to plates, photos and tables in the appendices or distant from the text itself can be confusing and overwhelming, particularly given the variety of measures evaluated. Please consider the following document design suggestions:

· Photo depiction of both measures retained for additional evaluation and those measures eliminated from further evaluation. It would be helpful to see photos and figures (e.g., Figure ES-1) with the locations of each measure within the project footprint. ES-1 is the only project map with features identified in the whole body of the document. More detailed figures are referenced within the text to other sections of the document.

· Figure 2 lacks sufficient clarity and detail, using the document link version, to discern chutes, channels, islands and lakes/backwaters. The text describing measures and project features would be much easier to understand and place in context with the overall site and each other with clear, appropriately sized project figures and maps.

· References to plates, figures or other pieces remote from the text should include page numbers. In a document such as this, some references are almost clandestine (e.g., C-102). Although it is the way these assessments will be made available for public or other agency review into the future, electronic versions of documents do make 'document search' more challenging. Sometimes review agencies are forced to print the entire document just to get a sense of content and arrangement.

Introduction

The purpose and need descriptions are excellent and clearly describe the problem to which the Corps is responding and the project objectives.

Affected Environment

Water Quality: Although the inclusion of water quality data in tabular form, as with Table 4 and Appendix F, is necessary to any such report, the narrative supporting the data is most critical, i.e., what are the data saying and why is it important? I would caution that the rationale supporting what, where, when and how often water quality is sampled is very critical to the incorporation of this data into project planning and adaptive management. It is important to determine which indicators of water quality are most relevant to measuring project success and where they should be measured. It is also important to establish a baseline of water quality condition in locations where one is looking for response. Monitoring in both chutes, baseline and response, would seem to be important. You might consider a characterization of the nutrient profile in lotic and lentic waters within the project area, baseline and response.

Climate/Hydrologic Changes: The document did not provide any information about how drought or high water events have affected the project site or this pool. How stable have water levels been at this site and within this pool over the past almost 80 years and in recent years of record high flows. Is this reach more or less vulnerable to extreme weather and flows? How vulnerable is project success to possible changes in hydrology, particularly extremes?

Potential Project Features

This chapter is very detailed, as it should be, and provides the first ‘cut’ on the evaluation of the suitability of individual measures which could be incorporated into alternatives. Given the detail, a map/figure showing the location of these measures would facilitate reader integration.

Some of the rationale supporting the elimination of several measures from further consideration is clear and self-explanatory, but some of it is not. Specifically, it is not clear what is meant when a measure is eliminated because it “would likely have an adverse impact on the floodplain analysis” (e.g., E.5.b) or “floodplain heights” (e.g., E.5.e). Alternative assembling and the selection of the recommended plan in Section V, page 63, includes similar references for the elimination of Alternatives 6, 7 and 8, i.e., “surpasses the planning constraints and exceeds floodplain impacts.” The same vagueness is associated with the statement “does not meet the objectives set forth by this study” (e.g., F.2). The document would be improved if these conclusions were more clearly elucidated.

The discussion supporting the treatment of the role of Best Management Practices (BMPs) in the design of this project under “Non-Structural Methods” is very revealing of what EPA has always believed is a flaw in HREP design and will most likely be unnoticed by most project participants and the public. The DPR/EA discusses the significance of the project’s location downstream from the Iowa River, the effect of watershed land management on both Iowa River and Pool 18 water quality and the significant dredging requirements for Pool 18. In G.1 of this section, the DPR/EA simply references that the application of BMPs is “outside of Corps authority” and eliminates the importance of this measure from further evaluation. NEPA requires the evaluation of all reasonable alternatives, even those “not within the jurisdiction of the lead agency” (40 CFR 1502.14(c)). A weakness not limited to this project, the overall HREP has historically been limited in its overall effect on mainstem ecological health by its reluctance to integrate Clean Water Act programs, administered by State environmental management agencies and largely operating outside of the main channel Mississippi River, into its assessments and planning. In many reaches along the UMR, the potential for restoration success and the sustainability of HREP projects is severely reduced by the counterproductive impacts of tributary watersheds. Nutrient and sediment loading from major tributaries not only contribute significantly to the original loss of function and habitat in the mainstem river, in addition to pool construction, but the degradation of confluence areas themselves results in the loss of important reproductive and feeding habitat for big river fish species. State agency partners to the EMP and the Corps have the authority to operate land use and management programs in UMR watersheds (e.g., CWA 404 and 303 and state and local controls) in such a manner that mainstem restoration projects will be more successful and sustainable. This concept has long been acknowledge by the Corps and assorted partner groups within the UMRS, but it has yet to be integrated into reach- or pool-specific restoration efforts. Regardless of the Corps’ limits in authority, this and all EMP NEPA compliance documents should more fully characterize 1) the connection between watershed management/tributary water quality and the ecological problems in the mainstem UMR to which the EMP is responding, 2) the association between tributary/watershed contributions of sediment and nutrients and the sustainability of HREP projects and 3) the actions necessary in the watershed to sustain improvements made within reaches through HREP at least to the extent that they affect individual projects. This later component would clarify what actions outside the mainstem are necessary to improve the condition of the river and sustain the improvements made under EMP. In this instance, it would not be unreasonable to assume that without improvements to water quality in the Iowa River, this project might not achieve its objectives.

Somewhere within the DPR/EA there should be a discussion of the sustainability of the project. The document references a 50-year life for the project, but I could not locate any significant discussion of the basis for this projection or how sustainable these habitat improvements are and under what conditions. Consistent with my comment above, it would also be informative for the public and other agencies to understand what conditions, both within and outside the river corridor, are necessary to the sustained success of this project.

I greatly appreciate the opportunity to review and provide comment on this document. It is a well-conceived project and thoroughly supported by the information in the document. If you have any questions about these comments, please contact me.

Larry Shepard

NEPA Team

U.S. Environmental Protection Agency

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Classification: UNCLASSIFIED
Caveats: NONE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office
1511 47th Avenue
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AUG 14 2013

IN REPLY REFER TO:
FWS/RIFO

August 13, 2013

Colonel Mark J. Deschenes
District Engineer
U.S. Army Corps of Engineers
Rock Island District
Attn: Mr. Ken Barr, Chief, Planning
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Deschenes:

This document constitutes our final Fish and Wildlife Coordination Act Report (FWCAR) for the Huron Island Habitat Rehabilitation and Enhancement Project (Huron Island Project, hereafter) in Mississippi River Pool 18, Des Moines County, Iowa. The U.S. Army Corps of Engineers, Rock Island District (COE) proposes to rehabilitate and enhance the Huron Island Complex (Complex) through the implementation 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 the Complex. This project lies within Federal fee title lands which are managed by the State of Iowa under the terms of successive cooperative agreements between the COE, U.S. Fish and Wildlife Service (Service), and Iowa Department of Natural Resources.

The COE's recommended plan and action area for the Complex includes increasing bathymetric diversity in Pools 1 and 2 of the Goose Lake backwater area, improving forest topographic diversity adjacent to Pools 1 and 2 by increasing the elevation to 537 and planting 15 mast tree species, construction of a closure structure in Garner Chute, and increasing forest diversity in non-diverse forested areas by increasing the elevation to 537.

By letter dated July 20, 2012, we have received the Biological Assessment (BA) for the Huron Island Project. The BA concludes that there will be no effect on the prairie bush clover, and the western prairie fringed orchid. We concur with that determination.

The BA also concludes that the project ***May Affect***, but is ***Not Likely to Adversely Affect*** the Indiana bat because:

1. No effects to any designated critical habitat or known swarming habitat associated with the project area will occur as a result of the proposed project.

2. Suitable habitat exists within the action area for the project; however, the COE would restrict tree clearing and/or removal to known periods of inactivity of tree roosting bats (September 15 – April 14). During the inactive period Indiana bats are known to have migrated to winter hibernaculum and are hibernating in caves and/or mines. Therefore, the project will avoid the direct killing or injuring of any individual bats.

3. Identified potential roost trees, trees within 150-meters of foraging corridors, or trees within 200-meters of capture sites will not be removed or disturbed within the project site.

4. An average of 10 trees per acre within the clearing area will be left standing to prevent complete tree loss.

5. Selected trees will be girdled and killed to produce potential roost trees for future use.

6. Greater than 800 mast producing trees will be planted in the project site, including those which produce exfoliating bark (i.e., hickory spp.). This will likely result in a positive long-term benefit for potential roost tree production, foraging habitat, and habitat diversity.

7. Clearing areas and the construction of measure F5 will be moved further south near the backwater to reduce tree clearing requirements and minimize effects to Indiana bat habitat disturbance.

8. The project should not diminish the overall quantity or quality of habitat on a scale that would result in the loss of productivity to a maternity colony of Indiana bats utilizing and occupying the Huron Island Complex. This project will affect 42 acres which represents 2.2 percent of the total acreage of forested habitat located within the Huron Island Complex.

We concur that the proposed action will not adversely affect the Indiana bat. The documentation of Indiana bats near the project site presents a unique opportunity to learn more about how the Indiana bat uses floodplain forests. Multiple bat species (including the Indiana bat) have been documented utilizing multiple roost trees and artificial roosting structures. The installation of artificial roosting structures provides an opportunity to research the use of artificial roosting structure as a potential mitigation technique for loss of natural roost structure. The Rock Island Field Office will work with COE biologists regarding the design and placement of artificial roosting structure throughout the Huron Island Complex. Following installation, the Service will also work with COE biologists to design and implement a monitoring plan to assess the use and effectiveness of those structures.

The BA concludes that the Huron Island Project, ***May Affect***, but is ***Not Likely to Adversely Affect the Higgins Eye Pearlymussel*** based on the following proposed conservation measures and justifications:

1. No effects to designated critical habitat or essential habitat areas will occur as a result of this project.

2. Surveys completed in and around the Huron Island Complex did not result in the collection of Higgins eye pearlymussels.

3. The overall area for the construction of the chevrons and closing structure is relatively small and affects habitat generally considered to be sub-optimal for Higgins eye pearlymussel.

4. Prior to construction, the COE, in cooperation with the Service, will conduct preliminary surveys of the impact area to determine potential changes in habitat and the likelihood of Higgins eye presence.

We concur that the proposed action will not adversely affect the Higgins eye pearlymussel.

The BA concludes that the project ***May Affect***, but is ***Not Likely to Adversely Affect the Spectaclecase Mussel*** based on the following proposed conservation measures and justifications:

1. No effects to designated critical habitat or essential habitat areas will occur as a result of this project. Surveys completed in and around the Huron Island Complex did not result in the collection of spectaclecase mussels.

2. The overall area for the construction of the chevrons and closing structure is relatively small and affects habitat generally considered to be sub-optimal for spectaclecase mussel.

3. Prior to construction, the COE, in cooperation with the Service, will conduct preliminary surveys of the impact area to determine potential changes in habitat and the likelihood of spectaclecase presence.

We concur that the proposed action will not adversely affect the spectaclecase mussel.

Additionally, the Service removed bald eagles from protection under the Endangered Species Act on August 8, 2007. However, they remain protected today under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act of 1940 (Eagle Act). The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). Disturb is defined in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

The bald eagle (*Haliaeetus leucocephalus*) is known to utilize and inhabit areas throughout Des Moines County, Iowa. Should any active bald eagle nests be observed near the project area, please contact our office for technical assistance regarding actions necessary to minimize impacts.

Upper Mississippi River (UMR) floodplain forests are generally dominated by over mature stands of silver maple which provide lesser wildlife value compared to mast producing tree species. According to a report[1] published by the Upper Mississippi River Conservation Committee (UMRCC), hard mast species (e.g. oak and hickory) comprise less than 10% of the floodplain forest and are still declining. The recently published "Upper Mississippi River Systemic forest Stewardship Plan[2]" emphasizes the continuing UMR system-wide decline in forests and that "...within 50-70 years... this will result in open conditions and promote undesirable species such as reed canary grass that make it difficult for floodplain forest trees to regenerate." Such changes will result in declines of wildlife species dependent upon a productive and diverse floodplain forest.

Implementation of Forest restoration projects such as the Huron Island Project are critical if management agencies are to maintain current forest conditions. Actions such as this, coupled with other system wide and project specific actions will be necessary to reverse floodplain forest decline. Forest managers have gained considerable knowledge in recent years concerning actions needed to ensure the success of floodplain forest projects. Two common causes for poor tree survival have been flooding and the lack of sustained attention to tree maintenance. Flood impacts will be minimized through the elevation of berms around tree establishment areas. In addition to the flood projection, a maintenance crew (responsible for tree care) should routinely attend to plantings during the growing season for two to four years following construction.

In addition to forestry management objectives, the proposed project seeks to improve Huron Island fishery resources by creating off-channel deep water habitat to enhance fish survival over the winter. In contrast to the forestry objectives, which can provide mast tree habitat capable of more than 100 years of productivity, the increased off-channel fishery habitat productivity will most likely not occur for more than fifty years. As indicated in the draft report, calculating an optimum acreage of overwintering backwater habitat is extremely difficult given our current knowledge of UMR fishery resources. Regardless, the ecological benefits of the addition of this habitat for local fish populations should not be discounted even in the near term.

It is our understanding that up to 42 acres of forest may be cleared to allow for berm construction. Any of the cleared land that is not planted with mast trees, or other ground cover, is at high risk of succeeding to reed canary grass and other undesirable species. It is recommended that any part of the cleared construction corridor, that is not already covered by a planting regime, be planted with aggressive native species that can compete with reed canary

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[1] Urich, R., G. Swenson, and E. Nelson, editors. 2002. Upper Mississippi and Illinois River Floodplain Forests. Desired Future and Recommended Actions. Upper Mississippi River Conservation Committee.

[2] Guyon, L. et. al. Upper Mississippi River Systemic Forest Stewardship Plan. August 2012. US Army Corps of Engineers. 124 pp.

grass. Desirable species for planting include wet prairie grasses such as cordgrass, red osier dogwood, button bush, and blue indigo (*Amorpha fruticosa*).

Bank stabilization in Huron chute is part of the proposed project. We understand that this stabilization will consist primarily of quarry rock. The Service recommends that trees cleared during construction be used in concert with stone for implementing stabilization projects. Utilizing wood and stone in varying combinations and independently will provide additional opportunity to refine river restoration practices and to compare the relative effectiveness of stone versus woody debris. In addition, woody debris may provide better cavity diversity for a variety of aquatic and semi-aquatic animals compared to stone. Excess trees should not be disposed of but rather be used to construct woody debris shelters used by a variety of wildlife.

This letter provides comments under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); and the Endangered Species Act of 1973, as amended. Questions concerning this letter should be directed to Mr. Jon Duyvejonck (telephone 309.757-5800, ext. 207).

Sincerely,

Richard C. Nelson
Field Supervisor

cc: USFWS (Clevenstine, Henry)
IADNR (Griffin, Robbins)

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UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX B

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

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-17F)

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX B

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

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**UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-17F)**

**HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT**

APPENDIX B

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

1. PROJECT DESCRIPTION

1.1. Location. The *Huron Island Habitat Rehabilitation and Enhancement Project* (Project) is located along the right descending bank of the Upper Mississippi River (UMR) in the northern portion of Des Moines County, IA. The project area is in Pool 18 between river miles 421.2 and 425.4, approximately 20 miles upstream of Burlington, Iowa.

1.2. General Description. The U.S. Army Corps of Engineers, Rock Island District (District) proposes to rehabilitate and enhance the Project 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 the Project. The purpose of this Definite Project Report (DPR) is to present a detailed account of the planning, engineering, and construction details of the Recommended Plan to allow final design and construction to proceed subsequent to approval of this document.

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

- The existing aquatic habitat is generally shallow, turbid, and lacks aquatic vegetation important for year-round habitat functioning.
- The existing topography lacks diversity and is completely inundated during minor flood events. Consequently, hard mast tree regeneration, growth, and survival are reduced.
- Without action the existing aquatic habitat will cease to function as fish habitat. Floodplain habitat will decrease in quality through succession to reed canary grass, which is an invasive species.

1.3. Authority and Purpose. The Upper Mississippi River Restoration - Environmental Management Program's original authorizing legislation was the Water Resources Development Act of 1986 (P.L. 99-662), Section 1103.

The purpose of this Project, under Section 1103, is "to ensure the coordinated development and enhancement of the UMR." The project is the result of planning efforts by the State of Iowa, the U.S. Fish and Wildlife Service (USFWS), and the U.S. Army Corps of Engineers.

1.4. General Description of Dredged and Fill Material. An estimated total of 234,680 cubic yards of material will need to be mechanically excavated within the project area. This includes 94,200 yards from Goose Lake Pool 1 and 75,000 yards from Goose Lake Pool 2. Geotechnical soil borings from the pools indicate the material is primarily a soft clay and sand mix, underlain by relatively stiffer clay. Based on information provided by the IA DNR (Christine Schwake, pers. comm.), elutriate testing or sieve analyses are not required (under Section 401 of the Clean Water Act) for this project because we are using mechanical dredging.

An estimated total of 42,725 yards of clean rip rap will be used to construct the Garner Chute closure structure (13,393 yards), bank stabilization at Goose Lake Pool 2 (13,575 yards), and Huron Chute island protection (15,757 yards). Cleared trees (<20) from the placement site will be installed within the dredged portion of Goose Lake Pools 1 and 2 representing minimal fill. Approximately 10-20 mature silver maple trees will be included. The dredged material from Pools 1 and 2 will be side cast within placement sites along Pools 1 and 2 totaling 234,680 yards of fill material.

1.5. Description of the Proposed Placement Sites. Plates 13-24 show the placement sites for all project features in the Recommended Plan. The proposed placement sites are adjacent to the dredge cut. The placement sites were selected due to the lack of topographic diversity (maximum elevation is roughly 2 feet below the 2-year flood elevation) and even-aged mature silver maple dominated forest community. The areas will be cleared of trees (up to 27 acres total) and stockpiled adjacent to the cuts. A small percentage of stockpiled trees will be used to increase cover and foraging habitat for fish in Gun Slough, Goose Lake Pool 1 and Pool 2. The maximum elevation of the placement site does not exceed an elevation of 537 (refer to Measure F1 for potential placement site shaping). The base (EL. 530-535) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Higher elevations, including the shelves and the top of the site would include planting an array of 15 species of native mast tree species.

Surficial soils within the placement sites are generally fluvaquent soils, which is described as an alluvium product in the USDA classification system. This series is described as frequently flooded and water table is said to vary between ground surface and 1 foot deep.

Subsurface borings indicate the area generally consists of soft fat clays gradually changing into stiff clay with increasing depth. Underlying this clay layer down to the bottom of the boring is clayey sand.

1.6. Description of the Placement Method. Mechanically dredged material will be side cast onto the placement sites, allowed to dry, and then mechanically shaped to desired dimensions. Rip rap placement for the closure structure, and bank stabilization will be barged to the site then placed mechanically.

2. FACTUAL DETERMINATIONS

2.1. Physical Substrate Determinations

2.1.1. Substrate Elevation and Slope. Flat pool in the project area is approximately elevation 528.0. The existing floodplain is primarily (95 percent) located below an elevation of 532.4.

The proposed project features intend to increase the floodplain elevation to increase topographic diversity. The target elevation for each measure is as follows:

1.	Goose Lake Pool 1 Dredging	elevation= 520.0	slope=4:1
2.	Goose Lake Pool 2 Dredging	elevation =520.0	slope=4:1
3.	Forest Diversity Berm Adjacent to Pool 1	elevation =537.0	slope=8:1
4.	Forest Diversity Berm Adjacent to Pool 2	elevation =537.0	slope=8:1
5.	Garner Chute Closure Structure	elevation =532.0	slope=3:1
6.	Huron Chute Island Protection	elevation =528-530	slope=2:1
7.	Forest Diversity Berm Above Pool 1	elevation =537.0	slope=3:1

2.1.2. Sediment Type. Surficial soils within the placement sites are generally fluvaquent soils, which is described as an alluvium product in the USDA classification system. This series is described as frequently flooded and water table is said to vary between ground surface and 1 foot deep.

Subsurface borings indicate the area generally consists of soft fat clays gradually changing into stiff clay with increasing depth. Underlying this clay layer down to the bottom of the boring is clayey sand.

2.1.3. Dredged/Fill Material Movement. Dredged material placement sites are in areas located above flat pool or low flow conditions, which indicates minimal movement of materials. Approximately, 2 feet of elevation difference exists between the base of the placement site and flat pool. Placement areas will be heavily planted with native mast trees, scrub/shrub species, and native grass species, which will help to ensure stability. Some loss of slope or height may occur as a result of settling or erosion during high flow events (2-year flood).

Rock placement should experience minimal material movement. Adequate rock size and bedding material is proposed to reduce settling and material movement during high flow events.

2.1.4. Physical Effects on Benthos. Any immobile benthos present at the placement site would be buried as a result of construction activities. With the increase in aquatic vegetation, woody debris, and rock benthic organisms should recolonize quickly.

2.1.5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible minimizes impacts to the benthic community. Construction materials to be used are physically stable and clean, reducing the chances for impacting the river. Mechanical dredging prevents excess water runoff back into the river and reduces instability through consolidated material. Tree plantings, ground cover, and erosion control materials will be installed following berm shaping.

2.2. Water Circulation, Fluctuation, and Salinity Determinations

2.2.1. Water. No significant differences in water chemistry are expected following project construction, and no violations of applicable State water standards are anticipated. The rock materials are inert material that would have little effect on water chemistry. Water clarity, odor, taste, pH, temperature, and dissolved gas levels would not change. The nature of all fill materials would not cause any significant changes in nutrient levels. The construction should not impair the aquatic ecosystem's capability to sustain life, or reduce the suitability of the Mississippi River for aquatic organisms, human consumption, recreation, or aesthetics.

2.2.2. Current Patterns and Circulation. Shallow water placements could have a minor effect on flow patterns in the immediate vicinity of the structures. However, no measurable reductions of inflow to backwater areas are anticipated. No significant effects to existing current patterns or water circulation are expected to result from this action.

2.2.3. Normal Water Level Fluctuation. No changes in normal water level fluctuations are anticipated to result from the proposed project.

2.2.4. Salinity Gradient. This consideration is not applicable in the location of the proposed project.

2.2.5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible and berms were designed and aligned to minimize any potential for adverse effects to water circulation and fluctuation.

2.3. Suspended Particulate/Turbidity Determinations

2.3.1. Expected Changes in Suspended Particles and Turbidity Levels in Vicinity of Placement Site. Suspended solids and turbidity values would be expected to temporarily increase during dredging and placement. A return to ambient conditions should occur shortly after completion of construction. No long-term impacts to suspended solids and turbidity levels are anticipated.

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

Light Penetration. The project would have short-term adverse impacts during construction due to turbidity plumes. Following construction, turbidity and associated light penetration would be expected to return to pre-construction levels.

Dissolved Oxygen (DO). Placement of dredged material should have no short- or long-term adverse impacts on DO levels. Aquatic features should help to maintain DO in the project areas at levels (5 mg/l minimum) suitable for year-round fish habitat.

Toxic Metals and Organics. No increase in contaminants in the aquatic environment would result from the placement of fill material. Dredging and placement of fine material is not expected to have toxic effects on fish, wildlife, or other aquatic organisms.

Aesthetics. Temporary increases in suspended sediments would have a minor short-term impact on aesthetics in the project area. No long-term negative effects on aesthetics are anticipated to result from the project.

2.3.3. Effects on Biota. Minor disturbances to organisms present in the construction zone could occur as a result of fill activity and dredging. Effects on photosynthesis and filter feeders would be short-term. No long-term adverse effects to biota would be anticipated to result from this action. The overall long-term impact of the HREP project is expected to be beneficial to biota in the project area and the river system.

2.4. Contaminant Determinations. No contaminants that would exceed State standards have been identified in substrates to be dredged. Possible introduction of equipment or construction-related contaminants would be controlled by adherence to runoff monitoring plans during construction activity. No toxic materials would be introduced to the area as a result of construction activities. Rock riprap would be clean, uncontaminated stone from an approved source.

2.5. Aquatic Ecosystem and Organism Determinations

2.5.1. Effects on Plankton. Only short-term and minimal effects are anticipated to occur as a result of dredging and fill activity. No significant impacts to plankton are expected.

2.5.2. Effects on Benthos. No significant impacts to benthos at the placement site or at the location of mechanical dredging are anticipated. For the most part, aquatic substrates would be affected incidentally to adjacent construction activities. Aquatic substrates would be directly affected by mechanical dredging. These substrates would eventually be covered with material of similar character. Recolonization of benthic organisms should occur quickly.

2.5.3. Effects on Nekton. The restoration of backwaters at Goose Lake Pools 1 and 2 would substantially improve the quality of fish habitat in this area. The primary factor that is limited at present and at risk in the future is overwintering habitat, due to limited deep off-channel aquatic areas protected from high current velocities. Channel excavation in the aforementioned backwater lakes would ensure areas of suitable depth, flow, dissolved oxygen, and temperature would be available during severe winter conditions in the future.

2.5.4. Effects on Aquatic Food Web. The loss of the benthic organisms within the footprint of the riprap bank protection should not cause any significant impact to any level/segment of the aquatic food web, or disrupt the flow of energy between trophic levels. This small benthic loss should not result in the reduction or potential elimination of food chain organism populations and should not cause any decrease in the overall productivity and nutrient export capability of the ecosystem.

Improvements in backwater and riverine habitat through aquatic vegetation establishment, spawning habitat protection, and increased depth should increase primary and secondary production in the project area. This increase in production should lead to an increased forage base for fish and wildlife.

2.5.5. Effects on Special Aquatic Sites

Sanctuaries and Refuges. The project area is located within the Upper Mississippi River Wildlife and Fish Refuge. No designated Fish and Wildlife Service designated "closed areas" are found in the project area.

Wetlands, Mud Flats and Vegetated Shallows. Approximately 90 acres of aquatic habitat and 105 acres of floodplain habitat would be directly or indirectly affected by construction of overwintering fish habitat in the backwaters and berm construction on the floodplain. Improvements through aquatic vegetation restoration, diverse forest plantings, and increased depth in the backwaters will have an overall positive effect on wetland and floodplain vegetation.

Threatened and Endangered Species. Correspondence from the USFWS indicates no impacts are envisioned to threatened or endangered species or their habitats, provided construction activities are scheduled and monitored to avoid direct impacts, conservation measures described in the Biological Assessment and Biological Opinion are implemented, and conditions do not change significantly (Appendix A, *Correspondence*).

Other Wildlife. Wildlife species which utilize forested and non-forested wetland habitats should benefit in the long term from the proposed action.

2.6. Proposed Placement Site Determinations

2.6.1. Mixing Zone Determinations. Discussions pertaining to turbidity and suspended particulates are summarized in section 2.3. Contaminants were discussed previously in section 2.4. A small amount of fine-grained material could migrate from the placement sites and become diluted with adjacent side channel and main channel border flow. Fine-grained material used for construction of berms would result in temporary localized increases in suspended material. The use of mechanical dredging should help to minimize these effects.

2.6.2. Determination of Compliance with Applicable Water Quality Standards. A joint application for State water quality certification under Section 401 and discharge of dredged or fill material under Section 404 of the Clean Water Act will be submitted to the USACE and Iowa Department of Natural Resources.

2.6.3. Potential Effects on Human-Use Characteristics. Implementation of the proposed project will have no significant adverse effects on municipal or private water supplies; recreational or commercial fisheries; water-related recreation or aesthetics; parks; national monuments; or other similar preserves.

2.6.4. Determination of Cumulative Effects on the Aquatic Ecosystem. The District continues the operation and maintenance of the 9-foot channel project. This includes continuation of dredging and disposal of sediment and dike construction (i.e., chevrons, closing structures, and wing dams).

The District Mississippi River operations and maintenance crew is currently developing a plan to construct an additional wing dam at the entrance to Huron Chute. This wing dam could potentially affect Huron Chute directly through rock placement and potential reduced flows into Huron Chute.

Foresters with the Rock Island District continue to implement timber stand improvements measures at locations within Huron Island and Lake Odessa. 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 estimated approximately 100 acres of active timber stand improvements strategies will be implemented in the next 20 years on Huron Island.

It is anticipated within the next 10 years the Keithsburg Division and Boston Bay HREPs will commence planning efforts for implementation. These projects would be similar to Huron 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. The potential for significant cumulative impacts is lessened by the ecosystem restoration efforts in Pool 18. This project, in concert with Lake Odessa, Keithsburg Division, and Boston Bay, should counter some of the past, current, and foreseeable actions described earlier. In total, 54 HREPs have been completed benefiting nearly 100,000 acres. Another 6 projects are in construction and 30 additional projects in various stages of planning, engineering, or design.

2.6.5. Determination of Secondary Effects on the Aquatic Ecosystem. No significant secondary effects should result from construction of the proposed project.

HURON ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 18, MISSISSIPPI RIVER MILES 421.2 THROUGH 425.4
DES MOINES COUNTY, IOWA

APPENDIX B
CLEAN WATER ACT

FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH THE RESTRICTIONS ON PLACEMENT

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

2. Alternatives which were considered for the proposed action are as follows:

   Alternative A: No Federal Action

   Alternative B: Preferred Alternative. The includes dredging deepwater habitat in Goose Lake Pools 1 and 2, placement and shaping of dredged material to construct berms up to an elevation of 537 for the purposes of creating a diverse mast tree community, installation of a closure structure in Garner Chute, and construction of island protection in Huron Chute.

   Alternative C: Management features considered but not selected included dredging all backwaters in the Project, installation of rock vanes for bank stabilization, rip rap for bank stabilization, and berms up to an elevation of 539.

3. Certification under Section 401 of the Clean Water Act will be obtained prior to initiation of project construction and will be in compliance with the water quality requirements of the State of Iowa.

4. The project will not introduce toxic substances into nearby waters or result in appreciable increases in existing levels of toxic materials.

5. No significant impact to federally-listed endangered species will result from this project. The U.S. Fish and Wildlife Service, Ecological Services Office, Moline, Illinois supports this determination.

6. The project is located along a freshwater inland river system. No marine sanctuaries are involved or will be affected, and no degradation of waters of the U. S. is anticipated.

7. No municipal or private water supplies will be affected. There will be no adverse impact to recreational fishing, and no unique or special aquatic sites are located in the project area. No long-term adverse changes to the ecology of the river system will result from this action.

8. Project construction materials will be chemically and physically stable. No contamination of the river is anticipated.

9. No other practical alternatives have been identified. The proposed project is in compliance with the guidelines for Section 404(b)(1) of the Clean Water Act, as amended. The proposed project will not significantly impact water quality or the integrity of the aquatic ecosystem.

11-13-13
(Date)

Mark J. Deschenes
Mark J. Deschenes
Colonel, US Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX C

MEMORANDUM OF AGREEMENT

MEMORANDUM OF AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
THE UNITED STATES FISH AND WILDLIFE SERVICE
FOR
HABITAT REHABILITATION AND ENHANCEMENT
OF THE
UPPER MISSISSIPPI RIVER SYSTEM
AT HURON ISLAND, MISSISSIPPI RIVER POOL 18,
DES MOINES COUNTY, IOWA
MANAGED BY IOWA DEPARTMENT OF NATURAL RESOURCES

I. PURPOSE

The purpose of this Memorandum of Agreement (MOA) is to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service (USFWS) and the Department of the Army (DOA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the *Huron Island, Des Moines County, Iowa, Habitat Rehabilitation and Enhancement Project*, a separable element of the Upper Mississippi River Restoration - Environmental Management Program (UMRS-EMP).

II. BACKGROUND

A. The project lands of the *Huron Island, Des Moines County, Iowa, Habitat Rehabilitation and Enhancement Project* are owned in fee by the United States of America and managed under the provisions of a cooperative agreement between the DOA and the USFWS, dated July 31, 2001. Management of these project lands has been assumed by the Iowa Department of Natural Resources (IADNR) under a successive cooperative agreement between the USFWS and the IADNR dated March 22, 2012.

B. Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. Under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, 100 percent of the construction costs of those fish and wildlife features for Huron Island are the responsibility of the DOA, and pursuant to Section 107 (b) of the Water Resources Development Act of 1992, Public Law 102-580, all costs of operation and maintenance for the *Huron Island, Des Moines County, Iowa, Habitat Rehabilitation and Enhancement Project* are 100 percent non-Federal.

III. GENERAL SCOPE

The project to be accomplished pursuant to this MOA shall consist of the following:

A. Increasing bathymetric and topographic diversity by mechanically dredging in Pools 1 and 2 of the Goose Lake backwater area;

B. Improving forest topographic diversity adjacent to Pools 1 and 2 by increasing the elevation and planting mast tree species;

C. Constructing a closure structure in Garner Chute;

D. Placing riprap for island bank protection within Huron Chute;

E. Increasing forest diversity in non-diverse forested areas by increasing the elevation.

IV. RESPONSIBILITIES

A. DOA is responsible for:

1. Construction. Construction of the project consists of placing riprap along the upstream end of two small islands in Huron Chute, mechanically dredging material from Goose Lake Pools 1 & 2 and side casting the material on the existing adjacent floodplain, shaping both dredged material placement sites from Goose Lake Pools 1 & 2 and planting a variation of native floodplain vegetation, constructing a rock closure structure near the upstream end of Garner Chute, and constructing topographic diversity in non-diverse forested areas.

2. Major Rehabilitation. The Federal share of any mutually agreed upon rehabilitation of the project that exceeds the annual operation and maintenance requirements identified in the definite project report and that is needed as a result of specific storm or flood events.

3. Construction Management. Subject to and using funds appropriated by the Congress of the United States, and in accordance with Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, the DOA will construct the Huron Island, Des Moines County, Iowa, Habitat Rehabilitation and Enhancement Project as described in the *Upper Mississippi River Restoration, Environmental Management Program, Definite Project Report with Integrated Environmental Assessment, Huron Island, Habitat Rehabilitation and Enhancement Project* dated _______, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The USFWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If DOA encounters potential delays related to construction of the project, DOA will promptly notify USFWS of such delays.

4. Maintenance of Records. The DOA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with construction of the project to the extent and in such detail as will properly reflect total costs. The DOA shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the project and resolution of all relevant claims arising there from, and shall make available at its offices, at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the USFWS.

B. USFWS Responsibilities: Upon completion of construction as determined by the District Engineer, Rock Island, the USFWS shall accept the project as part of the General Plans lands cooperatively managed between the USFWS and the IADNR. It is understood that in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580, 100 percent of all costs associated with the operation, maintenance, and repair of the *Huron Island, Des Moines County, Iowa, Habitat Rehabilitation and Enhancement Project* will be borne by the IADNR. It is further understood that if the State of Iowa fails to provide that funding that the terms of this agreement will be reviewed pursuant to Part V.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of 50 years after initiation of construction of the Project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties.

USFWS: Midwest Regional Director
U.S. Fish and Wildlife Service
One Federal Drive
Fort Snelling, Minnesota 55111-4056

DOA: District Engineer
US Army Corps of Engineers, Rock Island District
Clock Tower Building
P. O. Box 2004
Rock Island IL 61204-2004

VII. EFFECTIVE DATE OF MOA

This Huron Island MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF THE ARMY	THE U.S. FISH AND WILDLIFE SERVICE
______________________________	______________________________
Mark J. Deschenes Colonel, US Army Commander & District Engineer	Tom Melius Midwest Regional Director U.S. Fish and Wildlife Service
Dated ______________________	Dated ______________________

UPPER MISSISSIPPI RIVER RESTORATION ENVIRONMENTAL MANAGEMENT PROGRAM DEFINITE PROJECT REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX D

HABITAT EVALUATION AND QUANTIFICATION

UPPER MISSISSIPPI RIVER RESTORATION
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HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

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APPENDIX D

HABITAT EVALUATION AND QUANTIFICATION

1. INTRODUCTION

This appendix presents an ecological assessment of the Project area and quantification, to the extent possible, of the aquatic and floodplain ecological benefits resulting from the proposed alternatives for the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project). 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 of Biologists from the USFWS, Iowa Department of Natural Resources (IA DNR), and the U.S. Army Corps of Engineers (Corps), Rock Island District (District).

2. EXISTING AND FUTURE WITHOUT PROJECT BIOLOGICAL CONDITIONS

2.1. Aquatic Habitat. Tables D-1, D-2, and D-3 provide summaries of the existing conditions and Future Without Project (FWOP) conditions for the Project area. Existing food data was obtained from IA DNR electrofishing data from the Project, water quality data was collected by the Corps (2005-present), cover data was obtained through field surveys, substrate information was gathered from geotechnical borings and mussel survey data, and velocities were generated from H&H modeling and field collections. Future With and Without Project data was estimated using best professional judgment of the evaluation team and H&H modeling, when applicable. Inherent in best professional judgment are the underlying assumptions, which are described in Section 3. A description of how these parameters influence fish life history and habitat quality is included in Chapter 2 of the main report, *Assessment of Existing Resources.*

2.2. Floodplain Habitat. Following construction of lock and dam 18, the physical conditions at Huron Island were altered significantly. Water levels increased by about 8 feet which significantly altered the hydrology and forest conditions of the Project area. Where 14 species including several hard mast species were once prominent on the island, now only silver maple and 5 other species inhabit the area. This is due primarily to increased inundation during flood events (only 0.1 acres are above the 2-year event) and the inability for trees to regenerate. Forest stands are mature, even-aged, and experiencing a high rate of mortality without recruitment. Consequently, percent open canopy is increasing with reed canary grass (invasive species) thriving in those areas. Tables D-1 through D-4 provide summaries of the conditions in the Project area; information contained in table D-4 was obtained through pre-dam topography maps; 1982 & 2011 forest surveys; LIDAR survey data; GIS analyses; H&H modeling; and consensus of the resource managers.

Appendix D
Habitat Evaluation and Quantification

Table D-1. Aquatic Evaluation Areas With Associated Field Data for Food, Water Quality, Cover, Reproduction, and Water Velocity Parameters Under Existing Conditions (Year 0)

	FOOD	**WATER QUALITY**			**COVER**					**REPRODUCTION**	**OTHER**
Evaluation Area	**Forage**	**Temp (min/max)**	**Minimum D.O.**	**Avg Turbidity**	**% Cover (vegetation)**	**% Cover (logs, brush)**	**% Pool/ Backwater**	**Avg Depth**	**% Area > 4ft depth**	**Substrate**	**Velocity (spawn, rear, overwinter)**
Goose Lake Pools 1 & 2	125 g/m^3	0.2 / 29.6	<1.5 mg/L	125 ppm	0.50%	10%	80%	0.7 m	0%	sand/silt/ floodplain	10.5, 2.5, 0.5 cm/s
Garner Chute	75 g/m^3	0.2 / 29.6	>5 mg/L	125 ppm	4%	6%	5%	4.5 m	85%	littoral zone sand/structure	30 cm/s
Huron Chute Islands	75 g/m^3	0.2 / 29.6°C	>5 mg/L	125 ppm	3%		1%	3.2 m	85%	littoral zone sand/structure	30 cm/s

Table D-2. Aquatic Evaluation Areas With Associated Estimates for Food, Water Quality, Cover, Reproduction, and Water Velocity Parameters Under the No Action Alternative (Target Year 20)

	FOOD	**WATER QUALITY**			**COVER**					**REPRODUCTION**	**OTHER**
Evaluation Area	**Forage**	**Temp (min/max)**	**Minimum D.O.**	**Avg Turbidity**	**% Cover (vegetation)**	**% Cover (logs, brush)**	**% Pool/ Backwater**	**Avg Depth**	**% Area > 4ft depth**	**Spawning Habitat**	**Velocity (spawn, rear, overwinter)**
Goose Lake Pools 1 & 2	125 g/m^3	0.2 / 30.0	<1.5 mg/L	125 ppm	0.50%	10%	60%	0.6 m	0%	sand/silt/ floodplain	10.5, 2.5, 0.25 cm/s
Garner Chute	75 g/m^3	0.2 / 29.6	>5 mg/L	125 ppm	4%	6%	5%	4.5 m	85%	littoral zone sand/structure	30 cm/s
Huron Chute Islands	50 g/m^3	0.2 / 29.6°C	>5 mg/L	125 ppm	1.81%		0.62%	3.7 m	90%	littoral zone sand/structure	30 cm/s

Table D-3. Aquatic Evaluation Areas With Associated Estimates for Food, Water Quality, Cover, Reproduction, and Water Velocity Parameters Under the No Action Alternative (Target Year 50)

	FOOD	WATER QUALITY			COVER					REPRODUCTION	OTHER
Evaluation Area	**Forage**	**Temp (min/max)**	**Minimum D.O.**	**Avg Turbidity**	**% Cover (vegetation)**	**% Cover (logs, brush)**	**% Pool/ Backwater**	**Avg Depth**	**% Area > 4ft depth**	**Substrate**	**Velocity (spawn, rear, overwinter)**
Goose Lake Pools 1 & 2	125 g/m^3	0.2 / 29.6	<1.5 mg/L	125 ppm	0.50%	10%	30%	0.4 m	0%	sand/silt/ floodplain	10.5, 2.5, 0 cm/s
Garner Chute	75 g/m^3	0.2 / 29.6	>5 mg/L	125 ppm	4%	6%	5%	4.5 m	85%	littoral zone sand/structure	30 cm/s
Huron Chute Islands	30 g/m^3	0.2 / 29.6°C	>5 mg/L	125 ppm	0.10%		0.05%	4.5 m	100%	no littoral zone	30 cm/s

Table D-4. Floodplain Habitat Evaluation Area With Measurements for Various Floodplain Habitat Parameters By Pre-Dam Conditions, Existing Conditions, and Future Without Project Conditions (Target Years 25 and 50)

Evaluation Period	% Forested	% Open Canopy	Surface Acres > 2-yr Flood El.	Dominant Species & % Total[1]				# Species Present	Forest Stand Average Age	Reed Canary Grass %
Pre-Dam	95%	5%	53.7	8 Spp 50%	ACSA2 30%	ULAM 12%	Other 8%	14		
Existing	95%	5%	0.1 acres	ACSA2 80%	ULAM 10%	PODE 3 5%	3 Spp. 5%	6	120	4%
FWOP TY 25	75%	25%	0.1 acres	ACSA2 85%	ULAM 10%	PODE 3 5%		3	145	18%
FWOP TY 50	55%	45%	0.1 acres	ACSA2 95%	ULAM 5%			2	170	34%

[1] ACSA2 = silver maple
ULAM = American elm
PODE3 = eastern cottonwood
other *spp.* = pin oak, bur oak, swamp white oak, river birch, pecan, black walnut, black willow, Kentucky coffeetree, etc.

3. HABITAT BENEFIT EVALUATION METHODS

The purpose of the habitat benefit evaluation is to evaluate and quantify, to the extent possible, environmental benefits of alternative plans for aquatic and floodplain habitat improvements. The evaluation was conducted by a multi-agency team which included representatives from the USFWS, IA DNR, and Corps. Aquatic benefits were quantified through the use of the Habitat Evaluation Procedures (HEP; USFWS 1980). Floodplain benefits were quantified through the use of the Topographic Diversity Index (TDI).

3.1. Quantity Component. Traditionally, the Corps has used the quantity and quality of habitat jointly, in the form of habitat units, to measure benefits provided by ecosystem restoration projects. The quantity portion is often measured as area (acres of habitat, landform, etc.) or number of species; in some systems, it is measured as length (miles of stream bank). The evaluation conducted for the Huron Island HREP uses acres, delineated by polygons, to represent the quantity. The area associated with each management measure must have a clear definition for use as guidance in estimating the area component of the ecosystem output model, and must be applied consistently to all actions evaluated.

For this Project, three different scales of area were considered to determine which would be the most suitable area metric to use in the analysis. For each scale, the capabilities and limitations were considered.

3.1.1. Action Footprint. The action footprint is a measurement of the physical footprint of the management measures. For example, the surface area covered by excavated material placement or the area excavated in a backwater. When multiple management measures are included in an action, the footprint equals the total of the management-measure footprints with no double counting of overlap areas addressed by two or more management measures.

- **Capability.** Can be accurately quantified with a high degree of certainty
- **Limitation.** Grossly underestimates the areal extent of ecological benefits from each management measure because process restoration covers a broader area

3.1.2. Area of Restored Process. This is a measurement of the area directly affected by the restoration of processes. The measurement would include the footprint as well as the effect of processes (biotic and abiotic) which result in a detectable difference in composition, structure, or function, as compared to the existing condition.

- **Capability.** Can be accurately quantified with high level of certainty for some management measures (for example, those that restore wetland habitat gradation in which deep water transitions to aquatic bed to emergent wetland to seasonally inundated scrub/shrub habitat and finally to temporarily inundated forested wetland), and more fully captures the area that would experience ecological benefits from restoration of a process
- **Limitation.** Difficult to quantify with certainty for some management measures (for example, those management measures that restore sediment transport and delivery); does not identify whether an action is too small to have a significant benefit to the ecosystem

3.1.3. Potential Area of Influence. This is a measurement of the area that could benefit from the process restoration provided by the action. In some cases, this may be the same as the area of restored process. In other cases, it could extend beyond the area of restored process to the greater ecosystem area that a stressor affects or indirect effects can extend well beyond the immediate area of stressor removal. While potential area of influence is an estimated area that is more consistent with the guidance calling for a systems approach (ER 1165-2-501), it was not feasible to devise consistent rules for defining this area. For instance, an increase in primary productivity has an effect across a much larger spatial area than just the area where new aquatic vegetation is placed; however, the affected area would be difficult to quantify systematically.

- **Capability.** Fully captures the area of ecological benefits of a given management measure
- **Limitation.** Not feasible to estimate with any degree of certainty and consistency

For this Project it was determined, of the three scales considered, using area of restored process is the optimal approach to estimating ecological benefits beyond the specific action footprint with the least amount of uncertainty. The action footprint was considered to provide too significant an underestimate and did not fully measure the benefits of the Project. Estimating the potential area of influence scale was considered too uncertain and speculative.

To define the area of restored process for each measure at the proposed action locations, the target processes were identified (table D-5) and the area of restored process determined (table D-6).

Table D-5. Management Measures Which Restore Process and Area of Restored Process

<table>
<tr><th>Management Measure</th><th>Process Restored</th><th>Area of Restored Process</th></tr>
<tr><td>Backwater Excavation and Revegetation</td><td rowspan="2">Habitat connectivity and vegetative processes - littoral zone, habitat structure and function, primary productivity, nutrient processing)</td><td rowspan="2">Excavated area plus revegetated area plus area of direct influence resulting from the interconnection of habitat. This area includes the restored photic zone, littoral zone, and interconnected spawning, rearing, and overwintering fish habitat.</td></tr>
<tr><td>Aquatic Vegetation Restoration</td></tr>
<tr><td>Closure Structure</td><td>Hydrology - flow and velocity</td><td>Area of low flow created by structure during overwintering conditions</td></tr>
<tr><td>Island protection and Stabilization</td><td>Hydrology - flow, velocity, sediment transport; Littoral processes, habitat connectivity, habitat structure</td><td>Area of flow, sediment transport, and habitat structure and function restored, (compared to existing hydrology) by the feature.</td></tr>
<tr><td>Increased Floodplain Elevation Through Excavated Material Placement</td><td>Hydrology - water inundation and duration</td><td rowspan="2">Footprint plus area in which the measure has an influence on forest canopy cover, species composition; or reproduction, rearing, and foraging habitat. This edge influence has been shown to be more than 100-m for some primary and secondary processes (Harper et al. 2005).</td></tr>
<tr><td>Mast Tree Planting</td><td>Habitat connectivity, forest structure and function</td></tr>
</table>

Table D-6. Aquatic and Floodplain Areas Under Consideration for This Assessment, Including Approximate River Mile and Area Used for Evaluation

Habitat Type	Evaluation Area	Measure Number	River Mile	Area Evaluated
Aquatic	Goose Lake Pool 1	T1 & T2	422.6 - 422.1	29.1 acres
	Goose Lake Pool 2	T3 & T4	422.8 - 422.1	25.7 acres
	Garner Chute	T9	424.9 - 424.1	22.3 acres
	Huron Chute - Upper and Lower Islands	I1	423.2 - 422.9	5.9 acres
Floodplain	Forest Diversity Adjacent to Pool 1	F1, F2	422.6 - 422.1	41.1 acres
	Forest Diversity Adjacent to Pool 2	F3, F4	422.8 - 422.1	36.3 acres
	Topographic Diversity Using Existing Soil	F5, F6	422.6 - 422.1	27.9 acres

3.2. Quality of Aquatic Benefits. The methodology utilized for evaluating benefits to aquatic habitat incorporates the HEP format, which was developed by the USFWS. HEP is a habitat-based evaluation methodology used in project planning. The procedure documents the quality and quantity of available habitat for selected fish and wildlife species. HEP is based on the assumption that habitat for selected fish and wildlife species can be described by a Habitat Suitability Index (HSI). This index value (on a scale from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain Habitat Units (HUs), which are used in comparisons of the relative value of fish and wildlife habitat at points in time.

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the life of the Project (50 years). HUs are calculated for select target years (existing, 1, 10, 20, 30, 40, 50) and annualized (using IWR Planning Suite NER Annualizer) over the life of the Project to derive Average Annual Habitat Units (AAHUs). AAHUs are used as the output measurement to compare the features and alternatives for the proposed Project.

3.2.1. Backwater Habitat. The largemouth bass (Stuber et al. 1982b) and bluegill (Stuber et al. 1982a; Palesh and Anderson 1990) Corps-approved (per EC 1105-2-412) HSI models were used to assess the backwater habitat benefits resulting from excavation of Goose Lake Pool 1, Goose Lake Pool 2, and the installation of a closure structure to create backwater habitat in Garner Chute. These species were selected because they require backwater habitat for all or most of their life cycle and are often limited in the availability of high quality overwintering habitat and aquatic vegetation. While the bluegill model emphasizes overwintering habitat, the largemouth bass model emphasizes spawning and rearing habitat. The combination of these models provides an all-inclusive analysis of the year-round habitat afforded by these measures. Aggregation of the models was accomplished using the arithmetic mean (or simply the mean or average) of the bluegill and largemouth bass model quality values. The arithmetic mean was chosen because it gives equal weight to both high and low values and treats each species equally.

The following assumptions in applying the largemouth bass and bluegill HSI models were made:

Baseline Condition. Detailed water quality data was collected from 2006 to present at one monitoring station in each Goose Lake Pool 1 and Pool 2. Due to the length of the data collection and location, it was assumed the data collected at each station was representative of the entire backwater. For the purposes of model input, the spawning season was May to June, growing season June to September, and overwintering December to February. It was assumed the water quality of Garner Chute was similar to Huron Chute and the main channel.

Future Without Project Conditions. Future conditions of Goose Lake Pools 1 & 2 were based on an average sedimentation rate of 1 cm/year over the next 50 years. This rate was determined based on H&H modeling output. It's not likely aquatic habitat loss would be linear as most sedimentation occurs during flooding events. Nonetheless, over time aquatic habitat will be reduced by about 70 percent. Remaining lentic habitat will consist of isolated interior shallow pools with fish access only during high water events. It is probable the Huron 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 18. Finally, overwintering habitat will continue to be nonexistent within the interior backwaters of the Project.

Future With Project Conditions. The proposed final depth of Goose Lake Pools 1 & 2 is 8 feet. With approximately 1.6 feet of sediment accumulating over 50 years, adequate depths would still be present for overwintering habitat. Therefore, it was assumed percent backwater would remain the same as present, minimum D.O. of >4 mg/l after excavation, average temperature would be 2°C , and average velocity would be 0.2 cm/s (with berm placement site). Percent of the backwater greater than 4 feet in depth would increase to 32.4 percent with a decrease over time due to sedimentation on the slopes of the excavation site.

3.2.2. Riverine Habitat. The Corps-approved (EC 1105-2-412) channel catfish (McMahon and Terrell 1982) and walleye (McMahon et al. 1984) HSI models were used to assess the riverine habitat benefits resulting from Huron Chute island protection via rip-rap bank stabilization and forested wetland protection via rip-rap bank stabilization. Channel catfish was selected because it is eurytopic, which means it utilizes both riverine and backwater habitats. Using the channel catfish allows us to capture the benefits of the unique habitat diversity afforded by the measures. Walleye was selected 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. The combination of these models provides a more robust analysis of the year-round habitat afforded by these measures. Aggregation of the models was accomplished using the arithmetic mean (or simply the mean or average) of the channel catfish and walleye model quality values. The arithmetic mean was chosen because it gives equal weight to both high and low values and treats each species equally.

The following assumptions in applying channel catfish and walleye HSI models were made:

Baseline Condition. Water quality data from the main channel was assumed to be similar to Huron Chute. Although the volume of water flowing through Huron Chute is less, the velocities should be similar. For the purposes of model input, the spawning season for walleye was March to May and growing season June to October. The spawning season for channel catfish was May to July and growing season July to September.

Future Without Project Conditions. It was assumed the small islands in Huron Chute would continue to experience erosion at a rate of 2 percent loss in acreage per year. This essentially reduces the island to almost zero by year 50. Consequently, available habitat structure and cover, food production, and potential spawning habitat for both walleye and channel catfish would be reduced.

Future With Project Conditions. Protection of the islands in Huron Chute would reduce erosion and potentially initiate island growth through reduced year-round velocities and aggradation of sediments. Rock would increase habitat structure for fish cover. Due to the increase in habitat availability and complexity, cover and forage fish abundance is expected to increase.

3.3. Quality of Floodplain Benefits. The methodology utilized for evaluating benefits to floodplain habitat utilizes a newly developed TDI. This model was developed by the Rock Island District specifically for use in the Huron Island HREP. The theory behind the TDI is firmly entrenched in plant community ecology; plants are adapted to specific moisture tolerance. Many plant species drown when inundated, whereas some tree species have adaptations that allow them to move oxygen and carbon dioxide in and out thorough pores above the flood stage water line. The quantity metric is acres within specific flood zones that are relevant to the survival and distribution of trees. A quality factor is applied to the quantity within each flood zone to provide the overall habitat suitability related to the survival, growth, and regeneration of hard mast trees in the floodplain. The index value (on a scale from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain HUs, which are used in comparisons of the relative value of the forest community habitat at points in time.

Changes will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the life of the Project (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 NER Annualizer) over the life of the Project (50-years) to derive AAHUs. AAHUs are used as the output measurement to compare the features and alternatives for the proposed Project.

3.3.1. Background. Implementation of the Upper Mississippi River System 9-foot Channel Project altered physical conditions at Huron Island by raising water levels about 8 feet and stabilizing low to moderate flow river stages to maintain the 9-foot deep navigation channel (Theiling and Nestler 2010). A conceptual model with accurate flood stage estimates for pre-dam and existing conditions helps explain the river stage impacts of impoundment, levees, and watershed development (figure D-1). The pre-dam reference illustrates river stage at the Project site was four feet lower than after the dam was built. Pre-dam floods were lower for similar frequency floods and there was a larger stage difference between the 50 percent and 25 percent floods prior to dam construction. The pre-dam stage-elevation relationship indicates there were large parts of the island in each flood zone.

The existing condition represents the regulated physical conditions which includes higher stable low flow stages, and an elevated and wider range of hydrologic variation. Low flow stage is more than 4 feet higher than pre-dam until flooding occurs. Frequent floods achieve higher elevations than previously because of levees, channelization, and increased discharge (Theiling and Nestler, 2010). The elevation difference between the 50 percent and 25 percent frequency of occurrence floods is also lower in the post dam period, which means that most of the island now experiences the same hydrology compared to the flood stage zonation exhibited in the pre-dam period. The elevation of the 10 percent frequency of occurrence flood is so high in the post-dam era that only a very small portion of the island remains exposed. Alternative conditions can include a range of project alternatives that either lower water levels or raise the ground elevation to decrease the frequency of inundation and thereby increase tree diversity.

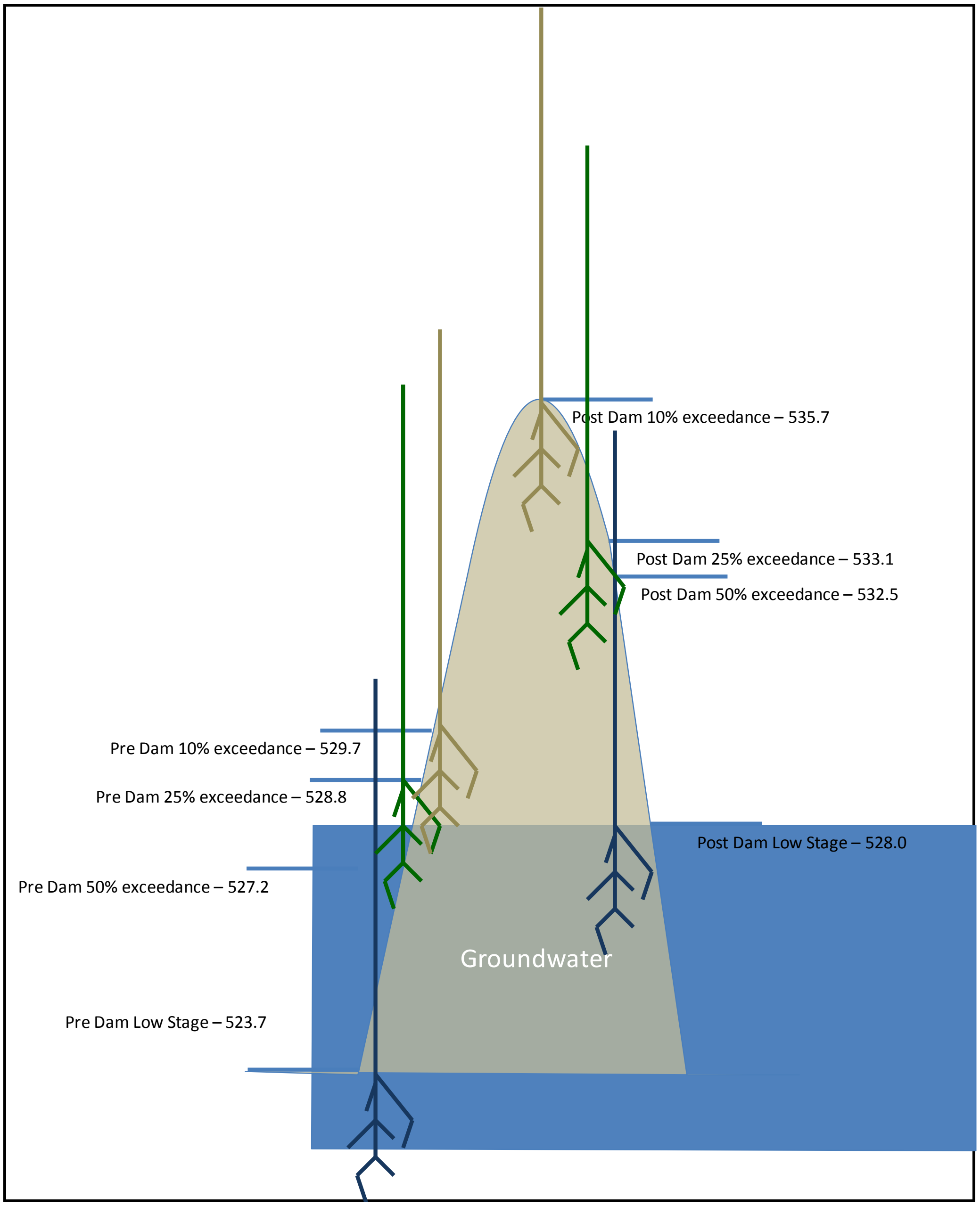

Figure D-1. Topographic Diversity Index Conceptual Model

3.3.2. Purpose of Model. The TDI was developed to estimate the potential forest community benefit from changing the relative surface area of the Project site 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 hydrology has been in place since the 1970s. Alternative restoration states include the area and height of berms constructed to enhance 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.

3.3.3. Model Description and Depiction. The topographic diversity index is an integrated GIS mapping and hydrologic analysis that incorporates input from digital elevation maps and river stage frequency analyses to estimate the terrestrial area that occurs within specific flood zones. 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. The pre-dam hydrologic condition was established as the reference condition against which the existing condition and project alternatives are compared.

3.3.4. Hydrologic Analysis. The Hydrologic Engineering Center's Ecosystem Functions Model (HEC-EFM) was used to contrast pre-and post-impoundment stage duration and frequency relationships at the Keithsburg Gage. The results at Keithsburg (river mile 427) were then interpolated downstream to Huron Island (river mile 425 to 421) based on established water surface profiles for the given discharge.

Forest species 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. For each of the three tolerances, HEC-EFM was used to query the growing season portion to determine the elevation that 1) meets the specified inundation duration conditions and 2) meets a specified exceedance probability. For example the moderately tolerant species can withstand 35 to 45 consecutive days of inundation. For a given year, EFM uses a moving 35-day window to identify each 35-day minimum that occurs within the growing season. EFM returns the maximum of all the 35-day minimum values in a given year, for every year included in the period of record. Finally, an exceedance probability is specified, for example 50 percent, and EFM ranks each of the annual maximum values from the previous step and returns the value that has a 50 percent exceedance probability.

This EFM analysis was performed for two different periods of record: pre-impoundment (1900 – 1936); and post-impoundment (1980 to 2010). Comparison of the results for these two different periods of record indicate a significant difference in flood stages that occurred during the growing season prior to impoundment and those that occur presently. An example of these results for moderately tolerant species is shown in table D-7. The less the exceedance probability, the lower the mortality risk for trees planted at that elevation.

Table D-7. Comparison of Results From HEC-EFM for the Moderately Tolerant Floodplain Forest Species Using Pre- and Post-Impoundment Keithsburg Gage Records

Period of Record	Low Flow (71% Annual Duration)	EFM 50% Exceedance Stage	EFM 33.3% Exceedance Stage	EFM 25% Exceedance Stage	EFM 10% Exceedance Stage
Pre-Dam (1900-1936)	525.7	529.4	530.4	531	532
Post-Dam (1980-2010)	530	534.5	535	535.3	537.9

3.3.5. GIS Analysis. This spatial analysis was used to calculate the Topography Distribution Ratio (TDR) component for TDI calculations. River stage estimates from several points along the length of the island were interpolated as a TIN surface. The pre-dam stage estimates (figures D-2 and D-3) were overlaid on a 1890s topographic survey. Post dam stage estimates (figures D-2 and D-3) were overlaid on DEMs created from high resolution ortho-photography in 1994. Differences in inundation extent were most pronounced for the frequent flood stages. Low flow water surface area was not greatly increased and large flood extents have not changed. However, the combined effects of impoundment, levees, and watershed development increased the height and extent of frequent floods (figures D-2 and D-3). Initial analyses that considered the entire Huron Island Project area were refined to the forest stand of interest where restoration measures would be constructed (figure D-4).

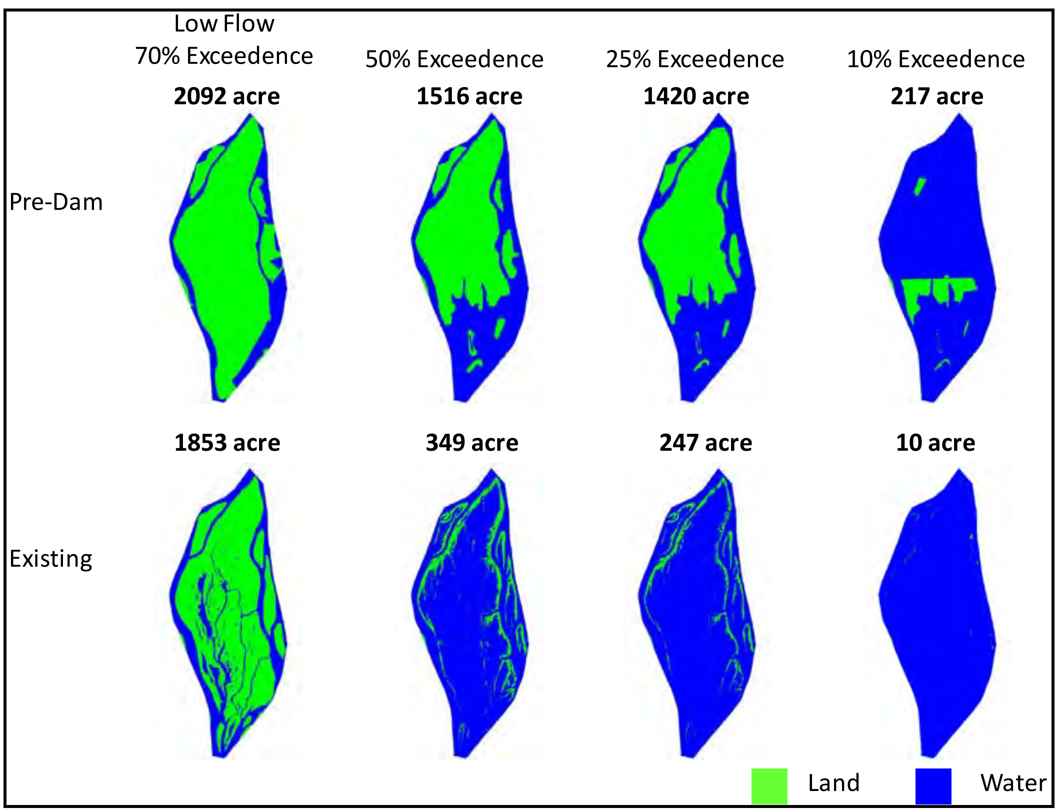

Figure D-2. Land and Water Area Distribution for Four Huron Island Flood Stage Scenarios During Pre-Dam and Post-Dam Periods

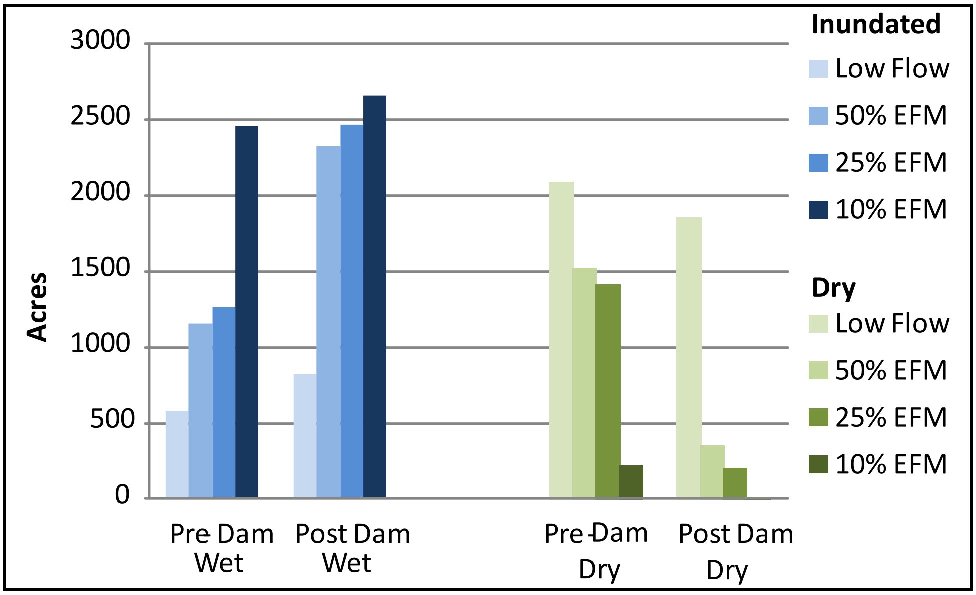

Figure D-3. Areal Change (acres) at Upper Mississippi River, Huron Island (River Miles 421 – 428)

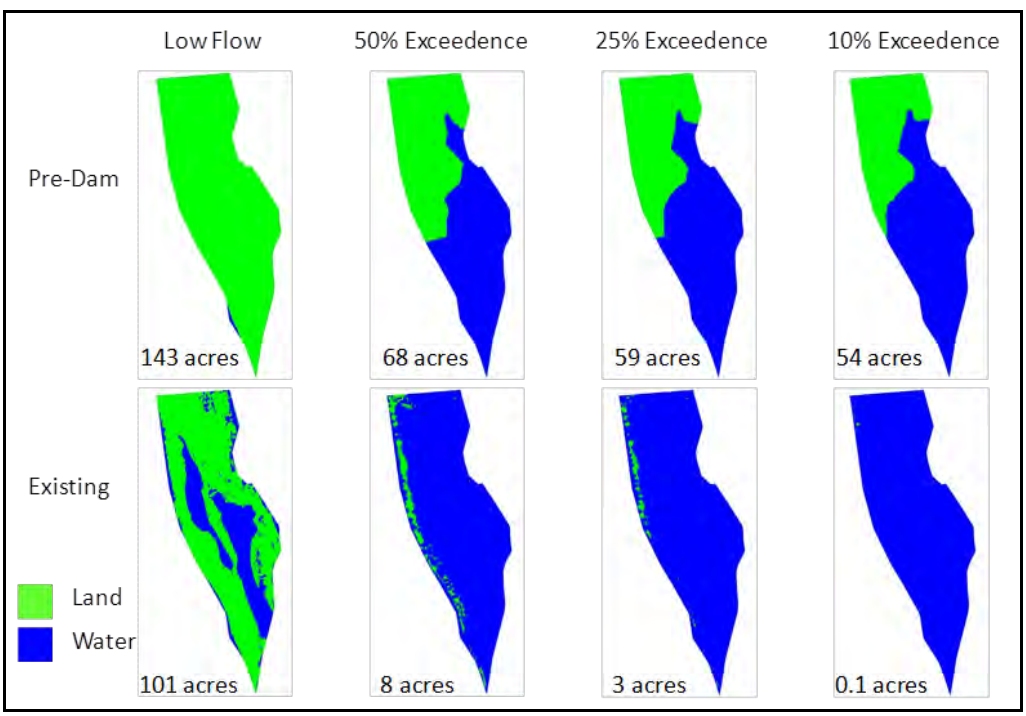

Figure D-4. Land and Water Area Distribution for Four Flood Stage Scenarios During Pre-Dam and Post-Dam Periods on the Huron Island Forest Stand Sampling Unit (includes Backwater Lake and Berm Construction Site)

3.3.6. Topographic Diversity Calculator. The quantitative basis for the TDI is derived from a recent paper by DeJager et al. (2012). Their analysis of forest stand data (Dam 2 to Dam 10 in UMRS) related to flood stage showed a general relationship between tree species diversity and frequency of water inundation (figure D-5). Floodplain areas which experience frequent flooding (>65 days per year) exhibited low tree species diversity and generally contained water tolerant species (e.g., silver maple, willow). Tree species diversity increased with decreasing flooding.

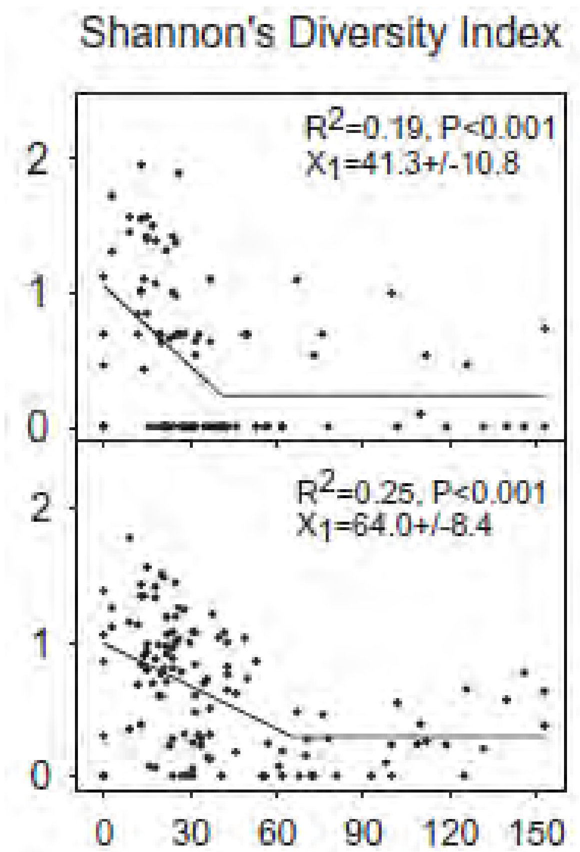

Figure D-5. Flood Frequency (x-axis), Understory (Top Graph) Diversity (y-axis), and Overstory (Bottom Graph) Relationships in Upper Mississippi River Floodplain Forests (DeJager et al., 2012)

Using the data and results from DeJager et al. (2012), an additional analysis was conducted to develop a more discrete estimate of the number of tree species likely to be present (95 percent confidence interval) based on ranges of water inundation corresponding to each modeled elevation (Nate DeJager, USGS, personal communication.). To compute the index, percent occurrence within flood day range categories were calculated for each tree species. For example, 28 percent of all cottonwood individuals were found at sites which flooded for less than 9 days during the growing season, 69 percent were found at sites which flooded for less than 19 days, and so on. The max days flood evaluated was 153 days. Next, a count statement was applied to the percentages which asked whether less than 95 percent of all individuals of a given species were found at sites which flood for a given duration. The sum of the count statement gives the number of species one would be 95 percent confident to find at a site of a given flood duration category (table D-8). The resulting conditional

Table D-8. Modeled Elevations and Corresponding Data Required to Compute the Conditional Richness Index (derived by Nate DeJager, USGS, personal communication)

Conditional Richness				
Exceedance Probability	**Modeled Elevation**	**Days Inundated**	**Flood Day Range**	**# Species Likely Present (95% Confidence)**
Low flow	523.8	151	>119	4.00
50%	527.2	73	50-79	8.00
33%	528.2	65	50-79	8.00
25%	528.8	49	40-49	10.00
10%	529.7	27	20-29	14.00

richness index along with the actual number of days of water inundation for each modeled elevation calculated using the river hydrograph (1980 to present) was used to estimate the number of species one would be 95 percent confident of observing at each modeled elevation at Huron Island. A plot of the data suggests a decline in richness with water inundation duration and provides the information needed to determine incremental benefits of increased elevation (i.e., decreased water inundation) and increased species richness. The following illustrates the various components and equations used to calculate TDI units.

$$TDI\ (units) = TDI\ \times Total\ Acres$$

where total acres is the Project area size.

The TDI is:

$$TDI = \sqrt[n]{\left(\prod_{j}^{n}\left(\sqrt{(\mathrm{TDR_j} \times \mathrm{CRR_j})}\right)\right)}$$

where,

j = river stage frequency considered (i.e., low flow or 50% exceedance flood, etc.)

n = number of river stage frequencies considered (i.e., low flow, 50% exceedance flood, etc.),

Topography Distribution Ratio (TDR). TDR refers to the proportional difference between land exposed during Pre-Dam, Existing, Future Without, and Multiple Project alternative reference conditions at each modeled flood stage.

TDR = acres dry @ elevation(j, reference condition)/acres dry @ elevation(j, historic reference)

Conditional Richness (CR). CR refers to the number of species one would be 95 percent confident to find at a site of given flood duration range (table D-8):

Conditional Richness Ratio (CRR). CRR refers to the number actual number of tree species present/number of tree species expected (CR). The number of actual tree species present was estimated for the reference condition (based on DeJager et al. 2012 results), existing condition (based on a 2011 forest stand survey at Huron Island), future with project (based on number of species planted at each elevation for each alternative), and FWOP conditions (based on forest stand survey trend data). CRR is expressed as a 1.0 if it meets or exceeds the likely species present for each flood stage. Otherwise, it is the proportion of the expected value achieved.

3.3.7. Capabilities and Limitations. The TDI integrates hydrologic drivers and expected tree species for the Huron Island HREP site on Upper Mississippi River (UMR) Pool 18. It is proposed as a one-time use model because of the unique historic topography data that were available for the site. The TDI evaluated historic river stage variation to establish low flow and multiple flood stage estimates for historic reference and existing conditions. The information was used to design the height of restoration features, and it was also incorporated into environmental benefits analysis.

The capacity to compile the input parameters at this site was very high because the UMR is data-rich in general, and this site in particular had historic topography and bathymetry digitized. Other information available at the site included contemporary hydraulic models, abundant historic river stage data, and detailed historic land cover and forestry data. With the exception of the digitized historic topography, these data are available system-wide. Application of the model at other sites would require digitizing historic data, but available hydrologic data will also support non-spatial analysis as in HEC-EFM. Application of the model outside of gauged streams would require alternative methods of estimating inundation area, of which there are many emerging methods beyond the scope of this discussion.

3.3.8. Assumptions. The TDI assumes tree species distribution is correlated with flood frequency as reported in the scientific literature. The FWOP conditions assume tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Open canopy areas will result in reed canary grass residence. Future With Project conditions assume sedimentation will continue to be homogenously distributed across the island resulting in a no net loss of topographic diversity. Also, tree species planted on berms would maintain the same density as a result of consistent operation, maintenance, and monitoring.

4. HABITAT EVALUATION RESULTS

Chapter 5 of the main report, *Evaluation of Feasible Project Features and Formulation of Alternatives*, describes each potential Project measure in detail. The Project planning team screened out several measures before this habitat quantification exercise. Tables D-9, D-10, and D-11 provide summaries of the results of the habitat benefit evaluation.

4.1. Aquatic Benefits. Tables D-9, D-10, and D-11 provide the species-specific final aggregated suitability index (SI), acres for each alternative, habitat units, gross AAHUs and net AAHUs (lift) for each target year under consideration.

Table D-9. Benefit Evaluation Results for the Huron Chute Island Protection Measure – Walleye and Channel Catfish (Island Habitat Diversity - Upper and Lower Islands)

				OUTPUT						
Number	**Description**	**Condition**	**Year**	**Walleye**	**Channel Catfish**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
I0	No Action	Existing	0	0.17	0.54	0.36	2.10	0.7	0.4	**0.0**
		FWOP	1	0.17	0.53	0.35	2.06	0.7		
			10	0.17	0.53	0.35	1.66	0.6		
			20	0.16	0.52	0.34	1.26	0.4		
			30	0.16	0.51	0.34	0.86	0.3		
			40	0.00	0.51	0.26	0.46	0.1		
			50	0.00	0.50	0.25	0.06	0.0		
I1	Bank Stabilization	With Project	1	0.46	0.60	0.53	5.90	3.1	3.2	**2.9**
			10	0.48	0.60	0.54	5.96	3.2		
			20	0.48	0.60	0.54	6.02	3.3		
			30	0.48	0.60	0.54	6.08	3.3		
			40	0.48	0.60	0.54	6.14	3.3		
			50	0.48	0.60	0.54	6.20	3.3		

Table D-10. Benefit Evaluation Results for the Goose Lake Excavation Measures - Bluegill and Largemouth Bass
(Topographic Diversity and Overwintering Fish Habitat)

Number	Description	Condition	Year	OUTPUT						
				Bluegill	Largemouth Bass	SI Final	Acres	HUs	AAHUs	Net AAHUs
$T0_1$	No Action Goose Lake Pool 1	Existing	0	0.24	0.00	0.12	29.1	3.5	0.4	**0.0**
		FWOP	1	0.24	0.00	0.12	28.89	3.5		
			10	0.00	0.00	0.00	26.8	0.0		
			20	0.00	0.00	0.00	24.92	0.0		
			30	0.00	0.00	0.00	23.23	0.0		
			40	0.00	0.00	0.00	21.71	0.0		
			50	0.00	0.00	0.00	20.33	0.0		
T1	Goose Lake Pool 1Topographic Diversity (537 Top)	With Project	1	0.79	0.85	0.82	29.1	23.9	24.0	**23.6**
			10	0.79	0.86	0.83	29.1	24.0		
			20	0.80	0.86	0.83	29.1	24.2		
			30	0.81	0.86	0.84	29.1	24.3		
			40	0.82	0.86	0.84	29.1	24.4		
			50	0.82	0.86	0.84	29.1	24.4		
T2	Goose Lake Pool 1Topographic Diversity (539 Top)	With Project	1	0.79	0.85	0.82	29.1	23.9	24.0	**23.6**
			10	0.79	0.86	0.83	29.1	24.0		
			20	0.80	0.86	0.83	29.1	24.2		
			30	0.81	0.86	0.84	29.1	24.3		
			40	0.82	0.86	0.84	29.1	24.4		
			50	0.82	0.86	0.84	29.1	24.4		
$T0_2$	No Action - Goose Lake Pool 2	Existing	0	0.24	0.00	0.12	25.7	3.1	0.3	**0.0**
		FWOP	1	0.24	0.00	0.12	23.51	2.8		
			10	0.00	0.00	0.00	21.65	0.0		
			20	0.00	0.00	0.00	19.99	0.0		
			30	0.00	0.00	0.00	18.5	0.0		
			40	0.00	0.00	0.00	17.15	0.0		
			50	0.00	0.00	0.00	15.93	0.0		
T3	Goose Lake Pool 2 Topographic Diversity (537 Top)	With Project	1	0.79	0.85	0.82	25.7	21.1	21.2	**20.9**
			10	0.79	0.86	0.83	25.7	21.2		
			20	0.80	0.86	0.83	25.7	21.3		
			30	0.81	0.86	0.84	25.7	21.5		
			40	0.82	0.86	0.84	25.7	21.6		
			50	0.82	0.86	0.84	25.7	21.6		
T4	Goose Lake Pool 2 Topographic Diversity (539 Top)	With Project	1	0.79	0.85	0.82	25.7	21.1	21.2	**20.9**
			10	0.79	0.86	0.83	25.7	21.2		
			20	0.8	0.86	0.83	25.7	21.3		
			30	0.81	0.86	0.84	25.7	21.5		
			40	0.82	0.86	0.84	25.7	21.6		
			50	0.82	0.86	0.84	25.7	21.6		

Table D-11. Benefit Evaluation Results for the Forested Wetland Protection Measures – Walleye and Channel Catfish

Number	Description	Condition	Year	WAE	CCF	SI Final	Acres	HUs	AAHUs	Net AAHUs
				OUTPUT						
E0	No Action	Existing	0	0.17	0.51	0.34	1.5	0.5	0.5	**0.0**
		FWOP	1	0.17	0.51	0.34	1.5	0.5		
			10	0.17	0.51	0.34	1.5	0.5		
			20	0.17	0.51	0.34	1.5	0.5		
			30	0.17	0.51	0.34	1.5	0.5		
			40	0.17	0.51	0.34	1.5	0.5		
			50	0.17	0.51	0.34	1.5	0.5		
E1	Bank Stabilization	With Project	1	0.46	0.6	0.53	1.5	0.8	0.8	**0.3**
			10	0.48	0.6	0.54	1.5	0.8		
			20	0.48	0.6	0.54	1.5	0.8		
			30	0.48	0.6	0.54	1.5	0.8		
			40	0.48	0.6	0.54	1.5	0.8		
			50	0.48	0.6	0.54	1.5	0.8		
E2	Rock Vanes	With Project	1	0.54	0.76	0.65	4.5	2.9	3.0	**2.5**
			10	0.56	0.78	0.67	4.5	3.0		
			20	0.56	0.78	0.67	4.5	3.0		
			30	0.56	0.78	0.67	4.5	3.0		
			40	0.56	0.78	0.67	4.5	3.0		
			50	0.56	0.78	0.67	4.5	3.0		

4.2. Floodplain Results. Table D-12 is taken from the TDI Benefit Calculator, which provides the raw data input for the reference condition (pre-dam), existing condition, and with and without Project conditions. Components of each TDI Unit calculation include the exceedance probability, corresponding elevations, dry acres by elevation, species richness scores at each elevation based on water inundation duration during the growing season, conditional richness (CR) ratio, TDI scores by elevation, and aggregated TDI score (geometric mean). Gross outputs are provided as TDI units, which are equivalent to HEP habitat units.

Table D-12. Example TDI Benefit Calculation Measure F1

	F1 - REFERENCE CONDITION						
EFM Exceedance	**Elevation**	**Acres Dry @ Elevation**	**TDR**	**# Species Present**	**CR**	**TDI**	**Composite TDI**
Low Flow	523.8	40.7	1.00	4	1.00	1.00	**1.00**
50%	527.2	19.3	1.00	8	1.00	1.00	
33%	528.2	17.7	1.00	8	1.00	1.00	
25%	528.8	16.9	1.00	10	1.00	1.00	
10%	529.7	15.6	1.00	14	1.00	1.00	
TOTAL	**Total Acres**	**41.1**				**TDI Units**	**41.1**

	F1 - EXISTING						
EFM Exceedance	**Elevation**	**Acres Dry**	**TDR**	**# Species Present**	**CR**	**TDI**	**Composite TDI**
Low Flow	529.1	28.8	0.71	4	1.00	0.84	**0.15**
50%	532.4	1.6	0.09	4	0.50	0.21	
33%	532.8	0.8	0.05	4	0.50	0.15	
25%	533.3	0.4	0.02	4	0.40	0.10	
10%	535.7	0.0	0.00	6	0.43	0.03	
TOTAL	**Total Acres**	**41.1**				**TDI Units**	**6.1**

	F1 - FUTURE WITHOUT PROJECT - Year 1						
EFM Exceedance	**Elevation**	**Acres Dry**	**TDR**	**# Species Present**	**CR**	**TDI**	**Composite TDI**
Low Flow	529.1	28.8	0.71	4	1.00	0.84	
50%	532.4	1.6	0.08	4	0.50	0.20	
33%	532.8	0.8	0.05	4	0.50	0.15	
25%	533.3	0.4	0.02	4	0.40	0.10	
10%	535.7	0.0	0.00	6	0.43	0.03	**0.15**
TOTAL	**Total Acres**	**41.1**				**TDI Units**	**6.1**

	F1 - WITH PROJECT						
EFM Exceedance	**Elevation**	**Acres Dry**	**TDR**	**# Species Present**	**CR**	**TDI**	**Composite TDI**
Low Flow	529.1	35.6	0.87	4	1.00	0.94	**0.64**
50%	532.4	9.7	0.50	6	0.75	0.61	
33%	532.8	7.3	0.41	6	0.75	0.56	
25%	533.3	7.1	0.42	10	1.00	0.65	
10%	535.7	4.5	0.29	15	1.00	0.54	
TOTAL	**Total Acres**	**41.1**				**TDI Units**	**26.5**

Table D-13 gives benefit evaluation results for the No Action and forest diversity adjacent to Pool 1 (F1 = el. 537; F2 = el. 539) alternatives. Table D-14 gives benefit evaluation results for the No Action and forest diversity adjacent to Pool 2 (F3 = el. 537; F4 = el. 539) alternatives.

Table D-13. TDI Calculation Results for No Action, F1, and F2

					OUTPUT				
Measure	**Number**	**Description**	**Condition**	**Year**	**TDI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Floodplain Forest Diversity	F0	No Action	Existing	0	0.15	41.1	6.1	4.3	**0.0**
			FWOP	1	0.15	41.1	6.1		
				25	0.10	41.1	4.1		
				50	0.07	41.1	2.9		
	F1	Forest Diversity Adjacent to Pool 1 (537 Top)	With Project	1 10 20 30 40 50	0.64	41.1	26.5	26.5	**22.2**
	F2	Forest Diversity Adjacent to Pool 1 (539 Top)	With Project	1 10 20 30 40 50	0.66	41.1	27.1	27.1	**22.8**

Table D-14. TDI Calculation Results for No Action, F3, and F4

					OUTPUT				
Measure	**Number**	**Description**	**Condition**	**Year**	**TDI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Floodplain Forest Diversity	F0	No Action	Existing	0	0.15	36.3	5.4	3.9	**0.0**
			FWOP	1	0.15	36.3	5.4		
				25	0.10	36.3	3.7		
				50	0.07	36.3	2.6		
	F3	Forest Diversity Adjacent to Pool 2 (537 Top)	With Project	1 10 20 30 40 50	0.61	36.3	22.0	22.0	**18.1**
	F4	Forest Diversity Adjacent to Pool 2 (539 Top)	With Project	1 10 20 30 40 50	0.62	36.3	22.5	22.5	**18.6**

Table D-15 shows benefit evaluation results for the No Action and forest diversity in non-diverse forest location using existing soil (F5 = el. 537; F6 = el. 539) alternatives.

Table D-15. TDI Calculation Results for No Action, F5, and F6

Measure	Number	Description	Condition	Year	OUTPUT TDI Final	Acres	HUs	AAHUs	Net AAHUs
Floodplain Forest Diversity	F0	No Action	Existing	0	0.15	27.9	4.2	3.0	**0.0**
			FWOP	1	0.15	27.9	4.2		
				25	0.10	27.9	2.8		
				50	0.07	27.9	2.0		
	F5	Forest Diversity in Non-Diverse Forest Location Using Existing Soil (537 Top)	With Project	1 10 20 30 40 50	0.59	27.9	16.5	16.5	**13.5**
	F6	Forest Diversity in Non-Diverse Forest Location Using Existing Soil (539 Top)	With Project	1 10 20 30 40 50	0.62	27.9	17.4	17.4	**14.4**

5. COST EFFECTIVENESS AND INCREMENTAL ANALYSIS OF ALTERNATIVES

Comparison of alternative feature designs and combinations of features is accomplished through cost-effectiveness evaluation and incremental cost analysis. Cost-effectiveness evaluation is used to identify the least costly solution to achieve a range of project benefits. Incremental cost analysis is a tool that can assist in making decisions on the scale or size of the project or of individual features by determining changes in costs associated with increasing levels of benefits.

5.1. Enhancement Features. The proposed Project involves four primary enhancement features: Bathymetric Diversity, Topographic Diversity, Native Floodplain Forest Plantings, and Erosion Protection.

Bathymetric Diversity and Topographic Diversity

T1-Goose Lake Pool 1 Bathymetric Diversity (537 Top) involves mechanically dredging material in Goose Lake Pool 1 and side casting the material on the existing floodplain (plate C-105 in Appendix P, *Plates*). The excavation site is 2,402 feet long. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project, while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides immediate access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute. The placement site consists of an upper site extending 1,002 feet and a lower site extending 1,163 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement site (El. 529-532 feet). Plantings will incorporate a stratified design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

T2-Goose Lake Pool 1 Bathymetric Diversity (539 Top) involves mechanically dredging material in Goose Lake Pool 1 and side casting the material on the existing floodplain (plate C-106 in Appendix P, *Plates)*. The excavation site is 2,402 feet long. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project , while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides immediate access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute. The placement site consists of an upper site extending 1,002 feet and a lower site extending 1,163 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement site (El. 529-532 feet). Plantings will incorporate a stratified design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

T3 - Goose Lake Pool 2 Bathymetric Diversity (537 Top) involves mechanically dredging material in Goose Lake Pool 2 and side casting the material on the existing floodplain (plate C-105 in Appendix P, *Plates*). The excavation site is 2,642 feet long. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project , while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute. The placement site is 2,642 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement site (El. 529-532 feet). Plantings will incorporate a stratified design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

T4-Goose Lake Pool 2 Bathymetric Diversity (539 Top) involves mechanically dredging material in Goose Lake Pool 2 and side casting the material on the existing floodplain (plate in Appendix P, *Plates* 106). The excavation site is 2,642 feet long. The pool would be excavated to a minimum depth of 520 feet, which is approximately 8 feet below flat pool. This elevation is optimal to address sedimentation over the life of the Project , while also providing overwintering fish habitat and aquatic habitat diversity year-round. The location of the channel provides immediate access to adjacent spawning and rearing habitat, and ingress and egress of fish by way of Huron Chute. The placement site is 2,642 feet. The base (El. 530-535 feet) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Permanently Inundated Aquatic Bed and Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed vegetation would be planted transitionally from the excavation site (El. 526-529 feet) to the base of the placement (El. 529-532 feet). Plantings will incorporate a stratified planting design which will include treatments of plant life stage, density, protection (i.e. exclosures), and elevation.

Note: T1, T2, T3, and T4 include bank protection of 2,415 feet in the form of riprap along the bankline of Huron Island near Goose Lake Pool 2 (plate C-108 in Appendix P, *Plates*). These measures are included to reduce active erosion and protect the investment made for the bathymetric diversity, placement sites, and aquatic vegetation. Riprap would consist of IADOT (Class A) or ILDOT (RR-5) size stone. Bedding sizes would be IADOT (No. 3) or IL DOT (RR-1).

T9-Garner Closure Structure involves the construction of a rock closure structure near the upstream end of Garner Chute between Garner Island and Huron Island (plate C-107 in Appendix P, *Plates*). The structure would be constructed of riprap and built to El. 532 feet. The top width (upstream to downstream) would be 14 feet. Upstream slopes would be 2H: 1V, and downstream slopes at 3H:1V. Garner Chute currently has adequate depths to support year-round fish habitat, but the average flow (>3 cm/sec) is too high to support centrarchid overwintering habitat. Construction of the closure structure would reduce water velocities and provide optimal overwintering habitat.

Native Floodplain Forest Plantings

F1-Forest Diversity Adjacent to Pool 1 (537 Top) involves shaping the 2,165 feet long placement site contained in Measure T1 as follows (Plate L-102): The placement site would slope up at a 8H:1V slope to El. 535 feet at which point a 30-foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to El. 537 feet . The top of the placement site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which include treatments of tree container size, protection, and elevation. Tree container sizes include #3, #5, and #15 Root Production Method™ (RPM) containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 537 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 537 feet) would be planted for this measure. Also, to increase ground cover post-construction, approximately 3 acres of an understory seed mix would be included (El. 533-537 feet).

F2-Forest Diversity Adjacent to Pool 1 (539 Top) involves shaping 2,165 feet long excavated material placement site contained in Measure T2 as follows (Plate L-102): The placement site would slope up at a 8H:1V slope to El. 535 feet at which point a 30-foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to El. 539 feet . The top of the placement site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which would include treatments of tree container size, protection, and elevation. Tree container sizes would include #3, #5, and #15 RPM containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 539 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 539 feet) would be planted for this measure. Also, to increase ground cover post-construction, approximately 3 acres of an understory seed mix would be included (El. 533-539 feet).

F3-Forest Diversity Adjacent to Pool 2 (537 Top) involves shaping 2,642 feet long placement site contained in Measure T3 as follows (Plate L-102): The placement site would slope up at a 8H:1V slope to El. 535 feet at which point a 30-foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to El. 537 feet . The top of the placement site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which would include treatments of tree container size, protection, and elevation. Tree container sizes would include #3, #5, and #15 RPM containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 537 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 537 feet) would be planted for this measure. Also, to increase ground cover post-construction, approximately 3 acres of an understory seed mix would be included (El. 533-537 feet).

F4-Forest Diversity Adjacent to Pool 2 (539 Top) involves shaping 2,642 feet long excavated material placement site contained in Measure T4 as follows (Plate - L102): The placement site would slope up at a 8H:1V slope to El. 535 feet at which point a 30-foot wide tier would be constructed. The placement site would continue to slope upward at a 3H:1V slope to El. 539 feet. The top of the placement site would be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species would be planted on each of the tiers. Plantings would incorporate a stratified random planting design of 0.5-acre plots which would include treatments of tree container size, protection, and elevation. Tree container sizes would include #3, #5, and #15 RPM containers. Exclosures would be installed for approximately half of the trees to protect against herbivory. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between El. 533-535 feet), temporarily inundated forested wetland scrub/shrub species (tiers at El. 535 & 539 feet), and temporarily inundated forested wetland trees (tiers at El. 535 & 539 feet) would be planted for this measure. Also, to increase ground cover post-construction, approximately 3 acres of an understory seed mix would be included (El. 533-539 feet).

Erosion Protection

I1-Huron Chute Diversity Island Bank Stabilization involves protection in the form of riprap along the head end of both the upstream and downstream islands. This measure is included to reduce active erosion and potentially allow the islands to expand on the downstream end over time. Riprap would be placed along 300 feet of bankline at both the upper and lower islands at a 2H:1V slope at a 24 inch thickness on 12 inches of bedding stone, with a 6 foot weighted toe. Riprap would consist of IADOT (Class A) or ILDOT (RR-5) size stone. Bedding sizes would be IADOT (No. 3) or IL DOT (RR-1).

Topographic Diversity, Native Floodplain Forest Plantings

F5-Forest Diversity in Non-Diverse Forest Location Using Existing Soil (537 Top) involves constructing a ridge and swale habitat that extends just over 1,000 feet. This feature was further modified throughout the planning process to include both excavated material and exiting soil to reduce costs and decrease disturbance of potential Indian bat habitat. The site would be constructed with 3 tiers at 2 elevations, with the highest tier being in the middle at El. 537 (with a width of 80 feet), and the lower 2 tiers on either end at El. 535 feet (each one with a width of 50 feet). Native floodplain vegetation including trees, scrub/shrub wetland plants, and an understory seed mix would be incorporated in the design. In order of increasing elevation, seasonally inundated scrub/shrub plants (slope between El. 533-535 feet), temporarily inundated scrub/shrub plants (tiers at El. 535 & 537 feet), and temporarily inundated wetland trees (tiers at El. 535 & 537 feet) would be planted for this measure. Also, to increase ground cover post-construction, approximately 7.0 acres of an understory seed mix would be included (El. 533-537 feet).

F6-Forest Diversity in Non-Diverse Forest Location Using Existing Soil (539 Top) involves constructing a ridge and swale habitat that extends just over 1,000 feet. This feature was further modified throughout the planning process to include both excavated material and exiting soil to reduce costs and decrease disturbance of potential Indian bat habitat. The site would be constructed with 3 tiers at 2 elevations, with the highest tier being in the middle at El. 539 (with a width of 80 feet), and the lower 2 tiers on either end at El. 535 feet (each one with a width of 50 feet). Native floodplain vegetation including trees, scrub/shrub wetland plants, and an understory seed mix would be incorporated in the design. In order of increasing elevation, seasonally inundated scrub/shrub plants (slope between El. 533-535 feet), temporarily inundated scrub/shrub plants (tiers at El. 535 & 539 feet), and temporarily inundated wetland trees (tiers at El. 535 & 539 feet) would be planted for this measure. Also, to increase ground cover post-construction, approximately 7.0 acres of an understory seed mix would be included (El. 533-539 feet).

5.2. Cost Estimates for Habitat Improvements. Table D-16 shows the estimated outputs (in AAHUs) and annualized costs for each feature alternative. A detailed breakdown of costs for the Recommended Plan is outlined in Appendix J, *Cost Estimate*. Costs were annualized and are based on estimates for construction, adaptive management, monitoring, and OMRR&R.

Table D-16. Annualized Cost Estimate and Net AAHUs[1]

Features	Symbol	Net AAHUs	Construction Costs	PED Costs	Construction Mgmt Costs	Contingency	Total Cost	Annualized Costs	Annualized Operation Costs	Annualized Maintenance Costs	Annualized Costs per Feature
Topographic Diversity Pool 1(537)	T1	23.60	$1,118,051	$111,805	$89,444	20%	$1,583,160	$70,568	$113	$85	$70,766
Topographic Diversity Pool 1(no-action)	T01	-	-	-	-			-			
Topographic Diversity Pool 1(539)	T2	23.60	$1,346,171	$134,617	$107,694	20%	$1,906,179	$84,966	$113	$85	$85,164
Topographic Diversity Pool 2 (no-action)	T03	-	-	-	-			-		-	-
Topographic Diversity Pool 2 (537)	T3	20.90	$1,172,739	$117,274	$93,819	20%	$1,660,599	$74,020	$113	$85	$74,218
Topographic Diversity Pool2 (539)	T4	20.90	$1,177,069	$117,707	$94,166	20%	$1,666,730	$74,293	$113	$85	$47,491
Garner Chute (no action)	T09	-	-	-	-			-	-	-	-
Garner Chute (T9)	T9	14.10	$451,582	$45,158	$36,127	20%	$639,441	$28,503	$300	-	$28,803
Bank Stabilization (No-Action)	E0	-	-	-	-			-	-	-	-
Bank Stabilization -Riprap	E1	0.30	$787,578	$78,758	$63,006	20%	$1,115,211	$49,710	$300	$5,715	$55,725
Island Protection (No-Action)	I0	0.40		-	-			-	-	-	-
Island Protection	I1	2.90	$324,441	$32,444	$25,955	20%	$459,408	$20,478	$300	$2,911	$23,689
Forest Diversity Pool 1 (537)	F1	22.20	$275,751	$27,575	$22,060	20%	$390,463	$17,405	$63	$194	$17,662
Forest Diversity Pool 1(No-Action)	F01	-	-	-	-			-	-	-	-
Forest Diversity Pool 1 (539)	F2	22.80	$380,846	$38,085	$30,468	20%	$539,278	$24,038	$63	$194	$24,295
Forest Diversity Pool 2 (No-Action)	F03	-	-	-	-			-	-	-	-
Forest Diversity Pool 2(537)	F3	17.70	$171,593	$17,159	$13,727	20%	$242,976	$10,830	$63	$241	$11,134
Forest Diversity Pool 2(539)	F4	18.20	$236,735	$23,674	$18,939	20%	$335,217	$14,942	$63	$241	$15,246
Forest Diversity in Non-Diverse Forest No-Action)	F0	-	-	-	-			-	-	-	-
Forest Diversity in Non-Diverse Forest (537)	F5	12.20	$1,101,457	$110,146	$88,117	20%	$1,559,664	$69,521	$63	$352	$69,936
Forest Diversity in Non-Diverse Forest (539)	F6	13.10	$1,489,330	$148,933	$119,146	20%	$2,108,892	$94,002	$63	$352	$94,417

[1] Annualized cost is based on a 50-year project life, 3.75 percent interest rate
[2] Contingency was added prior to annualization

5.3. Incremental Analysis of Project Alternatives. Potential management measures were combined into alternatives using the IWR Planning Suite II tool. IWR Planning Suite II tool was developed to aide environmental and ecosystem restoration planning studies perform cost-effectiveness and incremental cost analyses (CE/ICA) on alternatives. CE output determines which alternatives are the least costly for a given level of environmental output. ICA evaluates the efficiency of the cost-effective alternatives, to determine which provide the greatest increase in output for the least increase in cost.

Primary assumptions and constraints used to conduct the Huron Island CE/ICA are as follows:

- AAHUs for all analyzed habitats were assumed to have equal value in comparing alternative plans.
- Feature Forest Diversity Adjacent to Pool (F1-F4) was assumed to be dependent on their corresponding feature T1-T4 (Goose Lake Pools Bathymetric Diversity) since the increased Topographic Diversity is necessary to implement the forest diversity measures.
- Goose Lake Pools Bathymetric Diversity measures (T1-T4) are dependent on erosion protection costs to protect the Corps investment since significant bank erosion is occurring along Huron Island adjacent to the Goose Lake backwaters.
- Measures T1 and T2 are mutually exclusive of each other.
- Measures T3 and T4 are mutually exclusive of each other.
- Measures F5 and F6 are mutually exclusive of each other.

Changes to symbols were made to F5 and F6 since these two measures were the same measure but at different increments. Table D-17 shows the symbology used in the IWR planning suite that corresponds with the symbology used throughout the planning process.

Table D-17. CE/ICA Symbology

Symbol	IWR Symbol	Measure
F5	N1	Forest Diversity in Non-Diverse Forest Location Using Existing Soil (537 Top)
F6	N2	Forest Diversity in Non-Diverse Forest Location Using Existing Soil (539 Top)

Of the 300 Project alternatives (table D-18) were developed from all possible combinations, 40 were cost effective (table D-19). Cost effective alternatives were evaluated further with the inclusion of joint monitoring and adaptive management costs.

Table D-18. List of Possible Alternatives

F5	T1F6T9I1	T1T3F3F5T9	T1T4F1F4F6T9I1	T1T4F5T9I1	T2F6T9I1	T2T3F3F5T9	T2T4F2F4F6T9I1	T2T4F5T9I1	T3F6T9I1
F5I1	T1I1	T1T3F3F5T9I1	T1T4F1F4I1	T1T4F6	T2I1	T2T3F3F5T9I1	T2T4F2F4I1	T2T4F6	T3I1
F5T9	T1T3	T1T3F3F6	T1T4F1F4T9	T1T4F6I1	T2T3	T2T3F3F6	T2T4F2F4T9	T2T4F6I1	T3T9
F5T9I1	T1T3F1	T1T3F3F6I1	T1T4F1F4T9I1	T1T4F6T9	T2T3F2	T2T3F3F6I1	T2T4F2F4T9I1	T2T4F6T9	T3T9I1
F6	T1T3F1F3	T1T3F3F6T9	T1T4F1F5	T1T4F6T9I1	T2T3F2F3	T2T3F3F6T9	T2T4F2F5	T2T4F6T9I1	T4
F6I1	T1T3F1F3F5	T1T3F3F6T9I1	T1T4F1F5I1	T1T4I1	T2T3F2F3F5	T2T3F3F6T9I1	T2T4F2F5I1	T2T4I1	T4F4
F6T9	T1T3F1F3F5I1	T1T3F3I1	T1T4F1F5T9	T1T4T9	T2T3F2F3F5I1	T2T3F3I1	T2T4F2F5T9	T2T4T9	T4F4F5
F6T9I1	T1T3F1F3F5T9	T1T3F3T9	T1T4F1F5T9I1	T1T4T9I1	T2T3F2F3F5T9	T2T3F3T9	T2T4F2F5T9I1	T2T4T9I1	T4F4F5I1
I1	T1T3F1F3F5T9I1	T1T3F3T9I1	T1T4F1F6	T1T9	T2T3F2F3F5T9I1	T2T3F3T9I1	T2T4F2F6	T2T9	T4F4F5T9
No Action Plan	T1T3F1F3F6	T1T3F5	T1T4F1F6I1	T1T9I1	T2T3F2F3F6	T2T3F5	T2T4F2F6I1	T2T9I1	T4F4F5T9I1
T1	T1T3F1F3F6I1	T1T3F5I1	T1T4F1F6T9	T2	T2T3F2F3F6I1	T2T3F5I1	T2T4F2F6T9	T3	T4F4F6
T1F1	T1T3F1F3F6T9	T1T3F5T9	T1T4F1F6T9I1	T2F2	T2T3F2F3F6T9	T2T3F5T9	T2T4F2F6T9I1	T3F3	T4F4F6I1
T1F1F5	T1T3F1F3F6T9I1	T1T3F5T9I1	T1T4F1I1	T2F2F5	T2T3F2F3F6T9I1	T2T3F5T9I1	T2T4F2I1	T3F3F5	T4F4F6T9
T1F1F5I1	T1T3F1F3I1	T1T3F6	T1T4F1T9	T2F2F5I1	T2T3F2F3I1	T2T3F6	T2T4F2T9	T3F3F5I1	T4F4F6T9I1
T1F1F5T9	T1T3F1F3T9	T1T3F6I1	T1T4F1T9I1	T2F2F5T9	T2T3F2F3T9	T2T3F6I1	T2T4F2T9I1	T3F3F5T9	T4F4I1
T1F1F5T9I1	T1T3F1F3T9I1	T1T3F6T9	T1T4F4	T2F2F5T9I1	T2T3F2F3T9I1	T2T3F6T9	T2T4F4	T3F3F5T9I1	T4F4T9
T1F1F6	T1T3F1F5	T1T3F6T9I1	T1T4F4F5	T2F2F6	T2T3F2F5	T2T3F6T9I1	T2T4F4F5	T3F3F6	T4F4T9I1
T1F1F6I1	T1T3F1F5I1	T1T3I1	T1T4F4F5I1	T2F2F6I1	T2T3F2F5I1	T2T3I1	T2T4F4F5I1	T3F3F6I1	T4F5
T1F1F6T9	T1T3F1F5T9	T1T3T9	T1T4F4F5T9	T2F2F6T9	T2T3F2F5T9	T2T3T9	T2T4F4F5T9	T3F3F6T9	T4F5I1
T1F1F6T9I1	T1T3F1F5T9I1	T1T3T9I1	T1T4F4F5T9I1	T2F2F6T9I1	T2T3F2F5T9I1	T2T3T9I1	T2T4F4F5T9I1	T3F3F6T9I1	T4F5T9
T1F1I1	T1T3F1F6	T1T4	T1T4F4F6	T2F2I1	T2T3F2F6	T2T4	T2T4F4F6	T3F3I1	T4F5T9I1
T1F1T9	T1T3F1F6I1	T1T4F1	T1T4F4F6I1	T2F2T9	T2T3F2F6I1	T2T4F2	T2T4F4F6I1	T3F3T9	T4F6
T1F1T9I1	T1T3F1F6T9	T1T4F1F4	T1T4F4F6T9	T2F2T9I1	T2T3F2F6T9	T2T4F2F4	T2T4F4F6T9	T3F3T9I1	T4F6I1
T1F5	T1T3F1F6T9I1	T1T4F1F4F5	T1T4F4F6T9I1	T2F5	T2T3F2F6T9I1	T2T4F2F4F5	T2T4F4F6T9I1	T3F5	T4F6T9
T1F5I1	T1T3F1I1	T1T4F1F4F5I1	T1T4F4I1	T2F5I1	T2T3F2I1	T2T4F2F4F5I1	T2T4F4I1	T3F5I1	T4F6T9I1
T1F5T9	T1T3F1T9	T1T4F1F4F5T9	T1T4F4T9	T2F5T9	T2T3F2T9	T2T4F2F4F5T9	T2T4F4T9	T3F5T9	T4I1
T1F5T9I1	T1T3F1T9I1	T1T4F1F4F5T9I1	T1T4F4T9I1	T2F5T9I1	T2T3F2T9I1	T2T4F2F4F5T9I1	T2T4F4T9I1	T3F5T9I1	T4T9
T1F6	T1T3F3	T1T4F1F4F6	T1T4F5	T2F6	T2T3F3	T2T4F2F4F6	T2T4F5	T3F6	T4T9I1
T1F6I1	T1T3F3F5	T1T4F1F4F6I1	T1T4F5I1	T2F6I1	T2T3F3F5	T2T4F2F4F6I1	T2T4F5I1	T3F6I1	T9
T1F6T9	T1T3F3F5I1	T1T4F1F4F6T9	T1T4F5T9	T2F6T9	T2T3F3F5I1	T2T4F2F4F6T9	T2T4F5T9	T3F6T9	T9I1

Table D-19. Cost Effective Alternatives without Adaptive Management Costs Included

Total and Average Cost 8/21/2013

Cost Effective Plan Alternatives **Planning Set:** Huron Final

Counter	Name	Output HU	Cost $	Average Cost
1	No Action Plan	0.00	0.00	
2	T10T20T30T40F10F20F30F40N0T90I1E0	2.90	23,689.00	8,168.62
3	T10T20T30T40F10F20F30F40N0T91I0E0	14.10	28,803.00	2,042.77
4	T10T20T30T40F10F20F30F40N0T91I1E0	17.00	52,492.00	3,087.76
5	T10T20T30T40F10F20F30F40N1T91I0E0	27.60	98,739.00	3,577.50
6	T10T20T30T40F10F20F30F40N1T91I1E0	30.50	122,428.00	4,014.03
7	T10T20T31T40F10F20F31F40N0T90I0E1	39.30	141,077.00	3,589.75
8	T11T20T30T40F11F20F30F40N0T90I0E1	46.10	144,153.00	3,126.96
9	T10T21T30T40F10F21F30F40N0T90I0E1	46.70	165,184.00	3,537.13
10	T11T20T30T40F11F20F30F40N0T90I1E1	49.00	167,842.00	3,425.35
11	T10T20T31T40F10F20F31F40N0T91I0E1	53.40	169,880.00	3,181.27
12	T11T20T30T40F11F20F30F40N0T91I0E1	60.20	172,956.00	2,873.02
13	T10T21T30T40F10F21F30F40N0T91I0E1	60.80	193,987.00	3,190.58
14	T11T20T30T40F11F20F30F40N0T91I1E1	63.10	196,645.00	3,116.40
15	T11T20T30T41F10F20F30F41N0T90I0E1	63.40	216,228.00	3,410.54
16	T10T21T30T40F10F21F30F40N0T91I1E1	63.70	217,676.00	3,417.21
17	T11T20T31T40F11F20F30F40N0T90I0E1	67.00	218,371.00	3,259.27
18	T11T20T31T40F11F20F31F40N0T90I0E1	85.10	229,505.00	2,696.89
19	T11T20T30T41F11F20F30F41N0T90I0E1	85.60	233,890.00	2,732.36
20	T10T21T31T40F10F21F31F40N0T90I0E1	85.70	250,536.00	2,923.41
21	T11T20T31T40F11F20F31F40N0T90I1E1	88.00	253,194.00	2,877.20
22	T11T20T30T41F11F20F30F41N0T90I1E1	88.50	257,579.00	2,910.50
23	T11T20T31T40F11F20F31F40N0T91I0E1	99.20	258,308.00	2,603.91
24	T11T20T30T41F11F20F30F41N0T91I0E1	99.70	262,693.00	2,634.83
25	T10T21T31T40F10F21F31F40N0T91I0E1	99.80	279,339.00	2,798.99
26	T11T20T31T40F11F20F31F40N0T91I1E1	102.10	281,997.00	2,761.97
27	T11T20T30T41F11F20F30F41N0T91I1E1	102.60	286,382.00	2,791.25
28	T10T21T31T40F10F21F31F40N0T91I1E1	102.70	303,028.00	2,950.61
29	T10T21T30T41F10F21F30F41N0T91I1E1	103.20	307,413.00	2,978.81

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Total and Average Cost

8/21/2013

Cost Effective Plan Alternatives **Planning Set:** Huron Final

Counter	Name	Output HU	Cost $	Average Cost
30	T11T20T31T40F11F20F31F40N1T91I0E1	112.70	328,244.00	2,912.55
31	T11T20T30T41F11F20F30F41N1T91I0E1	113.20	332,629.00	2,938.42
32	T10T21T31T40F10F21F31F40N1T91I0E1	113.30	349,275.00	3,082.74
33	T11T20T31T40F11F20F31F40N1T91I1E1	115.60	351,933.00	3,044.40
34	T11T20T30T41F11F20F30F41N1T91I1E1	116.10	356,318.00	3,069.06
35	T10T21T31T40F10F21F31F40N1T91I1E1	116.20	372,964.00	3,209.67
36	T11T20T31T40F11F20F31F40N2T91I1E1	116.50	376,414.00	3,231.02
37	T10T21T30T41F10F21F30F41N1T91I1E1	116.70	377,349.00	3,233.50
38	T11T20T30T41F11F20F30F41N2T91I1E1	117.00	380,799.00	3,254.69
39	T10T21T31T40F10F21F31F40N2T91I1E1	117.10	397,445.00	3,394.06
40	T10T21T30T41F10F21F30F41N2T91I1E1	117.60	401,830.00	3,416.92

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The IWR planning suite II tool was rerun with the inclusion of the adaptive management costs, no additional assumptions or constraints were necessary. Adaptive management costs had to be added per alternative not per measure so as not to double count costs that are shared for multiple measures, such as fish telemetry. For a more detailed breakdown of adaptive management costs please refer to table K-2 in Appendix K. Table D-20 shows the costs of each alternative with the annualized cost of each adaptive management measure associated with that alternative. Majority of the cost effective alternatives remained cost effective in the second iteration (table D-21 and figure D-6). Eight “Best Buy” plans were identified (figure D-7).

Table D-20. Adaptive Management Costs Per Alternative

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
No Action Plan	0	-	-	-	-	-	-	-	-	-
I1	2.9	382,840	-	176,801	0	-	-	176,801	7,881	28,157
F5	13.5	1,299,720	-	-	141,405	-	-	141,405	6,303	64,652
T9	14.1	532,867	-	176,801	-	30,907	-	207,708	9,258	33,311
F6	14.4	1,757,410	-	-	141,405	-	-	141,405	6,303	85,053
F5I1	16.4	1,682,560	-	176,801	141,405	-	-	318,206	14,184	92,809
T9I1	17	915,707	-	176,801	-	30,907	-	207,708	9,258	53,586
F6I1	17.3	2,140,250	-	176,801	141,405	-	-	318,206	14,184	113,210
T3	21.2	2,313,174	163,343	176,801	-	-	46,892	387,036	17,252	126,573
T4	21.2	2,318,284	163,343	176,801	-	-	46,892	387,036	17,252	126,801
T1	23.9	2,248,642	163,343	176,801	-	-	46,892	387,036	17,252	123,696
T2	23.9	2,517,824	163,343	176,801	-	-	46,892	387,036	17,252	135,695
T3I1	24.1	2,696,014	163,343	176,801	-	-	46,892	387,036	17,252	146,849
T4I1	24.1	2,701,124	163,343	176,801	-	-	46,892	387,036	17,252	147,076
T1I1	26.8	2,631,482	163,343	176,801	-	-	46,892	387,036	17,252	143,972
T2I1	26.8	2,900,664	163,343	176,801	-	-	46,892	387,036	17,252	155,971
F5T9	27.6	1,832,587	-	176,801	141,405	30,907	-	349,113	15,561	97,963
F6T9	28.5	2,290,277	-	176,801	141,405	30,907	-	349,113	15,561	118,364
F5T9I1	30.5	2,215,427	-	176,801	141,405	30,907	-	349,113	15,561	118,238
F6T9I1	31.4	2,673,117	-	176,801	141,405	30,907	-	349,113	15,561	138,640
T3F5	34.7	3,612,894	163,343	176,801	141,405	-	46,892	528,441	23,555	191,225
T4F5	34.7	3,618,004	163,343	176,801	141,405	-	46,892	528,441	23,555	191,453
T3T9	35.3	2,846,041	163,343	176,801	-	30,907	46,892	417,943	18,629	152,003
T4T9	35.3	2,851,151	163,343	176,801	-	30,907	46,892	417,943	18,629	152,230

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T3F6	35.6	4,070,584	163,343	176,801	141,405	-	46,892	528,441	23,555	211,626
T4F6	35.6	4,075,694	163,343	176,801	141,405	-	46,892	528,441	23,555	211,854
T1F5	37.4	3,548,362	163,343	176,801	141,405	-	46,892	528,441	23,555	188,348
T2F5	37.4	3,817,544	163,343	176,801	141,405	-	46,892	528,441	23,555	200,347
T3F5I1	37.6	3,995,734	163,343	176,801	141,405	-	46,892	528,441	23,555	211,501
T4F5I1	37.6	4,000,844	163,343	176,801	141,405	-	46,892	528,441	23,555	211,728
T1T9	38	2,781,509	163,343	176,801	-	30,907	46,892	417,943	18,629	149,126
T2T9	38	3,050,691	163,343	176,801	-	30,907	46,892	417,943	18,629	161,125
T3T9I1	38.2	3,228,881	163,343	176,801	-	30,907	46,892	417,943	18,629	172,278
T4T9I1	38.2	3,233,991	163,343	176,801	141,405	30,907	46,892	559,348	24,932	178,809
T1F6	38.3	4,006,052	163,343	176,801	141,405	-	46,892	528,441	23,555	208,749
T2F6	38.3	4,275,234	163,343	176,801	141,405	-	46,892	528,441	23,555	220,748
T3F6I1	38.5	4,453,424	163,343	176,801	141,405	-	46,892	528,441	23,555	231,902
T4F6I1	38.5	4,458,534	163,343	176,801	141,405	-	46,892	528,441	23,555	232,130
T3F3	39.3	2,515,654	163,343	176,801	141,405	-	46,892	528,441	23,555	142,205
T4F4	39.8	2,597,631	163,343	176,801	141,405	-	46,892	528,441	23,555	145,859
T1F5I1	40.3	3,931,202	163,343	176,801	141,405	-	46,892	528,441	23,555	208,624
T2F5I1	40.3	4,200,384	163,343	176,801	141,405	-	46,892	528,441	23,555	220,623
T1T9I1	40.9	3,164,349	163,343	176,801	-	30,907	46,892	417,943	18,629	169,402
T2T9I1	40.9	3,433,531	163,343	176,801	-	30,907	46,892	417,943	18,629	181,400
T1F6I1	41.2	4,388,892	163,343	176,801	141,405	-	46,892	528,441	23,555	229,025
T2F6I1	41.2	4,658,074	163,343	176,801	141,405	-	46,892	528,441	23,555	241,024
T3F3I1	42.2	2,898,494	163,343	176,801	141,405	-	46,892	528,441	23,555	162,481
T4F4I1	42.7	2,980,471	163,343	176,801	141,405	-	46,892	528,441	23,555	166,135
T1T3	44.8	3,632,474	163,343	176,801	-	-	46,892	387,036	17,252	185,578
T1T4	44.8	3,637,584	163,343	176,801	-	-	46,892	387,036	17,252	185,805

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T2T3	44.8	3,901,656	163,343	176,801	-	-	46,892	387,036	17,252	197,576
T2T4	44.8	3,906,766	163,343	176,801	-	-	46,892	387,036	17,252	197,804
T1F1	46.1	2,574,028	163,343	176,801	141,405	-	46,892	528,441	23,555	144,760
T2F2	46.7	2,967,222	163,343	176,801	141,405	-	46,892	528,441	23,555	162,286
T1T3I1	47.7	4,015,314	163,343	176,801	-	-	46,892	387,036	17,252	205,853
T1T4I1	47.7	4,020,424	163,343	176,801	-	-	46,892	387,036	17,252	206,081
T2T3I1	47.7	4,284,496	163,343	176,801	-	-	46,892	387,036	17,252	217,852
T2T4I1	47.7	4,289,606	163,343	176,801	-	-	46,892	387,036	17,252	218,080
T3F5T9	48.8	4,145,761	163,343	176,801	141,405	30,907	46,892	559,348	24,932	216,655
T4F5T9	48.8	4,150,871	163,343	176,801	141,405	30,907	46,892	559,348	24,932	216,882
T1F1I1	49	2,956,868	163,343	176,801	141,405	-	46,892	528,441	23,555	165,036
T2F2I1	49.6	3,350,062	163,343	176,801	141,405	-	46,892	528,441	23,555	182,562
T3F6T9	49.7	4,603,451	163,343	176,801	141,405	30,907	46,892	559,348	24,932	237,056
T4F6T9	49.7	4,608,561	163,343	176,801	141,405	30,907	46,892	559,348	24,932	237,284
T1F5T9	51.5	4,081,229	163,343	176,801	141,405	30,907	46,892	559,348	24,932	213,778
T2F5T9	51.5	4,350,411	163,343	176,801	141,405	30,907	46,892	559,348	24,932	225,777
T3F5T9I1	51.7	4,528,601	163,343	176,801	141,405	30,907	46,892	559,348	24,932	236,930
T4F5T9I1	51.7	4,533,711	163,343	176,801	141,405	30,907	46,892	559,348	24,932	237,158
T1F6T9	52.4	4,538,919	163,343	176,801	141,405	30,907	46,892	559,348	24,932	234,179
T2F6T9	52.4	4,808,101	163,343	176,801	141,405	30,907	46,892	559,348	24,932	246,178
T3F6T9I1	52.6	4,986,291	163,343	176,801	141,405	30,907	46,892	559,348	24,932	257,332
T4F6T9I1	52.6	4,991,401	163,343	176,801	141,405	30,907	46,892	559,348	24,932	257,559
T3F3F5	52.8	3,815,374	163,343	176,801	141,405	-	46,892	528,441	23,555	200,554
T4F4F5	53.3	3,897,351	163,343	176,801	141,405	-	46,892	528,441	23,555	204,208
T3F3T9	53.4	3,048,521	163,343	176,801	141,405	30,907	46,892	559,348	24,932	167,635
T3F3F6	53.7	4,273,064	163,343	176,801	141,405	-	46,892	528,441	23,555	220,955

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T4F4T9	53.9	3,130,498	163,343	176,801	141,405	30,907	46,892	559,348	24,932	171,289
T4F4F6	54.2	4,355,041	163,343	176,801	141,405	-	46,892	528,441	23,555	224,609
T1F5T9I1	54.4	4,464,069	163,343	176,801	141,405	30,907	46,892	559,348	24,932	234,054
T2F5T9I1	54.4	4,733,251	163,343	176,801	141,405	30,907	46,892	559,348	24,932	246,052
T1F6T9I1	55.3	4,921,759	163,343	176,801	141,405	30,907	46,892	559,348	24,932	254,455
T2F6T9I1	55.3	5,190,941	163,343	176,801	141,405	30,907	46,892	559,348	24,932	266,454
T3F3F5I1	55.7	4,198,214	163,343	176,801	141,405	-	46,892	528,441	23,555	220,830
T4F4F5I1	56.2	4,280,191	163,343	176,801	141,405	-	46,892	528,441	23,555	224,484
T3F3T9I1	56.3	3,431,361	163,343	176,801	141,405	30,907	46,892	559,348	24,932	187,911
T3F3F6I1	56.6	4,655,904	163,343	176,801	141,405	-	46,892	528,441	23,555	241,231
T4F4T9I1	56.8	3,513,338	163,343	176,801	141,405	30,907	46,892	559,348	24,932	191,565
T4F4F6I1	57.1	4,737,881	163,343	176,801	141,405	-	46,892	528,441	23,555	244,885
T1T3F5	58.3	4,932,194	163,343	176,801	141,405	-	46,892	528,441	23,555	250,230
T1T4F5	58.3	4,937,304	163,343	176,801	141,405	-	46,892	528,441	23,555	250,457
T2T3F5	58.3	5,201,376	163,343	176,801	141,405	-	46,892	528,441	23,555	262,228
T2T4F5	58.3	5,206,486	163,343	176,801	141,405	-	46,892	528,441	23,555	262,456
T1T3T9	58.9	4,165,341	163,343	176,801	-	30,907	46,892	417,943	18,629	211,007
T1T4T9	58.9	4,170,451	163,343	176,801	-	30,907	46,892	417,943	18,629	211,235
T2T3T9	58.9	4,434,523	163,343	176,801	-	30,907	46,892	417,943	18,629	223,006
T2T4T9	58.9	4,439,633	163,343	176,801	-	30,907	46,892	417,943	18,629	223,234
T1T3F6	59.2	5,389,884	163,343	176,801	141,405	-	46,892	528,441	23,555	270,631
T1T4F6	59.2	5,394,994	163,343	176,801	141,405	-	46,892	528,441	23,555	270,858
T2T3F6	59.2	5,659,066	163,343	176,801	141,405	-	46,892	528,441	23,555	282,629
T2T4F6	59.2	5,664,176	163,343	176,801	141,405	-	46,892	528,441	23,555	282,857
T1F1F5	59.6	3,873,748	163,343	176,801	141,405	-	46,892	528,441	23,555	203,109
T1F1T9	60.2	3,106,895	163,343	176,801	141,405	30,907	46,892	559,348	24,932	170,190

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T2F2F5	60.2	4,266,942	163,343	176,801	141,405	-	46,892	528,441	23,555	220,635
T1F1F6	60.5	4,331,438	163,343	176,801	141,405	-	46,892	528,441	23,555	223,510
T2F2T9	60.8	3,500,089	163,343	176,801	141,405	30,907	46,892	559,348	24,932	187,716
T2F2F6	61.1	4,724,632	163,343	176,801	141,405	-	46,892	528,441	23,555	241,037
T1T3F5I1	61.2	5,315,034	163,343	176,801	141,405	-	46,892	528,441	23,555	270,505
T1T4F5I1	61.2	5,320,144	163,343	176,801	141,405	-	46,892	528,441	23,555	270,733
T2T3F5I1	61.2	5,584,216	163,343	176,801	141,405	-	46,892	528,441	23,555	282,504
T2T4F5I1	61.2	5,589,326	163,343	176,801	141,405	-	46,892	528,441	23,555	282,732
T1T3T9I1	61.8	4,548,181	163,343	176,801	-	30,907	46,892	417,943	18,629	231,283
T1T4T9I1	61.8	4,553,291	163,343	176,801	-	30,907	46,892	417,943	18,629	231,511
T2T3T9I1	61.8	4,817,363	163,343	176,801	-	30,907	46,892	417,943	18,629	243,282
T2T4T9I1	61.8	4,822,473	163,343	176,801	-	30,907	46,892	417,943	18,629	243,509
T1T3F6I1	62.1	5,772,724	163,343	176,801	141,405	-	46,892	528,441	23,555	290,907
T1T4F6I1	62.1	5,777,834	163,343	176,801	141,405	-	46,892	528,441	23,555	291,134
T2T3F6I1	62.1	6,041,906	163,343	176,801	141,405	-	46,892	528,441	23,555	302,905
T2T4F6I1	62.1	6,047,016	163,343	176,801	141,405	-	46,892	528,441	23,555	303,133
T1F1F5I1	62.5	4,256,588	163,343	176,801	141,405	-	46,892	528,441	23,555	223,385
T1T3F3	62.9	3,834,954	163,343	176,801	141,405	-	46,892	528,441	23,555	201,210
T2T3F3	62.9	4,104,136	163,343	176,801	141,405	-	46,892	528,441	23,555	213,208
T1F1T9I1	63.1	3,489,735	163,343	176,801	141,405	30,907	46,892	559,348	24,932	190,466
T2F2F5I1	63.1	4,649,782	163,343	176,801	141,405	-	46,892	528,441	23,555	240,911
T1F1F6I1	63.4	4,714,278	163,343	176,801	141,405	-	46,892	528,441	23,555	243,786
T1T4F4	63.4	3,916,931	163,343	176,801	141,405	-	46,892	528,441	23,555	204,864
T2T4F4	63.4	4,186,113	163,343	176,801	141,405	-	46,892	528,441	23,555	216,863
T2F2T9I1	63.7	3,882,929	163,343	176,801	141,405	30,907	46,892	559,348	24,932	207,992
T2F2F6I1	64	5,107,472	163,343	176,801	141,405	-	46,892	528,441	23,555	261,312

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T1T3F3I1	65.8	4,217,794	163,343	176,801	141,405	-	46,892	528,441	23,555	221,486
T2T3F3I1	65.8	4,486,976	163,343	176,801	141,405	-	46,892	528,441	23,555	233,484
T1T4F4I1	66.3	4,299,771	163,343	176,801	141,405	-	46,892	528,441	23,555	225,140
T2T4F4I1	66.3	4,568,953	163,343	176,801	141,405	-	46,892	528,441	23,555	237,138
T3F3F5T9	66.9	4,348,241	163,343	176,801	141,405	30,907	46,892	559,348	24,932	225,984
T1T3F1	67	3,957,860	163,343	176,801	141,405	-	46,892	528,441	23,555	206,641
T1T4F1	67	3,962,970	163,343	176,801	141,405	-	46,892	528,441	23,555	206,869
T4F4F5T9	67.4	4,430,218	163,343	176,801	141,405	30,907	46,892	559,348	24,932	229,638
T2T3F2	67.6	4,351,054	163,343	176,801	141,405	-	46,892	528,441	23,555	224,168
T2T4F2	67.6	4,356,164	163,343	176,801	141,405	-	46,892	528,441	23,555	224,395
T3F3F6T9	67.8	4,805,931	163,343	176,801	141,405	30,907	46,892	559,348	24,932	246,385
T4F4F6T9	68.3	4,887,908	163,343	176,801	141,405	30,907	46,892	559,348	24,932	250,039
T3F3F5T9I1	69.8	4,731,081	163,343	176,801	141,405	30,907	46,892	559,348	24,932	246,260
T1T3F1I1	69.9	4,340,700	163,343	176,801	141,405	-	46,892	528,441	23,555	226,917
T1T4F1I1	69.9	4,345,810	163,343	176,801	141,405	-	46,892	528,441	23,555	227,145
T4F4F5T9I1	70.3	4,813,058	163,343	176,801	141,405	30,907	46,892	559,348	24,932	249,914
T2T3F2I1	70.5	4,733,894	163,343	176,801	141,405	-	46,892	528,441	23,555	244,443
T2T4F2I1	70.5	4,739,004	163,343	176,801	141,405	-	46,892	528,441	23,555	244,671
T3F3F6T9I1	70.7	5,188,771	163,343	176,801	141,405	30,907	46,892	559,348	24,932	266,661
T4F4F6T9I1	71.2	5,270,748	163,343	176,801	141,405	30,907	46,892	559,348	24,932	270,315
T1T3F5T9	72.4	5,465,061	163,343	176,801	141,405	30,907	46,892	559,348	24,932	275,659
T1T4F5T9	72.4	5,470,171	163,343	176,801	141,405	30,907	46,892	559,348	24,932	275,887
T2T3F5T9	72.4	5,734,243	163,343	176,801	141,405	30,907	46,892	559,348	24,932	287,658
T2T4F5T9	72.4	5,739,353	163,343	176,801	141,405	30,907	46,892	559,348	24,932	287,886
T1T3F6T9	73.3	5,922,751	163,343	176,801	141,405	30,907	46,892	559,348	24,932	296,060
T1T4F6T9	73.3	5,927,861	163,343	176,801	141,405	30,907	46,892	559,348	24,932	296,288

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T2T3F6T9	73.3	6,191,933	163,343	176,801	141,405	30,907	46,892	559,348	24,932	308,059
T2T4F6T9	73.3	6,197,043	163,343	176,801	141,405	30,907	46,892	559,348	24,932	308,287
T1F1F5T9	73.7	4,406,615	163,343	176,801	141,405	30,907	46,892	559,348	24,932	228,539
T2F2F5T9	74.3	4,799,809	163,343	176,801	141,405	30,907	46,892	559,348	24,932	246,065
T1F1F6T9	74.6	4,864,305	163,343	176,801	141,405	30,907	46,892	559,348	24,932	248,940
T2F2F6T9	75.2	5,257,499	163,343	176,801	141,405	30,907	46,892	559,348	24,932	266,466
T1T3F5T9I1	75.3	5,847,901	163,343	176,801	141,405	30,907	46,892	559,348	24,932	295,935
T1T4F5T9I1	75.3	5,853,011	163,343	176,801	141,405	30,907	46,892	559,348	24,932	296,163
T2T3F5T9I1	75.3	6,117,083	163,343	176,801	141,405	30,907	46,892	559,348	24,932	307,934
T2T4F5T9I1	75.3	6,122,193	163,343	176,801	141,405	30,907	46,892	559,348	24,932	308,161
T1T3F6T9I1	76.2	6,305,591	163,343	176,801	141,405	30,907	46,892	559,348	24,932	316,336
T1T4F6T9I1	76.2	6,310,701	163,343	176,801	141,405	30,907	46,892	559,348	24,932	316,564
T2T3F6T9I1	76.2	6,574,773	163,343	176,801	141,405	30,907	46,892	559,348	24,932	328,335
T2T4F6T9I1	76.2	6,579,883	163,343	176,801	141,405	30,907	46,892	559,348	24,932	328,563
T1T3F3F5	76.4	5,134,674	163,343	176,801	141,405	-	46,892	528,441	23,555	259,559
T2T3F3F5	76.4	5,403,856	163,343	176,801	141,405	-	46,892	528,441	23,555	271,558
T1F1F5T9I1	76.6	4,789,455	163,343	176,801	141,405	30,907	46,892	559,348	24,932	248,815
T1T4F4F5	76.9	5,216,651	163,343	176,801	141,405	-	46,892	528,441	23,555	263,213
T2T4F4F5	76.9	5,485,833	163,343	176,801	141,405	-	46,892	528,441	23,555	275,212
T1T3F3T9	77	4,367,821	163,343	176,801	141,405	30,907	46,892	559,348	24,932	226,640
T2T3F3T9	77	4,637,003	163,343	176,801	141,405	30,907	46,892	559,348	24,932	238,638
T2F2F5T9I1	77.2	5,182,649	163,343	176,801	141,405	30,907	46,892	559,348	24,932	266,341
T1T3F3F6	77.3	5,592,364	163,343	176,801	141,405	-	46,892	528,441	23,555	279,960
T2T3F3F6	77.3	5,861,546	163,343	176,801	141,405	-	46,892	528,441	23,555	291,959
T1F1F6T9I1	77.5	5,247,145	163,343	176,801	141,405	30,907	46,892	559,348	24,932	269,216
T1T4F4T9	77.5	4,449,798	163,343	176,801	141,405	30,907	46,892	559,348	24,932	230,294

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T2T4F4T9	77.5	4,718,980	163,343	176,801	141,405	30,907	46,892	559,348	24,932	242,292
T1T4F4F6	77.8	5,674,341	163,343	176,801	141,405	-	46,892	528,441	23,555	283,614
T2T4F4F6	77.8	5,943,523	163,343	176,801	141,405	-	46,892	528,441	23,555	295,613
T2F2F6T9I1	78.1	5,640,339	163,343	176,801	141,405	30,907	46,892	559,348	24,932	286,742
T1T3F3F5I1	79.3	5,517,514	163,343	176,801	141,405	-	46,892	528,441	23,555	279,835
T2T3F3F5I1	79.3	5,786,696	163,343	176,801	141,405	-	46,892	528,441	23,555	291,833
T1T4F4F5I1	79.8	5,599,491	163,343	176,801	141,405	-	46,892	528,441	23,555	283,489
T2T4F4F5I1	79.8	5,868,673	163,343	176,801	141,405	-	46,892	528,441	23,555	295,487
T1T3F3T9I1	79.9	4,750,661	163,343	176,801	141,405	30,907	46,892	559,348	24,932	246,916
T2T3F3T9I1	79.9	5,019,843	163,343	176,801	141,405	30,907	46,892	559,348	24,932	258,914
T1T3F3F6I1	80.2	5,975,204	163,343	176,801	141,405	-	46,892	528,441	23,555	300,236
T2T3F3F6I1	80.2	6,244,386	163,343	176,801	141,405	-	46,892	528,441	23,555	312,234
T1T4F4T9I1	80.4	4,832,638	163,343	176,801	141,405	30,907	46,892	559,348	24,932	250,570
T2T4F4T9I1	80.4	5,101,820	163,343	176,801	141,405	30,907	46,892	559,348	24,932	262,568
T1T3F1F5	80.5	5,257,580	163,343	176,801	141,405	-	46,892	528,441	23,555	264,990
T1T4F1F5	80.5	5,262,690	163,343	176,801	141,405	-	46,892	528,441	23,555	265,218
T1T4F4F6I1	80.7	6,057,181	163,343	176,801	141,405	-	46,892	528,441	23,555	303,890
T2T4F4F6I1	80.7	6,326,363	163,343	176,801	141,405	-	46,892	528,441	23,555	315,889
T1T3F1T9	81.1	4,490,727	163,343	176,801	141,405	30,907	46,892	559,348	24,932	232,071
T1T4F1T9	81.1	4,495,837	163,343	176,801	141,405	30,907	46,892	559,348	24,932	232,299
T2T3F2F5	81.1	5,650,774	163,343	176,801	141,405	-	46,892	528,441	23,555	282,517
T2T4F2F5	81.1	5,655,884	163,343	176,801	141,405	-	46,892	528,441	23,555	282,744
T1T3F1F6	81.4	5,715,270	163,343	176,801	141,405	-	46,892	528,441	23,555	285,392
T1T4F1F6	81.4	5,720,380	163,343	176,801	141,405	-	46,892	528,441	23,555	285,619
T2T3F2T9	81.7	4,883,921	163,343	176,801	141,405	30,907	46,892	559,348	24,932	249,597
T2T4F2T9	81.7	4,889,031	163,343	176,801	141,405	30,907	46,892	559,348	24,932	249,825

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T2T3F2F6	82	6,108,464	163,343	176,801	141,405	-	46,892	528,441	23,555	302,918
T2T4F2F6	82	6,113,574	163,343	176,801	141,405	-	46,892	528,441	23,555	303,146
T1T3F1F5I1	83.4	5,640,420	163,343	176,801	141,405	-	46,892	528,441	23,555	285,266
T1T4F1F5I1	83.4	5,645,530	163,343	176,801	141,405	-	46,892	528,441	23,555	285,494
T1T3F1T9I1	84	4,873,567	163,343	176,801	141,405	30,907	46,892	559,348	24,932	252,347
T1T4F1T9I1	84	4,878,677	163,343	176,801	141,405	30,907	46,892	559,348	24,932	252,575
T2T3F2F5I1	84	6,033,614	163,343	176,801	141,405	-	46,892	528,441	23,555	302,792
T2T4F2F5I1	84	6,038,724	163,343	176,801	141,405	-	46,892	528,441	23,555	303,020
T1T3F1F6I1	84.3	6,098,110	163,343	176,801	141,405	-	46,892	528,441	23,555	305,667
T1T4F1F6I1	84.3	6,103,220	163,343	176,801	141,405	-	46,892	528,441	23,555	305,895
T2T3F2T9I1	84.6	5,266,761	163,343	176,801	141,405	30,907	46,892	559,348	24,932	269,873
T2T4F2T9I1	84.6	5,271,871	163,343	176,801	141,405	30,907	46,892	559,348	24,932	270,101
T2T3F2F6I1	84.9	6,491,304	163,343	176,801	141,405	-	46,892	528,441	23,555	323,194
T2T4F2F6I1	84.9	6,496,414	163,343	176,801	141,405	-	46,892	528,441	23,555	323,421
T1T3F1F3	85.1	4,160,340	163,343	176,801	141,405	-	46,892	528,441	23,555	215,971
T1T4F1F4	85.6	4,242,317	163,343	176,801	141,405	-	46,892	528,441	23,555	219,625
T2T3F2F3	85.7	4,553,534	163,343	176,801	141,405	-	46,892	528,441	23,555	233,497
T2T4F2F4	86.2	4,635,511	163,343	176,801	141,405	-	46,892	528,441	23,555	237,151
T1T3F1F3I1	88	4,543,180	163,343	176,801	141,405	-	46,892	528,441	23,555	236,247
T1T4F1F4I1	88.5	4,625,157	163,343	176,801	141,405	-	46,892	528,441	23,555	239,901
T2T3F2F3I1	88.6	4,936,374	163,343	176,801	141,405	-	46,892	528,441	23,555	253,773
T2T4F2F4I1	89.1	5,018,351	163,343	176,801	141,405	-	46,892	528,441	23,555	257,427
T1T3F3F5T9	90.5	5,667,541	163,343	176,801	141,405	30,907	46,892	559,348	24,932	284,989
T2T3F3F5T9	90.5	5,936,723	163,343	176,801	141,405	30,907	46,892	559,348	24,932	296,987
T1T4F4F5T9	91	5,749,518	163,343	176,801	141,405	30,907	46,892	559,348	24,932	288,643
T2T4F4F5T9	91	6,018,700	163,343	176,801	141,405	30,907	46,892	559,348	24,932	300,641

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T1T3F3F6T9	91.4	6,125,231	163,343	176,801	141,405	30,907	46,892	559,348	24,932	305,390
T2T3F3F6T9	91.4	6,394,413	163,343	176,801	141,405	30,907	46,892	559,348	24,932	317,388
T1T4F4F6T9	91.9	6,207,208	163,343	176,801	141,405	30,907	46,892	559,348	24,932	309,044
T2T4F4F6T9	91.9	6,476,390	163,343	176,801	141,405	30,907	46,892	559,348	24,932	321,043
T1T3F3F5T9I1	93.4	6,050,381	163,343	176,801	141,405	30,907	46,892	559,348	24,932	305,265
T2T3F3F5T9I1	93.4	6,319,563	163,343	176,801	141,405	30,907	46,892	559,348	24,932	317,263
T1T4F4F5T9I1	93.9	6,132,358	163,343	176,801	141,405	30,907	46,892	559,348	24,932	308,919
T2T4F4F5T9I1	93.9	6,401,540	163,343	176,801	141,405	30,907	46,892	559,348	24,932	320,917
T1T3F3F6T9I1	94.3	6,508,071	163,343	176,801	141,405	30,907	46,892	559,348	24,932	325,666
T2T3F3F6T9I1	94.3	6,777,253	163,343	176,801	141,405	30,907	46,892	559,348	24,932	337,664
T1T3F1F5T9	94.6	5,790,447	163,343	176,801	141,405	30,907	46,892	559,348	24,932	290,420
T1T4F1F5T9	94.6	5,795,557	163,343	176,801	141,405	30,907	46,892	559,348	24,932	290,648
T1T4F4F6T9I1	94.8	6,590,048	163,343	176,801	141,405	30,907	46,892	559,348	24,932	329,320
T2T4F4F6T9I1	94.8	6,859,230	163,343	176,801	141,405	30,907	46,892	559,348	24,932	341,318
T2T3F2F5T9	95.2	6,183,641	163,343	176,801	141,405	30,907	46,892	559,348	24,932	307,946
T2T4F2F5T9	95.2	6,188,751	163,343	176,801	141,405	30,907	46,892	559,348	24,932	308,174
T1T3F1F6T9	95.5	6,248,137	163,343	176,801	141,405	30,907	46,892	559,348	24,932	310,821
T1T4F1F6T9	95.5	6,253,247	163,343	176,801	141,405	30,907	46,892	559,348	24,932	311,049
T2T3F2F6T9	96.1	6,641,331	163,343	176,801	141,405	30,907	46,892	559,348	24,932	328,348
T2T4F2F6T9	96.1	6,646,441	163,343	176,801	141,405	30,907	46,892	559,348	24,932	328,575
T1T3F1F5T9I1	97.5	6,173,287	163,343	176,801	141,405	30,907	46,892	559,348	24,932	310,696
T1T4F1F5T9I1	97.5	6,178,397	163,343	176,801	141,405	30,907	46,892	559,348	24,932	310,924
T2T3F2F5T9I1	98.1	6,566,481	163,343	176,801	141,405	30,907	46,892	559,348	24,932	328,222
T2T4F2F5T9I1	98.1	6,571,591	163,343	176,801	141,405	30,907	46,892	559,348	24,932	328,450
T1T3F1F6T9I1	98.4	6,630,977	163,343	176,801	141,405	30,907	46,892	559,348	24,932	331,097
T1T4F1F6T9I1	98.4	6,636,087	163,343	176,801	141,405	30,907	46,892	559,348	24,932	331,325

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T1T3F1F3F5	98.6	5,460,060	163,343	176,801	141,405	-	46,892	528,441	23,555	274,320
T2T3F2F6T9I1	99	7,024,171	163,343	176,801	141,405	30,907	46,892	559,348	24,932	348,623
T2T4F2F6T9I1	99	7,029,281	163,343	176,801	141,405	30,907	46,892	559,348	24,932	348,851
T1T4F1F4F5	99.1	5,542,037	163,343	176,801	141,405	-	46,892	528,441	23,555	277,974
T1T3F1F3T9	99.2	4,693,207	163,343	176,801	141,405	30,907	46,892	559,348	24,932	241,401
T2T3F2F3F5	99.2	5,853,254	163,343	176,801	141,405	-	46,892	528,441	23,555	291,846
T1T3F1F3F6	99.5	5,917,750	163,343	176,801	141,405	-	46,892	528,441	23,555	294,721
T1T4F1F4T9	99.7	4,775,184	163,343	176,801	141,405	30,907	46,892	559,348	24,932	245,055
T2T4F2F4F5	99.7	5,935,231	163,343	176,801	141,405	-	46,892	528,441	23,555	295,500
T2T3F2F3T9	99.8	5,086,401	163,343	176,801	141,405	30,907	46,892	559,348	24,932	258,927
T1T4F1F4F6	100	5,999,727	163,343	176,801	141,405	-	46,892	528,441	23,555	298,375
T2T3F2F3F6	100.1	6,310,944	163,343	176,801	141,405	-	46,892	528,441	23,555	312,247
T2T4F2F4T9	100.3	5,168,378	163,343	176,801	141,405	30,907	46,892	559,348	24,932	262,581
T2T4F2F4F6	100.6	6,392,921	163,343	176,801	141,405	-	46,892	528,441	23,555	315,901
T1T3F1F3F5I1	101.5	5,842,900	163,343	176,801	141,405	-	46,892	528,441	23,555	294,596
T1T4F1F4F5I1	102	5,924,877	163,343	176,801	141,405	-	46,892	528,441	23,555	298,250
T1T3F1F3T9I1	102.1	5,076,047	163,343	176,801	141,405	30,907	46,892	559,348	24,932	261,676
T2T3F2F3F5I1	102.1	6,236,094	163,343	176,801	141,405	-	46,892	528,441	23,555	312,122
T1T3F1F3F6I1	102.4	6,300,590	163,343	176,801	141,405	-	46,892	528,441	23,555	314,997
T1T4F1F4T9I1	102.6	5,158,024	163,343	176,801	141,405	30,907	46,892	559,348	24,932	265,330
T2T4F2F4F5I1	102.6	6,318,071	163,343	176,801	141,405	-	46,892	528,441	23,555	315,776
T2T3F2F3T9I1	102.7	5,469,241	163,343	176,801	141,405	30,907	46,892	559,348	24,932	279,203
T1T4F1F4F6I1	102.9	6,382,567	163,343	176,801	141,405	-	46,892	528,441	23,555	318,651
T2T3F2F3F6I1	103	6,693,784	163,343	176,801	141,405	-	46,892	528,441	23,555	332,523
T2T4F2F4T9I1	103.2	5,551,218	163,343	176,801	141,405	30,907	46,892	559,348	24,932	282,857
T2T4F2F4F6I1	103.5	6,775,761	163,343	176,801	141,405	-	46,892	528,441	23,555	336,177

Alternative	Output	Total Cost without AM	Aquatic Vegetation	Aquatic	Forest	Garner Closure	Bathymetric Diversity	Total AM	Annualized AM	Annualized Costs with AM and O&M
T1T3F1F3F5T9	112.7	5,992,927	163,343	176,801	141,405	30,907	46,892	559,348	24,932	299,750
T1T4F1F4F5T9	113.2	6,074,904	163,343	176,801	141,405	30,907	46,892	559,348	24,932	303,404
T2T3F2F3F5T9	113.3	6,386,121	163,343	176,801	141,405	30,907	46,892	559,348	24,932	317,276
T1T3F1F3F6T9	113.6	6,450,617	163,343	176,801	141,405	30,907	46,892	559,348	24,932	320,151
T2T4F2F4F5T9	113.8	6,468,098	163,343	176,801	141,405	30,907	46,892	559,348	24,932	320,930
T1T4F1F4F6T9	114.1	6,532,594	163,343	176,801	141,405	30,907	46,892	559,348	24,932	323,805
T2T3F2F3F6T9	114.2	6,843,811	163,343	176,801	141,405	30,907	46,892	559,348	24,932	337,677
T2T4F2F4F6T9	114.7	6,925,788	163,343	176,801	141,405	30,907	46,892	559,348	24,932	341,331
T1T3F1F3F5T9I1	115.6	6,375,767	163,343	176,801	141,405	30,907	46,892	559,348	24,932	320,025
T1T4F1F4F5T9I1	116.1	6,457,744	163,343	176,801	141,405	30,907	46,892	559,348	24,932	323,679
T2T3F2F3F5T9I1	116.2	6,768,961	163,343	176,801	141,405	30,907	46,892	559,348	24,932	337,552
T1T3F1F3F6T9I1	116.5	6,833,457	163,343	176,801	141,405	30,907	46,892	559,348	24,932	340,427
T2T4F2F4F5T9I1	116.7	6,850,938	163,343	176,801	141,405	30,907	46,892	559,348	24,932	341,206
T1T4F1F4F6T9I1	117	6,915,434	163,343	176,801	141,405	30,907	46,892	559,348	24,932	344,081
T2T3F2F3F6T9I1	117.1	7,226,651	163,343	176,801	141,405	30,907	46,892	559,348	24,932	357,953
T2T4F2F4F6T9I1	117.6	7,308,628	163,343	176,801	141,405	30,907	46,892	559,348	24,932	361,607

Table D-21. Cost Effective Alternatives Including Adaptive Management and Contingency Costs

Total and Average Cost 8/21/2013

Cost Effective Plan Alternatives **Planning Set:** CEICA Analysis 12

Counter	Name	AAHUs (Output)	Costs (Cost)	Average Cost
1	No Action Plan	0.00	0.00	
2	I1	2.90	28,157.00	9,709.31
3	T9	14.10	33,311.00	2,362.48
4	T9I1	17.00	53,587.00	3,152.18
5	F5T9	27.60	97,963.00	3,549.38
6	F5T9I1	30.50	118,239.00	3,876.69
7	F6T9I1	31.40	138,640.00	4,415.29
8	T3F3	39.30	142,206.00	3,618.47
9	T1F1	46.10	144,761.00	3,140.15
10	T2F2	46.70	162,287.00	3,475.10
11	T1F1I1	49.00	165,036.00	3,368.08
12	T3F3T9	53.40	167,635.00	3,139.23
13	T1F1T9	60.20	170,190.00	2,827.08
14	T2F2T9	60.80	187,717.00	3,087.45
15	T1F1T9I1	63.10	190,466.00	3,018.48
16	T1T4F4	63.40	204,864.00	3,231.29
17	T1T3F1	67.00	206,642.00	3,084.21
18	T1T3F1F3	85.10	215,971.00	2,537.85
19	T1T4F1F4	85.60	219,625.00	2,565.71
20	T2T3F2F3	85.70	233,498.00	2,724.60
21	T1T3F1F3I1	88.00	236,247.00	2,684.63
22	T1T4F1F4I1	88.50	239,901.00	2,710.75
23	T1T3F1F3T9	99.20	241,401.00	2,433.48
24	T1T4F1F4T9	99.70	245,055.00	2,457.92
25	T2T3F2F3T9	99.80	258,927.00	2,594.46
26	T1T3F1F3T9I1	102.10	261,677.00	2,562.95
27	T1T4F1F4T9I1	102.60	265,331.00	2,586.07
28	T2T3F2F3T9I1	102.70	279,203.00	2,718.63
29	T2T4F2F4T9I1	103.20	282,857.00	2,740.86
30	T1T3F1F3F5T9	112.70	299,750.00	2,659.72
31	T1T4F1F4F5T9	113.20	303,404.00	2,680.25
32	T2T3F2F3F5T9	113.30	317,276.00	2,800.32
33	T1T3F1F3F5T9I1	115.60	320,026.00	2,768.39
34	T1T4F1F4F5T9I1	116.10	323,680.00	2,787.94
35	T2T3F2F3F5T9I1	116.20	337,552.00	2,904.92
36	T1T3F1F3F6T9I1	116.50	340,427.00	2,922.12
37	T2T4F2F4F5T9I1	116.70	341,206.00	2,923.79
38	T1T4F1F4F6T9I1	117.00	344,081.00	2,940.86
39	T2T3F2F3F6T9I1	117.10	357,953.00	3,056.81
40	T2T4F2F4F6T9I1	117.60	361,607.00	3,074.89

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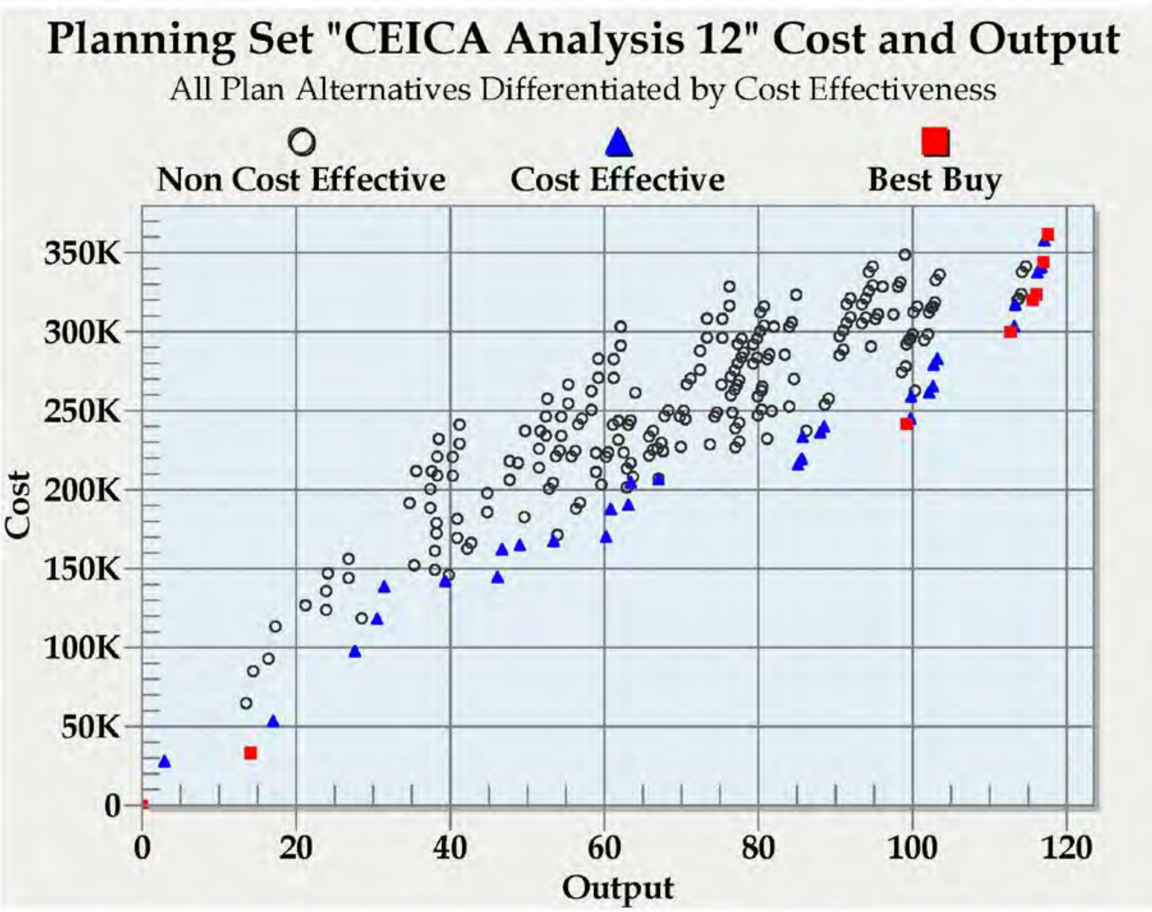

Figure D-6. Cost Effectiveness of Alternatives

Figure D-7. "Best Buy" Plans

6. RECOMMENDED PLAN DISCUSSION

The results of the habitat analysis support the premise that the functions and values of the Huron Island Project can be restored with the features for this Project. The HEP and TDI analyses indicate substantial improvements in both the aquatic and floodplain habitats of the Project. Overwintering habitat would be significantly improved through excavation and island protection greatly enhances habitat diversity through habitat complexity, protection, and growth. Floodplain habitat can certainly be improved through Topographic Diversity, which creates the opportunity for hardwood species to survive and grow. This in turn provides a significant improvement in food, cover, breeding, and overwintering habitat for nearly every species of wildlife residing and/or migrating in the floodplain. Due to the acreage of the Project floodplain, it is difficult for a single Project to re-create the conditions which were present prior to the 9-foot channel implementation. However, this Project made great strides in recreating those conditions. Furthermore, it is certainly realistic these conditions can be re-created across the entire Project by incorporating an excavated material placement program which utilizes the Project as the dump facility. Coordination is currently underway to develop this program.

7. LITERATURE CITED

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UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX E

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

15 June 2011
S. Gustafson

CEMVR-EC-DN

MEMORANDUM FOR RECORD

SUBJECT: 15 June 2011 Hazardous, Toxic, and Radiological Waste (HTRW) Assessment for the Huron Island Complex, Habitat Rehabilitation and Enhancement Project, Des Moines County, Iowa Pool 18, Mississippi River, River Mile 421.2-425.4.

1. Summary. An Environmental Site Assessment (ESA) Transaction Screening Process was completed on 15 June 2011 for the proposed work and staging areas for the Huron Island Complex Habitat Rehabilitation and Enhancement Project (Project Area) in general conformance with ASTM Practices E 1528-06, ER 1165-2-132, and MVD DIVR 1165-2-9. The inquiry consisted of an inspection of aerial photographs (1930, 1950, 1960, 1990, 2004 and 2010), an 1837 Land Survey Map, a USGS Topographical Map, records research and an interview. These inquiry activities revealed no evidence of hazardous substances, HTRW, or other regulated contaminants in connection within the Project Area.

2. Location. The Huron Island Complex is located along the right descending bank of the Upper Mississippi River System, Pool 18, between river miles 422 and 425.3 about 20 miles upstream of Burlington, Iowa in Des Moines County, Iowa. The Iowa River enters the Mississippi River just upstream of the island. Areas considered as part of this complex include Buffalo Slough, Gun Slough, Cody Chute, Beaver Chute, Huron Chute and areas associated with Pin Island. Target properties investigated within the scope of this ESA include:

- Proposed work and staging area.

3. Records Review. There is no documentation to suggest that there have ever been any spills or that any cleanups have been required within the Project Area. A search of United States Environmental Protection Agency (EPA), Iowa Department of Natural Resources (DNR), and National Response Center databases revealed no Recognized Environmental Conditions (REC) within a 1 mile radius of the Project Area.

4. Current and Historic Use. The Project Area is currently a 664 acre wooded island complex located on the right descending bank of the Mississippi. Based on the historical research, topographic maps and historical air photos, the Project Area has remained undeveloped since the 1830's. The Project Area has been utilized as wildlife habitat, and likely has been frequented by hunters and fisherman long prior to European colonization. The Project Area is federally owned by the Corps of Engineers and is out granted to the U.S. Fish and Wildlife Service (USFWS) and managed by the Iowa DNR). The responsibility for the operation, maintenance, and repair has been out granted to the Iowa DNR by the USFWS through a cooperative agreement.

5. Interviews. Dennis Ostwinkle, Supervisor, Iowa Department of Natural Resources Spill Division was contacted on June 1, 2011. Mr. Ostwinkle has no records of spills or incidents at the Project Area.

6. Site Reconnaissance. Steve Gustafson (EC-DN), Emily Johnson (EC-DN), Nate Richards (PM-A) and Kara Mitvalsky (EC-DN) visited the Project Area on June 14, 2011. Minor amounts of flood debris (plastic, bottles, wood) were observed. A brick/concrete dilapidated foundation was observed on the west side of the Project Area. Several duck hunting blinds were observed in various conditions, from standing to completely destroyed.

No indications of recognized environmental conditions were observed.

7. Conclusions and Recommendations. While there may be minimal recognized environmental conditions on target properties due to trace amounts of fertilizers, pesticides, fungicides and herbicides because of agricultural activities, there are no physical signs, records or specialized knowledge indicating a significant environmental condition of concern for the project. It is recommended that no further HTRW assessments be conducted for this project.

It is recommended that no further HTRW assessments be conducted for this project.

8. The assessment was investigated and documented by Steve Gustafson, P.G.

Heather Anderson, P.E.
Chief, Environmental Engineering
Section

15 June 2011
S. Gustafson

CEMVR-EC-DN

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- Proposed work and staging area.

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5. Interviews. Dennis Ostwinkle, Supervisor, Iowa Department of Natural Resources Spill Division was contacted on June 1, 2011. Mr. Ostwinkle has no records of spills or incidents at the Project Area.

6. Site Reconnaissance. Steve Gustafson (EC-DN), Emily Johnson (EC-DN), Nate Richards (PM-A) and Kara Mitvalsky (EC-DN) visited the Project Area on June 14, 2011. Minor amounts of flood debris (plastic, bottles, wood) were observed. A brick/concrete dilapidated foundation was observed on the west side of the Project Area. Several duck hunting blinds were observed in various conditions, from standing to completely destroyed.

No indications of recognized environmental conditions were observed.

7. Conclusions and Recommendations. While there may be minimal recognized environmental conditions on target properties due to trace amounts of fertilizers, pesticides, fungicides and herbicides because of agricultural activities, there are no physical signs, records or specialized knowledge indicating a significant environmental condition of concern for the project. It is recommended that no further HTRW assessments be conducted for this project.

It is recommended that no further HTRW assessments be conducted for this project.

8. The assessment was investigated and documented by Steve Gustafson, P.G.

Heather Anderson, P.E.
Chief, Environmental Engineering
Section

CEMVR-ED-DN

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE DOCUMENTATION REPORT

DREDGED MATERIAL MANAGEMENT PLAN FOR DREDGED MATERIAL PLACEMENT

UPPER MISSISSIPPI RIVER MILES 423.5-426.7 POOL 18

SITE PLAN FOR THE KEITHSBURG LOWER/HURON ISLAND DREDGE CUT

March 2000

Executive Summary

BACKGROUND

This report documents the Phase I Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessment for the Keithsburg Lower/Huron Island Dredge Cut Dredged Material Management Plan (DMMP) in accordance with ER 1165-2-132, HTRW Guidance for Civil Works Projects, and ER 405-1-12, Real Estate Handbook. The Phase I Environmental Site Assessment was performed in conformance with the scope and limitations of the American Society for Testing and Materials (ASTM) Standards E 1527-97 and E 1528-96 for the sites described by the subject DMMP near Keithsburg, Illinois. The information was obtained through site reconnaissance, informal interviews, a review of maps and aerial photographs, U.S. Army Corps of Engineer (USACE) records, and a search of federal and state environmental databases. These screening methods have been selected based on the particular nature of the proposed placement site and the characteristics of the dredged material.

SUMMARY

A review of the environmental data near the dredge cut and at the placement sites indicates that there is very low risk for HTRW contamination within these areas. No HTRW sites were located immediately within the project locations, and sites located within the approximate minimum search distance were determined to have no direct impact on the project locations. Effluent from the dredged material at the agricultural field placement sites 14 could contain low concentrations of pesticides, herbicides, and constituents of fertilizer such as nitrates. These contaminants, however, are expected to be well within the regulatory limits and would be addressed through compliance with water quality standards required for all dredging operations. Previous dredging operations in this area indicate that the sediment along this stretch of the Mississippi River consists primarily of medium to fine sands. The dredge cut is located in an area that has upstream industrial activity where releases of unknown quantities of toxic constituents have occurred. Very low concentrations of contaminants could be bound in a few and isolated spots in the dredge cut areas where there is a high concentration of fines and clay sediments. Periodic dredging occurs in these areas, and due to the large volume of both coarse sediments and water in the Mississippi River, it is unlikely that there are significant contaminants bound into these sediments to cause an HTRW concern. The present level of inquiry is appropriate to the operation scale. There are no stresses to the topography or documentation regarding a direct impact to this site due to contamination.

In summary, this assessment has revealed no evidence of recognized environmental conditions in connection with the properties associated with the dredge material placement sites. Only de minimis environmental conditions such as low level contamination from agricultural activities may exist at Site 14. It is not recommended that any further HTRW Environmental Site Assessments be conducted.

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1. General

a. Authority. The River and Harbor Act of 1930 authorized the 9-foot navigation channel and subsequent channel maintenance dredging. Under the authority delegated from the Secretary of the Army and in accordance with Section 404 of the Clean Water Act (CWA) of 1977, the U.S. Army Corps of Engineers Rock Island District (CEMVR) regulates the discharge of fill material into waters of the United States. The District also adheres to the dredging regulations published in the Code of Federal Regulations (3 CFR, Parts 335-338).

b. Guidance and Policy. The U.S. Army Corps of Engineers Engineering Regulation (ER) providing guidance for the conduct of Civil Works Planning Studies is contained in ER 1105-2-100. The policies and authorities outlined in ER 1165-2-132, Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects, and ER 405-1-12, Real Estate Handbook, were developed to facilitate the early identification and appropriate consideration of HTRW issues in all of the various phases of a water resources study or project. American Society for Testing and Materials (ASTM) Standards E1527-97 and E1528-96 provide a comprehensive guide for conducting Phase I Environmental Site Assessments (ESA). These references provide information on what considerations are to be factored into project planning and implementation. The policy of the U.S. Army Corps of Engineers (Corps) is to avoid construction of Civil Works projects when HTRW is located within project boundaries or may affect or be affected by such projects.

2. Introduction

a. Purpose and Scope. The specific purpose of a Hazardous, Toxic, and Radioactive Waste Documentation Report (HTRWDR) is to adequately document an appropriate inquiry into HTRW activities on potential project lands. The scope of this report documents the HTRW investigation for the Dredged Material Management Plan (DMMP) for the Keithsburg Lower/Huron Island Dredge Cuts. The goal of the DMMP is to identify, evaluate, and recommend long-term placement alternatives for dredging operations. This inquiry is required in order to minimize and prevent Federal liability under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and to reduce any threats to project workers and avoid costly delays associated with environmental abatement activities. Appendix A contains a list of acronyms used in this report. A list of documents and records reviewed or referenced is contained in Appendix B.

Phase I Environmental Site Assessments use only practically reviewable information. This investigation and assessment of the property is guided by the level appropriate for the type of property, information developed in the course of the assessment, project requirements, regulatory agency requirements, and potential risks. The screening methods used to prepare the Phase I ESA have been selected based on the location, physical setting, surrounding land uses, and particular nature of the dredged material placement sites. Intrusive field sampling and lab analyses are not used for the Phase I ESA, but are reserved for the Phase II ESA when required.

b. Limiting Conditions and Methodologies Used. The Keithsburg Lower/Huron Island Dredged Material Placement project involves work on land owned by the federal government and on land which has historically been used for agricultural activities, and not for any known or suspected industrial purposes. The techniques used to assess HTRW contamination within and adjacent to the project area consisted of informal interviews with project team members, a review of maps and photographs, site visits, and a search of Federal and state environmental databases. The scope of inquiry was limited to investigating onsite HTRW potential within the project boundaries as well as offsite HTRW potential within a reasonable distance from the project.

c. Site Safety. A formal Site Specific Safety and Health Plan (SSHP) has been developed and is contained in Appendix C. Assessment methods did not involve intrusive techniques, such as collecting and analyzing soil samples at the placement sites for this report.

3. <u>Site Description</u>

a. Location and Legal Description. There are four proposed placement sites for the Keithsburg Lower/Huron Island Dredged Material Placement project.

(1) Site 1 is on Willow Bar Island, located at River Miles (RM) 425.5-426.5 on the left descending bank. This island is a federal land and has been used historically as a dredged material placement site for the U.S. Army Corps of Engineers. Placement of dredged material would be conducted on the interior of the island, beginning at the upstream end, with return water discharging from the main channel side.

(2) Site 3 is at the Big River State Forest Beneficial Use Site, located at RM 424.1 on the left descending bank. This site is a federal land as well. Placement of dredged material would be accomplished by hydraulic dredging. Construction of a berm incidental to placement operations would be required. Return water would follow existing contours and discharge back to the river.

(3) Site 13 is on Kingston Bar III, located at RM 423.3-423.7 on the right descending bank. This site is a wildlife refuge and is to be used only minimally for emergencies and/or if equipment capabilities exclude utilization of Site 14. Placement of dredged material would be accomplished by hydraulic dredging. Return water would follow existing contours and discharge back to the river.

(4) Site 14, designated as the Upland Site, is located at RM 424.4-424.7 on the left descending bank. This site is an unutilized agricultural field owned by four private individuals from which land interest would need to be purchased. Placement of dredged material would be accomplished by hydraulic dredging. This site would require the construction of a containment berm approximately six feet high. An outlet structure and pipe would be installed in the containment berm to discharge return water back to the river.

For Keithsburg Lower, it is estimated that a dredging event would occur every 3 years, with 26,800 cubic meters of material being removed for each event. For Huron Island, it is estimated that a dredging event would occur every 4 years, with the same amount of material being removed for each event. The estimated dredging requirement for both areas is 26,800 cubic meters of material every 1.7 years. For a 40-year plan, 14 dredging events are estimated to occur, totaling 375,000 cubic meters. The four placement sites discussed above have a total potential capacity of approximately 415,000 cubic meters.

b. Site and Vicinity Characteristics. Since dredged material placement at Site 14 would be on a former farm field, it is assumed that pesticides and herbicides were applied in order to control pests and weeds in a manner consistent with normal agricultural activities. Pesticides and herbicides applied to lands during the course of normal agricultural activities are exempt from the CERCLA or Resource Conservation and Recovery Act and Amendments (RCRA) regulations. Contamination of soil from runoff of pesticides and herbicides is not considered HTRW, and is therefore a de minimus environmental condition.

c. Utilities/Transportation Features. USGS quadrangle maps within and adjacent to the project area were reviewed. Since Site 1 is on an island and Site 13 is on a bar in the river, utilities are not a concern. Barge and recreational traffic navigate through the river. Site 3 is located approximately 1,000 feet downstream of the access area and adjacent to the picnic area for Big River State Forest. A secondary highway runs adjacent to the eastern border of Site 14 and residential homes are located within 1000 feet from the upstream and downstream borders. There are no railway lines adjacent to the sites.

d. Current Uses of Property. Sites 1, 3 and 13 are federally owned properties. Site 1 is an island, Site 3 is a state forest, and Site 13 is a wildlife refuge. Site 14 is an agricultural field that is privately owned. These sites are not used for industrial purposes. The Illinois Waterway is a river with some upstream industrial activities.

e. Past uses of Property. The proposed placement sites have been used as agricultural fields or fallow land. The property has not been used for any known industrial purposes. The Illinois Waterway has always been a river.

f. Current and Past Uses of Adjoining Properties. See description in Section 3.c. Some residential facilities are located near Site 14.

4. <u>Site Reconnaissance</u>

The site information used for the investigation was obtained from informal interviews with DMMP Team members. The consensus of these informal discussions was that there were no indications of an association or history of HTRW at the placement sites. Assessment methods did not involve intrusive techniques such as the taking and analyzing of soil samples.

a. Hazardous Substances in Connection with Identified Uses. None were identified.

b. Hazardous Substance Containers and Unidentified Substance Containers. None were identified.

c. Storage Tanks. None were identified.

d. Indication of PCBs. None were identified.

e. Indications of Solid Waste Disposal. None were identified.

f. Any other Condition of Concern. The residential homes located near Site 14 most likely have septic tanks. Since the closest residence is about 500 feet away, the chance of impact on these systems from dredged material placement is remote. Additionally, there is a chance that these residences have fuel tanks to provide heat. While fuel tanks could have a slight HTRW impact, a review of databases as described in the following sections did not indicate any leaking tanks or spills in this area from any source.

Since dredged material placement at Site 14 would be on a former farm field, it is assumed that pesticides and herbicides were applied in order to control pests and weeds in a manner consistent with normal agricultural activities. Pesticides and herbicides applied to lands during the course of normal agricultural activities are exempt from the CERCLA or Resource Conservation and Recovery Act and Amendments (RCRA) regulations. Contamination of soil from runoff of pesticides and herbicides is not considered HTRW, and is therefore a de minimus environmental condition.

A potential source for contamination of the placement sites could possibly be from the dredged material where toxic constituents may have collected. According to a grain-size analysis conducted in 1990, the sediment along this stretch of the Mississippi River consists primarily of sands. The likelihood of hazardous contaminants binding to such sediments is minimal, and any contaminants that leached into the river would be highly diluted. Additionally, since periodic dredging occurs in this area, it is unlikely that any significant amount of contaminants would accumulate. Since the potential for contamination in the dredged material is very low, it is improbable that any site where dredged material is placed would ever be included in a hazardous waste disposal site investigation. Therefore, the potential for a hazardous condition to humans or the environment is minimal or nonexistent.

g. Site Reconnaissance Conclusions. The site reconnaissance revealed that there is no evidence of recognized environmental concerns in connection with the property. While the placement site has been used for agricultural purposes, any herbicides or pesticides used or remaining on this site were used in a manner consistent with normal agricultural activities, and thus are exempt from CERCLA and RCRA regulations. Contamination of soil from runoff of pesticides and herbicides is not considered HTRW, and is therefore a de minimus environmental condition. Since there are residential homes located near Site 14, it is possible that there are septic tanks and fuel tanks located at these facilities. A review of databases did not indicate any concern with these systems at this location. No other HTRW is expected to be encountered on or adjacent to this placement site.

5. Interviews

Informal interviews were conducted with members of the Rock Island District’s DMMP team as mentioned in Section 4. No HTRW concerns were discovered through these interviews.

6. Records Review

The purpose of a record review is to obtain and review records that will help identify recognized environmental conditions in connection with the property. Some of the records reviewed pertain not just to the property, but also to properties within an approximate minimum search distance to help assess the likelihood of problems from migrating hazardous substances or petroleum products. Factors considered in determining the approximate minimum search distance include the density of the setting, the distance that hazardous substances or petroleum products that are likely to migrate based on local geologic or hydrogeologic conditions, and other reasonable factors. This record review included querying several environmental databases and reviewing historical and current maps and photos.

a. EnviroFacts. When an Envirofacts database query was conducted using the zip code for Keithsburg, Illinois (61442), five facilities were identified. One facility was permitted discharges to water, one had both toxic and air releases reported, one was a hazardous waste handler, another had air releases reported and one had a system risk management plan. The facilities did not have an active or archived Superfund report nor a BRS 1995 reporter. Appendix D displays the results of the database query.

An Envirofacts database query was also conducted by evaluating a two-mile radius around each site. For Site 1, three of the five facilities mentioned above were identified. For Site 14, one of the five facilities mentioned above was identified. The queries for both Sites 3 and 13 did not locate any facilities within the two-mile radius. No facilities were located at the proposed placement locations, and did not appear to have direct impacts on the placement locations. Appendix D shows the figures for this query.

b. EnviroMapper for Watersheds. EnviroMapper is a mapping application that applies environmental data in Envirofacts with interactive Geographic Information System (GIS) functions for the conterminous United States. EnviroMapper allows users to view this environmental data at the national, state, and county levels, as well as detailed reports for EPA-regulated facilities. A search for facilities with discharges to water, Superfund sites, hazardous waste, toxic releases, and air releases was conducted for the Keithsburg area. No facilities were located at the proposed placement locations, and those identified did not appear to have direct impacts on the placement locations.

c. Site Environmental Information Data System (SEIDS). Both federal and state laws authorize the Illinois EPA to compile and maintain certain records relating to various environmental programs, activities, conditions and sites within the state. The Illinois SEIDS list was reviewed for sites in both Henderson and Mercer counties. The query for Henderson County revealed one site in Biggsville, Illinois, that has a RCRA hazardous waste permit and is enrolled in the SRP. This site is approximately ten miles downstream of the proposed project, and would have no impact on the proposed placement sites. Appendix E summarizes the details and results of the database search.

d. Maps and Photos. Geological surveys and aerial photographs provide an excellent source of historical property usage of the placement sites and adjacent areas. Photographs from the 1930s confirm the non-industrial nature of the project area. Modern aerial photos from 1995 show that this same area continues to be used for non-industrial purposes. It can be assumed that the predominant historical use of Site 14 would be agricultural activities. Currently, the land is sitting idle. USGS maps show no residential homes on any of the proposed placement sites. No indications of HTRW were noted.

e. Miscellaneous Analysis Review. No environmental sampling was performed for this assessment report. The only potential source for contamination at the placement sites could be from the dredged material where toxic constituents may have collected. According to previous dredging operations in this area, the sediment along this stretch of the Mississippi River consists primarily of medium to fine sands. The likelihood of HTRW contaminants binding to such sediments is minimal, and any such contaminants that leached into the river would be highly diluted. Additionally, since periodic dredging occurs in this area, it is unlikely that any significant amount of HTRW contaminants would accumulate. Since the potential for contamination in the dredged material is very low, it is improbable that any site where dredged material is placed would ever be included in a hazardous waste disposal site investigation. Therefore, the potential for a hazardous condition to humans or the environment is minimal or nonexistent.

f. Records Review Summary. A review of the environmental records near the dredge cuts and at the placement site indicates that there is a very low risk of HTRW contamination within these areas. No HTRW sites were located immediately within the project locations, and sites located within the approximate minimum search distance were determined to have no direct impact on the project locations.

7. Findings and Conclusions

The site reconnaissance revealed that there is no evidence of recognized environmental concerns in connection with the property. While the placement site has been used for agricultural purposes, any herbicides or pesticides used or remaining on this site were used in a manner consistent with normal agricultural activities, and thus are exempt from CERCLA and RCRA regulations. Contamination of soil from runoff of pesticides and herbicides is not considered HTRW, and is therefore a de minimus environmental condition. Since there are residential homes located near Site 14, it is possible that there are septic tanks and fuel tanks located at these facilities. A review of databases did not indicate any concern with these systems at this location. No other HTRW is expected to be encountered on or adjacent to this placement site.

No environmental sampling was performed for this assessment report. The only potential source for contamination at the placement sites could be from the dredged material where toxic constituents may have collected. According to previous dredging operations in this area, the sediment along this stretch of the Mississippi River consists primarily of medium to fine sands. The likelihood of HTRW contaminants binding to such sediments is minimal, and any such contaminants that leached into the river would be highly diluted. Additionally, since periodic dredging occurs in this area, it is unlikely that any significant amount of HTRW contaminants would accumulate. The potential for contamination in the dredged material is very low, and it is improbable that any site where dredged material is placed would ever be included in a hazardous waste disposal site investigation. Therefore, the potential for a hazardous condition to humans or the environment is minimal or nonexistent.

A review of the environmental records near the dredge cuts and at the placement site indicates that there is a very low risk of HTRW contamination within these areas. No HTRW sites were located immediately within the project locations, and sites located within the approximate minimum search distance were determined to have no direct impact on the project locations. Only de minimus environmental conditions such as low level contamination from agricultural activities may exist at Site 14. The present level of inquiry is appropriate to the operation scale. This assessment has revealed no evidence of recognized environmental conditions in connection with the property, the dredge locations, or placement sites.

The Phase I Environmental Site Assessment was performed in conformance with the scope and limitations of ASTM Standards for this property. This assessment has revealed no evidence of recognized environmental conditions in connection with the project.

8. Recommendations

It is not recommended that any further HTRW Environmental Site Assessments be conducted since there is no evidence of recognized environmental conditions in connection with the dredge locations, placement sites, or associated properties.

APPENDIX A
ACRONYMS

AIRS/AFS	Aerometric Information Retrieval System/AIRS Facility Subsystem
ASTM	American Society for Testing and Materials
BRS	Biennial Reporting System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CEMVR	Corps of Engineers, Mississippi Valley Division, Rock Island District
CMSP	Chicago, Milwaukee, St. Paul, and Pacific
DMMP	Dredged Material Management Plan
DNR	Department of Natural Resources
DOD	Department of Defense
ED-DN	Engineering Division - Environmental Engineering Section
EM	Engineering Manual
EMCI	EnviroFacts Master Chemical Integrator
EPA	Environmental Protection Agency
ER	Engineering Regulation
FII	Facility Identification Initiative
FWS	Fish and Wildlife Service
GICS	Grants Information and Control System
GIS	Geographic Information System
GREAT	Great River Environmental Action Team
HTRWDR	HTRW Documentation Report
HTRW	Hazardous, Toxic, and Radioactive Waste
ICR	Information Collection Rule
ILEPA	Illinois Environmental Protection Agency
L	Left Descending Bank
LUST	Leaking Underground Storage Tanks
NCOD	National Contaminant Occurrence Database
NPL	National Priorities List
OSIT	On-Site Inspection Team
PCS	Permit Compliance System
R	Right Descending Bank
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RM	River Mile
SDWIS	Safe Drinking Water Information System
SEIDS	Site Environmental Information Data System
SRP	Site Remediation Program
SSHP	Site Specific Safety and Health Plan
TRIS	Toxic Release Inventory System
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

APPENDIX B
REFERENCES AND ABSTRACTS

U. S. Army Corps of Engineers, Lower Mississippi Valley Division, ER 1165-2-9, Hazardous, Toxic, and Radioactive Waste Policy for Civil Works Projects, 14 June 1996

U. S. Army Corps of Engineers, Rock Island District, ER 1165-2-1, Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects, 26 June 1992

U. S. Army Corps of Engineers, Policy Guidance Letter No. 34, CECW-PA, Non-CERCLA Regulated Contaminated Materials at Civil Works Projects, 5 May 1992.

U. S. Army Corps of Engineers, ER 385-1-92, Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities, 18 March 1994.

U. S. Army Corps of Engineers, ER 405-1-12, Real Estate Handbook, Chapter 8.

U. S. Army Corps of Engineers, ER 500-1-1, Natural Disaster Procedures.

ASTM E 1527-97, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.

ASTM E 1528-98, Standard Practice for Environmental Site Assessments: Transaction Screen Process.

U.S. Army Corps of Engineers, Rock Island District, Dredged Material Management Plan for Dredged Material Placement, Upper Mississippi River Miles 423.5 – 426.7, Pool 18, Site Plan for the Keithsburg Lower / Huron Island Dredge Cut, June 1999.

U. S. Army Corps of Engineers, EM 1110-2-5027, Confined Disposal of Dredged Material, 30 September 1987.

Keithsburg Quadrangle, Illinois-Iowa, 7.5 Minute Series (Topographic) USGS Map, 1982.

U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River Ortho Photo, Pool 18, Sheets No. 423-426, 1995.

U.S. Army Corps of Engineers, Rock Island District, Upper Mississippi River Aerial Photo, Pool 18, Sheet No. 84, 1930's.

APPENDIX C
SITE SPECIFIC SAFETY AND HEALTH PLAN (SSHP)

SITE SPECIFIC SAFETY AND HEALTH PLAN TITLE PAGE Rock Island District Corps of Engineers	This SSHP is a part of the Rock Island District HTRW Program, which includes EM 385-1-1 and ER 385-1-92.
PROJECT NAME: Dredged Material Management Plan for Dredged Material Placement, Upper Mississippi River Miles 423.5 - 426.7, Pool 18, Site Plan for the Keithsburg Lower / Huron Island Dredge Cut	REQUEST FOR SERVICES NO.:
JOBSITE ADDRESS: Keithsburg (Mercer County), Illinois.	COST CODE:
PROJECT MANAGER: Fred Hanshaw	PHONE NO.: 309-794-5342
SITE CONTACT: Richard Nickel	PHONE NO.: 309-794-5886
PHONE NO.:	
( ) AMENDMENT NO. _____ TO EXISTING APPROVED SSHP. DATE EXISTING APPROVED SSHP:	
OBJECTIVES OF FIELD WORK: Environmental Site Assessment for the dredged material placement sites. A site visit of the project area will be made. Environmental concerns will be documented. No intrusive investigations (soil samples, etc.) will be conducted.	SITE TYPE: Check as many as applicable: ( ) Active ( ) Landfill (X) Natural (X) Inactive (X) Uncontrolled ( ) Military ( ) Secure ( ) Industrial (X) Other specify: Existing farm field. ( ) Unsecure ( ) Residential ( ) Enclosed space ( ) Well Field
DESCRIPTION AND FEATURES: Summarize below. Include principal operations and unusual features (containers, buildings, dikes, power lines, hills, slopes, rivers, etc.). The four sites are located within or adjacent to the Mississippi River. Two of the sites have no significant use, one is a beneficial use site, and the other is used primarily for agricultural activities. The possible utilities located near the agricultural site are septic systems at nearby residences. SURROUNDING POPULATION: ( ) Residential ( ) Industrial (X) Rural ( ) Urban ( ) Commercial: ( ) Other:	

SITE SPECIFIC SAFETY AND HEALTH PLAN
EMERGENCY CONTACTS & APPROVAL PAGE
Rock Island District Corps of Engineers

This SSHP is a part of the Rock Island District HTRW Program, which includes EM 385-1-1 and ER 385-1-92.

EMERGENCY CONTACTS		
Water Supply	N/A	
Site Telephone	N/A	
EPA Release Report No.	800-424-8802	

EMERGENCY CONTACTS	**NAME**	**PHONE**
Project Manager	Fred Hanshaw	309-794-5342
Safety and Health Manager	Jeff Cochran	309-794-5280
Industrial Hygienist		
Environmental Agency	Illinois EPA	217-782-3637
State Spill Number	Illinois Emergency Services and Disaster Agency	217-782-7860
Fire Department		911
Police Department		911
Poison Control Center		
Occupational Health Unit		

CONTINGENCY PLANS Read and Refer to **DM 385-1-2, Appendix H**. Enter any additional
Site Specific Information and clarifications below:

1. Evacuation Routes will be to the roads that lead away from the site and perpendicular to the alignment.

2. Personnel will evacuate if there appears to be any conditions that appear to expose any of the site visitors to an environmental or safety hazard.

3. All accidents will be reported in accordance with **DM 385-1-1, Appendix B**, including preparing an accident report form ENG 3394 as required by the appendix.

4. The overall plan is to evacuate the site in case of an emergency. In case of a medical emergency, the local EMS will be contacted from the nearest available phone (resident or business).

MEDICAL EMERGENCY	
Hospital Name:	
Hospital Address:	
Name of Contact at Hospital:	
Name of 24-Hour Ambulance:	

Route to Hospital (Provide description below and attach map with route to hospital on the following page). A route map was not prepared since the emergency plan is to call 911 from the nearest telephone should there be an emergency.

HEALTH AND SAFETY PLAN APPROVALS	
Prepared by: Rachel Fellman	Date: 20 December 1999
Reviewed by: Kara Mitvalsky	Date: 29 February 2000

APPENDIX D
EPA DATABASE

EPA Geographic Information Query System (Version 97.1.8), October 26, 1998.
Envirofacts Facility Databases Information.
Databases accessed via http://www.epa.gov/r10earth/gisapps/zipsearch.html and http://www.epa.gov/r10earth/gisapps/mapseries.html.

Search Description:

Search Type: Zip Code.
Data Inputted: 61442.
Requested Databases: Aerometric Information Retrieval System / AIRS Facility Subsystem (AIRS/AFS); Biennial Reporting System (BRS); Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS); Grants Information and Control System (GICS); Information Collection Rule (ICR); National Contaminant Occurrence Database (NCOD); Permit Compliance System (PCS); Resource Conservation and Recovery Information System (RCRIS); Safe Drinking Water Information System (SDWIS); Toxic Release Inventory System (TRIS).

Envirofacts, created by the Environmental Protection Agency (EPA), is a relational database warehouse implemented in the Oracle Relational Database Management System and is available through the Internet for public access. It has the ability to retrieve information from numersous environmental databases:

- AIRS/AFS - Aerometric Information Retrieval System / AIRS Facility Subsystem
- BRS - Biennial Reporting System
- CERCLIS - Comprehensive Environmental Response, Compensation, and .... Liability Information System
- GICS - Grants Information and Control System
- ICR - Information Collection Rule
- NCOD - National Contaminant Occurrence Database
- PCS - Permit Compliance System
- RCRIS - Resource Conservation and Recovery Information System
- SDWIS - Safe Drinking Water Information System
- TRIS - Toxic Release Inventory System

In addition, Envirofacts has a link with the Facility Identification Initiative (FII) and the Envirofacts Master Chemical Integrator (EMCI). The FII database links 23 facility identification data elements (ID number, name, address, location, etc.) to the databases listed above. This provides the power for multiple and complex queries to visually map facilities to their corresponding environmental data. The EMCI identifies the chemicals listed in the AIRS, PCS and TRIS. This allows the user to learn details about a chemical substance, such as chemical names, discharge limits, and reported releases.

Results:

When an Envirofacts database query was conducted using the zip code for Keithsburg, Illinois (61442), five facilities were identified. One facility was permitted discharges to water, one had both toxic and air releases reported, one was a hazardous waste handler, another had air releases reported and one had a system risk management plan. None of the facilities had an active or archived Superfund report or were a BRS 1995 reporter. The results are listed below in Table 1.

EPA Facility ID	*Facility Name*	*Facility Address*	*EPA Listing*
ILD075600023	ADM/Growmark	Highway 17	Air releases reported
000008900200	Bayhill Fertilizer Inc.	1011 E. 20th Ave.	System risk management plan
ILD984804047	Cannon Precision Mfg.	4th & Washington	Air and toxic releases reported
ILD984819516	Caseys General Stores Inc.	6th & Main	Hazardous waste handler
IL0000455683	City of Keithsburg	2nd St.	Permitted discharges to water

Table 1. EPA Envirofacts Zip Code Query Results.

An Envirofacts database query was also conducted by evaluating a two-mile radius around each site. The coordinates used for each site are listed below in Table 2. For Site 1, three of the five facilities mentioned above were identified. For Site 14, one of the five facilities mentioned above was identified. The queries for both Sites 3 and 13 did not locate any facilities within the two-mile radius. See the figures following Table 2 for details.

Location	*Latitude*	*Longitude*
Site 1	41.07268°	-90.94388°
Site 3	41.04945°	-90.93938°
Site 13	41.04335°	-90.94824°
Site 14	41.05903°	-90.93604°

Table 2. Coordinates for Dredged Material Placement Sites.

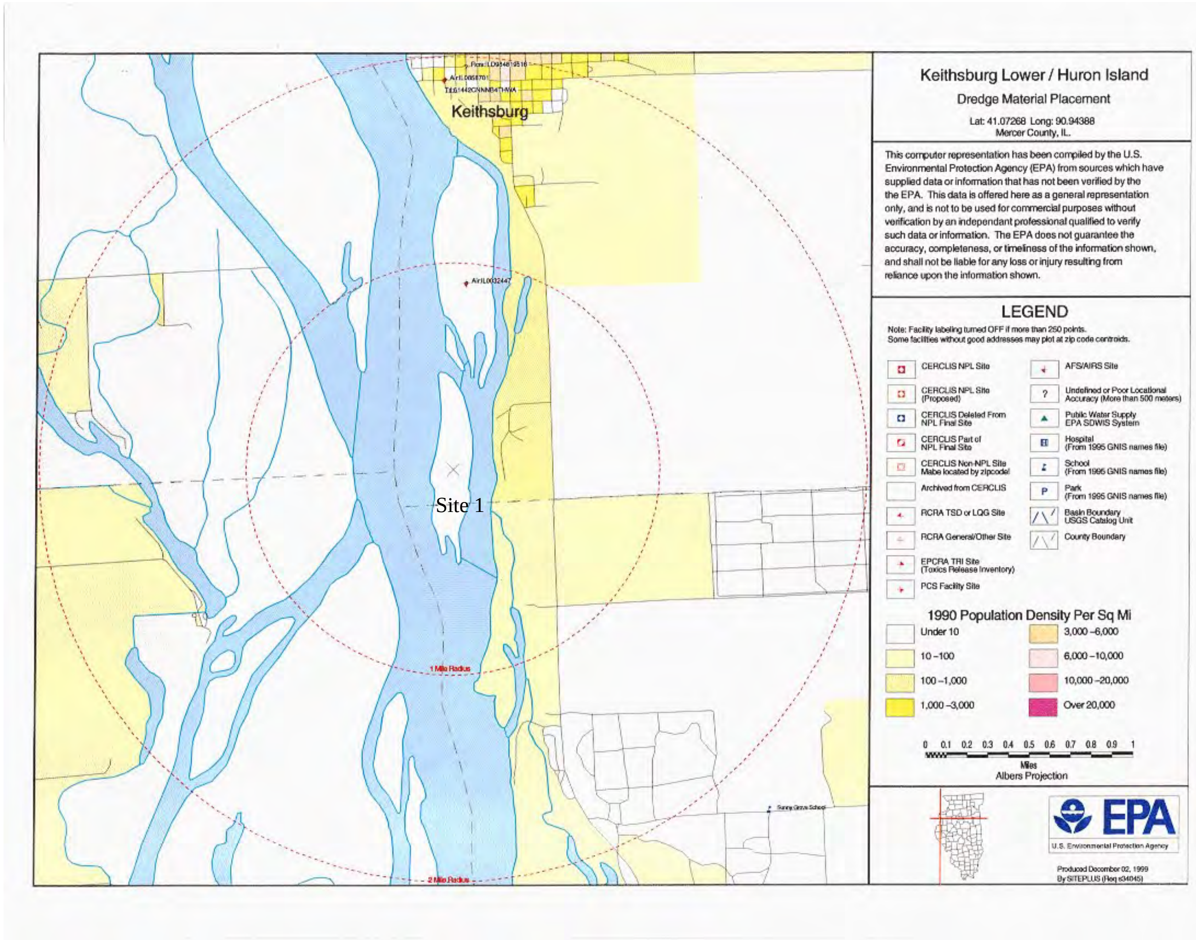

Figure 1. Site 1 Enviromap Results.

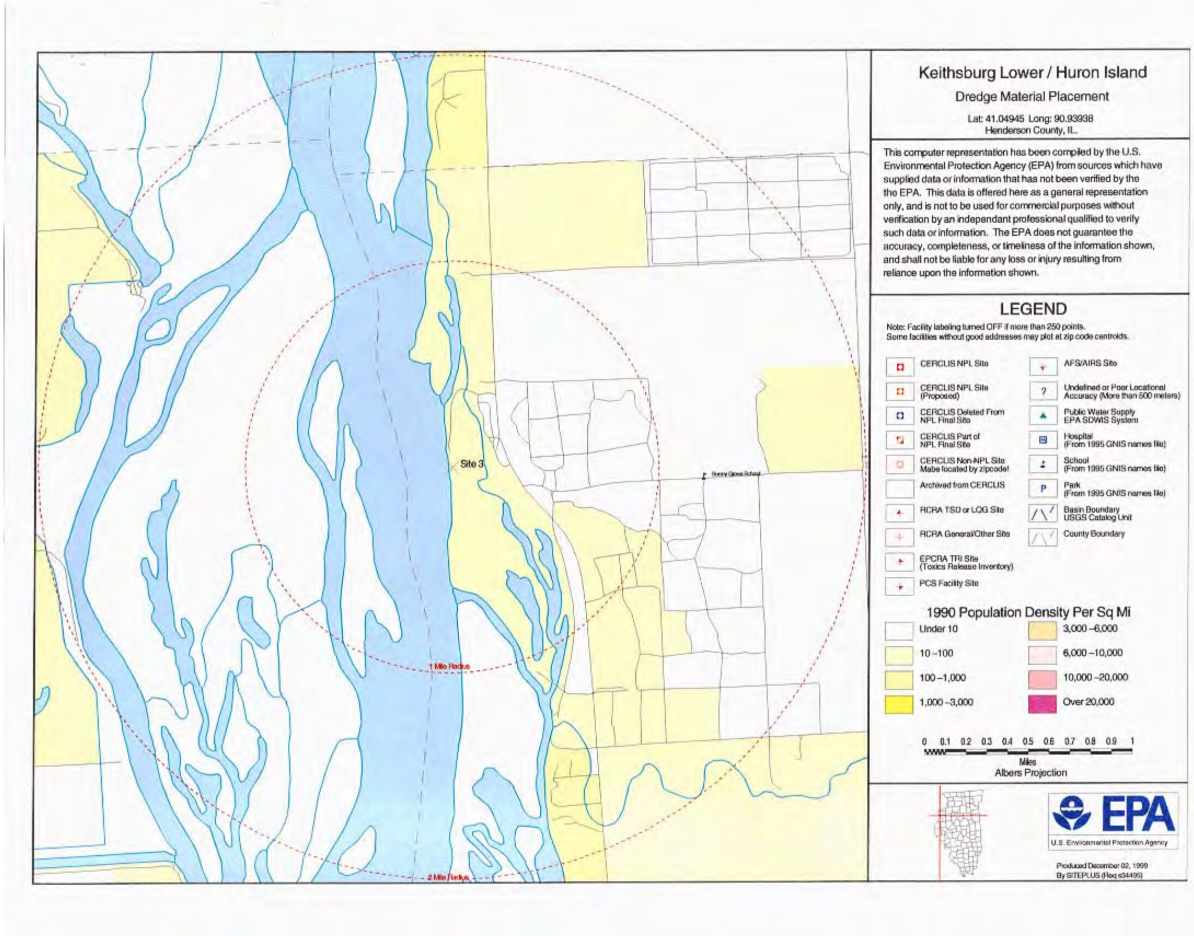

Figure 2. Site 3 Enviromap Results.

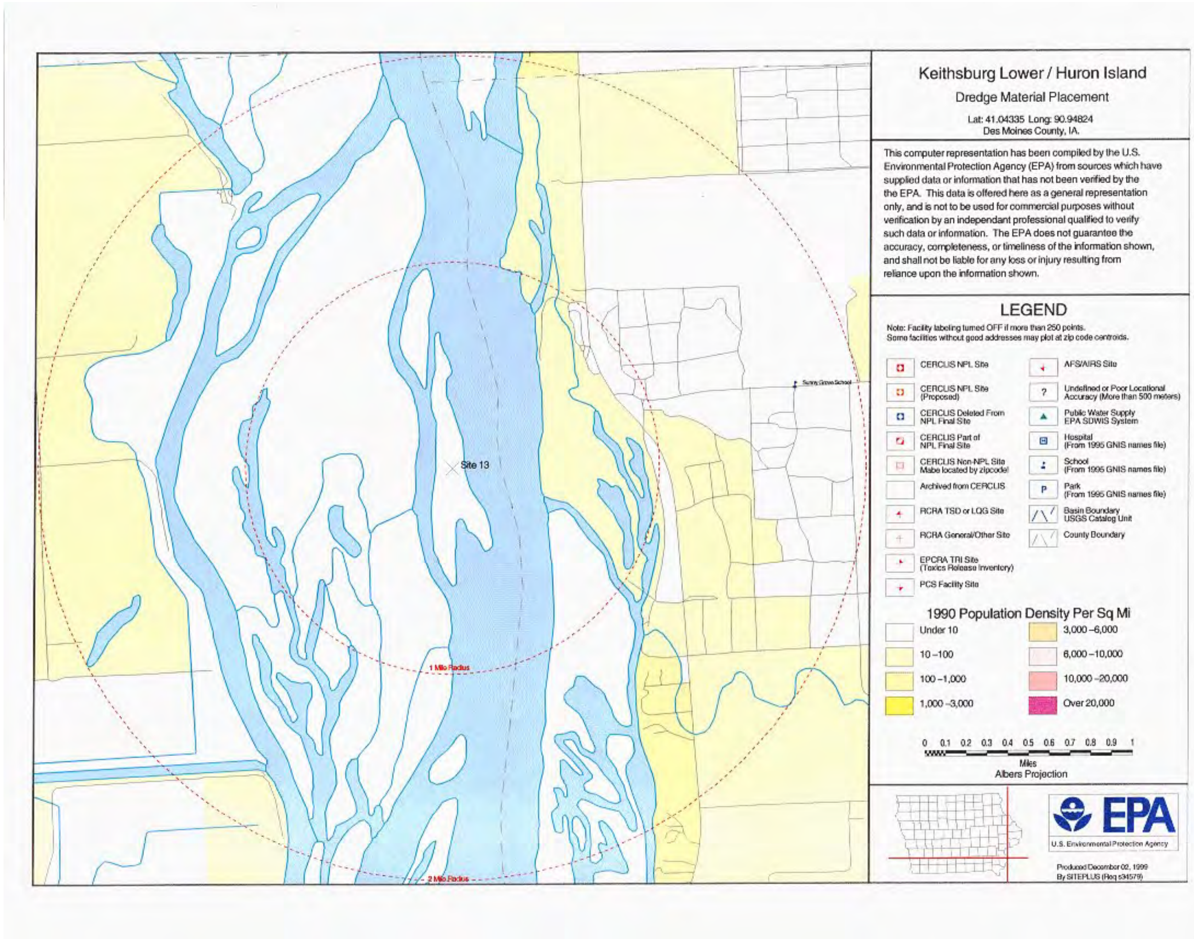

Figure 3. Site 13 Enviromap Results.

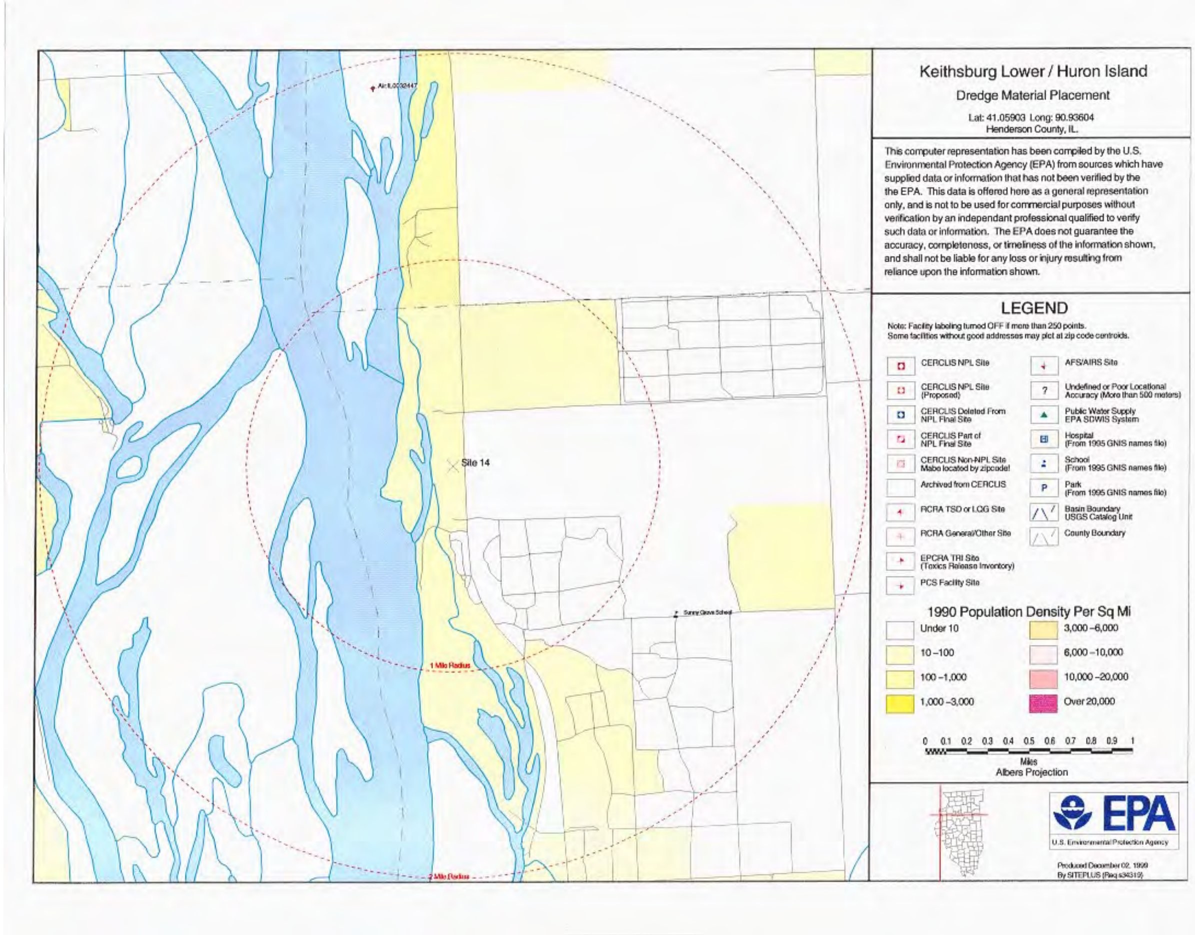

Figure 4. Site 14 Enviromap Results.

APPENDIX E
ILLINOIS EPA DATABASE

Illinois Environmental Protection Agency.
Site Environmental Information Data System (SEIDS).
Database accessed via http://www.epa.state.il.us/land/seids.

Search Description:

Search Type: County.
Unit Selected: Henderson and Mercer Counties.
Requested Databases: Site Remediation Program (SRP), Department of Defense (DoD), Leaking Underground Storage Tanks (LUST), Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS).

The SEIDS database lists sites where Leaking Underground Storage Tanks (LUST) have been reported, sites where cleanup activities have been performed by the Department of Defense (DOD), and areas enrolled in the Site Remediation Program (SRP). It also lists sites that have applied for or received Resource Conservation and Recovery Act (RCRA) hazardous waste permits and sites which have been identified or scored for potential listing on the National Priorities List (NPL).

Results:

The query revealed no sites in Mercer County. In Henderson County, there was one site in Biggsville, Illinois involved in a SRP, which also had a RCRA permit located. This site is down river and more than ten miles away from the proposed dredged material placement sites.

Site ID	*Facility Name*	*Facility Address*	*LUST*	*CERCLIS*	*DoD*	*SRP*	*RCRA*
0710050002	Crop Production Services	Highway 94 North				X	X

Table 3. Illinois EPA SEIDS Query Results.

APPENDIX F
Site Reconnaissance Photos and Maps

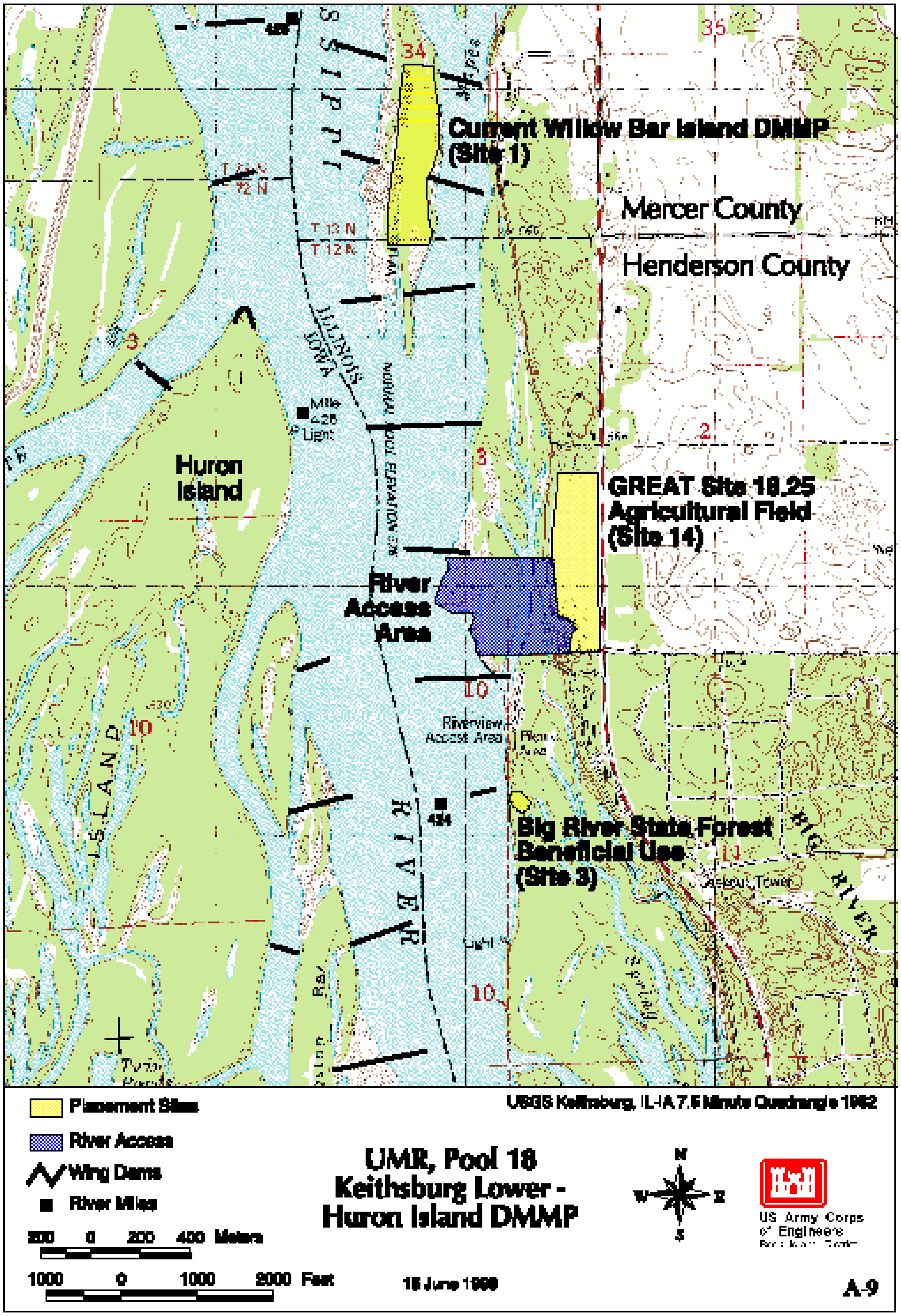

Figure 5. Map of Placement Sites.

Orthomap 1. Project Area-Historical.

Orthomap 2. Project Area.

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX F

WATER QUALITY

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-17F)

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX F

WATER QUALITY

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HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX F

WATER QUALITY

1. PURPOSE

The purpose of this appendix is to evaluate the results from water quality monitoring performed by Corps personnel at several potential environmental enhancement sites located within the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project). Water quality monitoring was performed with the primary objective of defining pre-project baseline water quality conditions.

2. INTRODUCTION

Baseline water quality monitoring was initiated at Huron Island in order to determine pre-project conditions and assist Project planners with selecting and locating alternatives for habitat rehabilitation and enhancement. Personnel with the Iowa and Illinois Departments of Natural Resources, Illinois EPA, USFWS and the Lucille A. Carver Mississippi Riverside Environmental Research Station were contacted in an effort to determine if water quality information from Huron Island was collected by other agencies; however, they were not aware of any significant water quality information available for the Project area. The USEPA's STORET website also failed to provide any water quality information for Huron Island.

Baseline water quality monitoring was initiated at Huron Island by Corps personnel on May 31, 2006 at sites W-M422.5C and W-M422.2G (Sheet O-101 in Appendix P). On December 27, 2006, sites W-M422.7E and W-M422.3I were added. Sampling ceased at the "flowing" sites W-M422.2G and W-M422.3I on September 9, 2009 and was initiated at the "backwater lake" sites W-M422.4E and W-M422.7F on December 21, 2009, in an effort to obtain baseline water quality data from additional areas on the interior of the island that were less subject to flow. Water quality monitoring is accomplished through a combination of collecting surface grab samples and deploying continuous monitors. The monitoring sites include three (W-M422.5C, W-M422.4E and W-M422.7F) that are lentic (lake-like) in their characteristics and three (W-M422.7E, W-M422.2G and W-M422.3I) that are lotic (riverine) in their characteristics.

3. METHODS

Monitoring was accomplished through a combination of collecting grab samples and deploying continuous monitors. In general, sampling date, time, water depth, Secchi disk depth, water velocity, wave height, air temperature, percent cloud cover, wind speed and direction, pH, water temperature, dissolved oxygen (DO) and specific conductance were recorded in the field. At each sampling site a water sample was collected just below the surface. The sample was placed on ice and shipped to either

Sherry Laboratories, South Bend, Indiana or Iowa State University, Ames, Iowa for total suspended solids and chlorophyll analyses. Sample collection/preservation and field/laboratory analytical procedures were performed according to USEPA approved methods. Turbidity and alkalinity analyses were performed in-house. In addition to the manually collected data, YSI and Hach multiparameter water quality monitoring sondes were deployed on numerous occasions. Typically the sondes were placed one to two feet from the bottom and were programmed to record DO, pH, temperature, depth, specific conductance and/or turbidity every two hours. Summer deployments typically lasted two weeks, while in the winter the sondes were deployed for about 6 weeks.

4. RESULTS AND DISCUSSION

Site W-M422.5C. The results from monitoring at site W-M422.5C are shown in table F-1. This site, located in Goose Lake Pool 2, is relatively isolated at flat pool and exhibited low velocities, with a median of 0.97 cm/sec. Winter velocities were generally lower, while significantly higher velocities were observed during flooding in the summer of 2008. Winter water temperatures were relatively high, with a minimum of 0.4°C. A very low DO concentration (0.72 mg/L) was observed on January 29, 2009. A continuous monitor deployed on this date erroneously indicated DO concentrations below zero and also some unbelievably high (> 400 percent saturation) DO concentrations (figure F-1); however, pH values measured during the deployment strongly suggest that DO concentrations were likely very low until February 25, 2009. This inference can be made because pH often correlates closely with DO, and since the pH values remained relatively low until February 25th, it is likely that the DO concentrations also remained low. A low DO concentration (4.45 mg/L) was also observed on June 15, 2010. As indicated by continuous monitor data, this condition persisted for several days (figure F-2).

Site W-M422.7E. This site is located in the channel that runs the length of the island (entering from Huron Chute). Velocities are moderate here, with a median of 11.40 cm/sec (table F-2). Winter water temperatures were lower (typically around 0.1°C except for the unusually warm winter of 2011-2012) at this flowing site compared to more isolated sites. Only one grab sample DO concentration was below 5.00 mg/L: 4.67 mg/L on September 13, 2011. The continuous monitor retrieved on this date showed that DO concentrations in early September oscillated around 5 mg/L (the State of Iowa Class B(WW-1) water quality standard for DO), with nighttime values nearly always below 5.00 mg/L (figure F-3).

Site W-M422.2G. This site is located in Cody Chute and experiences relatively high velocities, with a median value of 17.54 cm/sec (table F-3). This typically flowing site also had low winter water temperatures, with values of 0.0°C and 0.1°C common. A DO concentration below 5 mg/L was measured on only one occasion (3.83 mg/L on July 11, 2006). On this date, the water depth was at its minimum (0.370 m) for the site and there was little flow. Continuous monitor data indicate the DO recovered the following day and over the next two weeks exhibited a pattern of day-time highs above 5 mg/L and night-time lows below 5 mg/L (figure F-4).

Site W-M422.3I. This site is located closest to the main channel in a chute and exhibits water quality that is reflective of that typically seen in the main channel. Median velocities were highest at this site with a value of 40.12 cm/sec (table F-4). Winter water temperatures were lowest here, with a minimum of -0.1°C. All DO grab sample concentrations exceeded 5.00 mg/L, with a minimum value of 6.50 mg/L. The results from a sonde deployed here from June 27, 2007 to July 10, 2007 are shown in figure F-5, compared to a sonde deployed during the same period at site W-M422.5C. This figure exemplifies the typical differences in diurnal DO oscillations between a lentic site (W-M422.3I) and a lotic site (W-M422.5C), with the lentic site having significantly greater swings in daytime highs relative to nighttime low DO concentrations.

On two occasions (July 2008 and June 2009), continuous monitors deployed at site W-M422.3I over a two week period were buried under several inches of sand, indicating a significant bed load moving down the chute. The median total suspended solids concentration here (80 mg/L) was significantly higher than other sites (closest was 51 mg/L at site 422.2G).

Site W-M422.4E. The results from monitoring at site W-M422.4E are shown in table F-5. This site, located in Goose Lake Pool 1, is relatively isolated at flat pool and exhibited the second lowest velocity with a median value of 0.79 cm/sec. Winter water temperatures were generally lower here compared to site W-M422.5C, but were higher than those observed at the lotic sites. All DO grab sample concentrations here were above 5.00 mg/L. The results from a winter sonde deployment (February 14, 2011) at this site are shown in figure F-6. All DO concentrations were above 5 mg/L and there were minimal diurnal oscillations.

Site W-M422.7F. This relatively isolated site exhibited the lowest median velocity value of 0.55 cm/sec as shown in table F-6. Winter water temperatures here were the highest of all sites, with a minimum of 0.7°C. Two grab sample DO concentrations at this site were below 5 mg/L (4.73 mg/L on July 27, 2010 and 4.68 mg/L on August 2, 2011). The DO concentration in the main channel of the Mississippi River adjacent to Huron Island was only 4.18 mg/L on July 27, 2010. This was likely a contributing factor to all four Huron Island sites sampled on this day having relatively low DO concentrations. The results from the sonde deployed on this date show DO concentrations above 5 mg/L for much of the deployment, with values falling below 5 mg/L at the beginning and near the end (figure F-7). Sonde data also indicated an extended period of low winter DO at site W-M422.7F (figure F-8). Continuous DO concentrations below 5 mg/L extended from February 5 to March 9, 2010.

Site Summary. The monitoring sites include three (W-M422.5C, W-M422.4E and W-M422.7F) that are lentic in their characteristics and three (W-M422.7E, W-M422.2G and W-M422.3I) that are lotic in their characteristics. As shown in tables F-1 through F-4, grab sample results indicate the lentic sites had lower median velocity and dissolved oxygen (DO) values relative to the lotic sites. Median velocity values ranged from 0.55 to 0.97 cm/s at the lentic sites and from 11.40 to 40.12 cm/s at the lotic sites. Median DO concentrations ranged from 6.79 to 8.25 mg/L at the lentic sites and from 10.51 to 11.95 mg/L at the lotic sites. Minimum DO concentrations ranged from 0.72 to 5.17 mg/L at the lentic sites and from 3.83 to 6.50 mg/L at the lotic sites. Minimum water temperatures ranged from 0.1 to 0.7°C at the lentic sites and from -0.1 to 0.1°C at the lotic sites; while the maximum water temperature at all sites was close to 31.0°C. Values for pH occasionally exceeded 9 at the lotic sites, with the following maximums: 9.30 at W-M422.7E, 9.40 at W-M422.2G and 9.50 at W-M422.3I, all occurring on August 26, 2008. On this date, water levels and velocity values were relatively low and DO concentrations were supersaturated at all three sites. The high pH and DO values were likely due to extreme algal photosynthesis.

In general, during the summer the lentic sites exhibited noticeable diurnal DO concentration oscillations, typically in the 5 to 10 mg/L range but occasionally exceeding 15 mg/L. During 2010 and 2011, when water levels were high for most of the summer, diurnal DO oscillations were more subdued. Nighttime DO concentrations often fell below 5 mg/L but most often recovered the following day. However, on at least one instance, each of the three lentic sites experienced DO concentrations below 5 mg/L for more than two continuous days. On one occasion, the DO concentration remained below 5 mg/L for the entire two-week deployment: June 15 through 29, 2010 at site W-M422.5C. At the lotic sites, summer DO concentrations were generally higher and diurnal DO oscillations were more subtle, with nighttime DO concentrations sometimes falling below 5 mg/L but always recovering the following day.

Winter DO measured with a continuous monitor at the lentic sites varied from below 5 mg/L to supersaturated concentrations. Winter DO concentrations at site W-M422.4E were all above 5 mg/L, with minimal diurnal oscillations, while at sites W-M422.5C and W-M422.7F values below 5 mg/L were measured. During the January 29, 2009 deployment at site W-M422.5C, on approximately 21 days of the 39-day deployment, DO concentrations were likely below 5 mg/L. During the February 4, 2010 deployment (33-days) at site W-M422.7F, except for a few hours at the beginning and end, all DO concentrations were below 5 mg/L. During all three of these deployments, snow-covered ice was present.

Of the three lotic sites monitored, W-M422.3I is the closest to the main channel of the Mississippi River and exhibited the highest velocity measurements. Velocities at times here are sufficient to move considerable amounts of bed material. This was evident during the summers of 2008 and 2009 when discharge was high and during a two-week deployment the continuous monitor here was buried under several inches of sand.

5. CONCLUSIONS

Pre-project baseline water quality monitoring has been performed at six Huron Island sites dating back to May 31, 2006. The period of record for each sampling site varies, with the longest at site W-M422.5C (May 31, 2006 to the present). Monitoring has been accomplished through the collection of discrete grab samples, as well as by utilizing continuous monitors. The results indicate that three of the sites are lentic in their water quality characteristics (W-M422.5C, W-M422.4E and W-M422.7F), while the remaining three are lotic (W-M422.7E, W-M422.2G and W-M422.3I). The grab sample results indicate that on occasion, DO concentrations below 5 mg/L were measured in Huron Island backwater areas during both winter and summer months. Results from continuous monitors have also shown that extended periods of low DO can occur during either summer or winter. Supersaturated DO concentrations, typically accompanied by high pH values, can occur during both the summer and winter months. These conditions are typically indicative of intense algal photosynthesis.

Dredging of channels in Huron Island would allow for an increased volume of DO in these areas, thus affording fish a better chance for survival, particularly during periods of extended ice and snow cover. Dredging would also provide fish escape routes during the winter in areas that currently freeze to the bottom. During the summer months, dredge channels in lentic areas would stratify, providing cooler temperatures near the bottom for fish and other aquatic life, whereas during the colder months, these areas would provide warmer water preferred by overwintering fish.

If post-construction monitoring indicates DO concentrations are insufficient to support aquatic life in Goose Lake Pools 1 and/or 2, additional flow may be required to these backwater areas to increase DO concentrations to acceptable levels. This could be accomplished by dredging connecting channels between Huron Chute and Goose Lake Pool 2 and/or Gun Slough and Goose Lake Pool 1. Adaptive management strategies are discussed in detail in Appendix K.

Appendix F
Water Quality

Table F-1. Water Quality Monitoring Results From Samples Collected at Site W-M422.5C

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
5/31/2006	0.955	1.01	26.4	7.54	8.20	32.0	52.1	64
6/13/2006	0.640	3.43	23.1	8.80	8.20	25.0	46.8	52
6/27/2006	0.480	-	25.0	10.66	8.70	25.0	48.6	89
7/11/2006	0.480	-	27.0	5.19	8.20	-	30.5	33
7/25/2006	0.340	0.64	29.1	10.75	8.70	24.0	27.5	71
8/8/2006	0.460	1.46	26.4	5.27	8.20	26.0	52.6	110
8/22/2006	0.350	0.61	26.4	7.34	8.30	24.0	33.1	42
9/6/2006	0.380	2.33	22.6	7.81	8.40	19.4	37.3	41
12/27/2006	0.440	1.53	3.8	16.78	8.40	-	15.7	24
2/12/2007	0.470	0.57	0.4	10.20	7.50	-	16.7	21
3/30/2007	1.775	0.97	13.2	6.35	7.20	57.0	13.9	7
6/12/2007	0.710	-	26.6	14.21	8.60	27.5	34.6	72
6/27/2007	0.630	-	30.1	7.79	8.50	20.0	24.1	100
7/10/2007	0.525	-	29.8	11.22	8.50	16.0	48.5	120
7/24/2007	0.390	-	29.0	10.72	8.60	16.0	110.0	110
8/7/2007	0.462	3.41	30.5	6.76	8.40	14.8	137.0	170
8/21/2007	0.630	0.98	25.9	6.46	8.30	25.5	54.0	54
9/5/2007	0.960	1.65	26.8	6.32	7.70	38.0	19.9	26
9/18/2007	0.540	-	23.2	6.60	8.10	29.0	29.5	38
12/20/2007	0.640	-	1.1	24.24	8.40	-	11.8	15
2/7/2008	0.810	0.43	1.0	18.19	8.00	-	20.6	13
3/26/2008	1.450	2.88	7.6	11.25	7.50	26.0	76.4	48
6/10/2008	2.740	47.68	21.8	6.36	7.70	29.0	62.4	56
7/2/2008	2.520	21.34	23.9	6.71	7.80	29.0	37.0	41
7/15/2008	1.595	0.64	29.2	8.53	7.80	32.5	26.2	24
7/29/2008	0.890	1.19	28.7	11.45	7.50	32.5	25.6	24
8/12/2008	0.560	3.13	26.0	5.21	7.80	44.0	19.9	13
8/26/2008	0.520	2.08	27.8	7.17	8.40	29.0	21.7	15
9/9/2008	0.510	0.58	21.9	11.47	-	26.0	32.1	17
9/23/2008	0.530	5.66	24.4	8.35	-	27.0	23.0	22
12/29/2008	1.335	0.76	1.6	17.83	8.00	-	6.2	-
1/29/2009	1.010	0.30	0.6	0.72	7.40	-	9.9	-
3/9/2009	1.610	0.32	6.0	16.39	8.40	37.0	21.4	-
6/2/2009	1.000	0.53	21.2	7.20	7.80	25.0	63.2	79
6/16/2009	0.994	1.36	24.2	-	8.80	18.6	45.1	45
6/30/2009	0.762	0.40	25.5	-	7.92	16.0	108.0	134
7/14/2009	0.714	0.30	26.3	-	8.53	14.0	98.5	113

Table F-1 (cont). Water Quality Monitoring Results From Samples Collected at Site W-M422.5C

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
7/28/2009	0.654	0.72	28.4	10.56	8.50	17.0	41.6	78
8/11/2009	0.650	1.14	29.6	13.30	8.70	16.0	46.9	64
8/25/2009	0.608	1.44	26.8	11.33	8.50	11.0	63.7	116
9/9/2009	0.550	1.67	25.3	10.25	8.40	18.2	19.6	23
12/21/2009	0.910	0.09	3.0	17.88	8.20	-	7.9	-
2/4/2010	1.220	0.09	0.5	14.40	7.60	-	14.7	-
3/10/2010	0.880	0.10	1.2	16.70	8.10	-	3.2	-
6/2/2010	0.930	-	25.0	8.84	8.00	24.0	26.6	62
6/15/2010	1.295	-	25.9	4.45	7.80	27.5	32.4	42
6/29/2010	2.320	-	24.7	5.74	7.80	28.5	30.0	36
7/13/2010	2.140	-	24.8	6.03	7.90	39.5	25.0	31
7/27/2010	3.035	-	26.3	5.01	7.50	34.5	37.4	38
8/11/2010	1.570	-	27.6	8.17	7.90	37.5	20.6	23
8/24/2010	1.680	-	26.5	6.55	7.70	22.8	29.9	-
9/8/2010	0.840	-	20.5	6.33	7.80	26.0	54.1	-
12/21/2010	1.150	0.11	1.4	11.65	7.70	-	9.7	-
2/14/2011	1.300	0.41	0.4	10.90	7.60	-	18.3	-
3/2/2011	1.250	0.64	3.0	6.96	7.10	-	7.0	-
6/7/2011	2.170	7.65	26.3	6.37	7.70	32.4	19.6	20
6/21/2011	1.690	-	23.8	6.61	7.70	25.0	52.0	51
7/6/2011	1.800	0.12	27.5	8.25	8.20	26.4	22.9	28
7/19/2011	1.100	0.93	31.0	8.42	7.98	20.0	34.6	51
8/2/2011	2.050	6.71	28.9	5.94	7.60	31.0	36.7	36
8/16/2011	1.190	0.97	25.1	4.53	7.80	24.0	66.5	60
8/30/2011	0.690	0.92	24.7	6.77	8.10	15.0	74.6	122
9/13/2011	0.560	-	22.6	4.32	7.80	13.0	67.1	115
12/21/2011	0.630	0.31	4.2	10.11	7.90	60.0	7.2	-
2/1/2012	0.540	1.35	3.3	26.32	9.10	-	5.3	-
3/13/2012	0.760	2.24	11.8	13.45	8.90	27.0	15.5	-
MIN.	**0.340**	**0.09**	**0.4**	**0.72**	**7.10**	**11.0**	**3.2**	**7**
MAX.	**3.035**	**47.68**	**31.0**	**26.32**	**9.10**	**60.0**	**137.0**	**170**
AVG.	**1.030**	**2.83**	**19.9**	**9.59**	**-**	**26.6**	**36.8**	**56**
MEDIAN	**0.825**	**0.97**	**24.9**	**8.25**	**8.00**	**26.0**	**30.0**	**44**

Table F-2. Water Quality Monitoring Results From Samples Collected at Site W-M422.7E

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
12/27/2006	1.150	5.51	2.9	17.00	8.40	47.0	12.4	14
2/12/2007	1.150	1.07	0.1	14.70	7.70	-	3.7	4
3/30/2007	2.680	65.54	13.0	8.28	7.30	35.0	26.6	-
6/12/2007	1.655	-	26.4	10.67	7.70	24.5	30.1	51
6/27/2007	1.295	-	27.4	7.37	8.00	19.5	51.6	85
7/10/2007	1.220	-	29.4	12.40	8.80	32.0	27.8	32
7/24/2007	1.245	-	28.3	14.46	9.00	24.0	31.3	46
8/7/2007	1.330	1.86	30.7	5.13	8.10	26.2	28.5	-
8/21/2007	1.325	6.54	26.3	6.52	8.10	25.5	34.4	85
9/5/2007	1.850	21.23	26.4	7.32	8.00	30.5	27.9	40
9/18/2007	1.280	9.14	22.4	12.24	8.70	31.0	33.6	44
12/20/2007	1.400	-	0.2	16.94	8.10	-	5.9	5
2/7/2008	1.550	6.20	0.2	16.48	8.00	-	7.9	3
3/26/2008	2.280	41.61	6.1	12.89	7.60	36.0	72.7	53
6/10/2008	3.790	89.68	22.1	6.41	7.60	32.0	58.5	57
7/2/2008	3.190	42.16	23.9	6.57	7.80	28.0	40.1	43
7/15/2008	2.345	43.31	25.8	5.91	7.80	20.4	83.4	95
7/29/2008	1.710	16.25	27.2	11.45	8.00	30.0	44.2	43
8/12/2008	1.320	2.23	25.8	14.92	8.80	22.0	47.3	40
8/26/2008	1.510	2.29	27.6	13.90	9.30	23.0	46.0	37
9/9/2008	1.390	3.68	21.4	9.00	-	23.0	38.0	31
9/23/2008	1.330	3.24	23.4	8.58	-	18.0	52.0	36
12/29/2008	2.140	13.99	0.1	15.05	8.00	-	43.8	-
1/29/2009	1.850	7.51	0.1	16.15	7.80	-	4.1	-
3/9/2009	2.445	41.33	4.2	13.64	7.70	7.0	603.0	-
6/2/2009	1.700	18.93	20.2	7.49	7.80	11.2	90.4	102
6/16/2009	1.710	16.36	21.8	-	8.00	13.8	71.1	78
6/30/2009	1.472	11.88	25.1	-	8.14	15.0	59.4	83
7/14/2009	1.670	10.63	24.6	-	8.25	14.4	45.7	64
7/28/2009	1.348	10.41	27.2	12.46	8.60	18.4	45.2	59
8/11/2009	1.380	5.30	28.3	10.74	8.60	20.1	46.4	54
8/25/2009	1.344	8.91	27.1	18.57	9.00	19.0	36.5	50.0
9/9/2009	1.148	6.04	24.5	16.36	8.80	21.6	35.9	49.0
12/21/2009	1.600	8.85	0.1	15.49	8.30	-	6.0	-
2/4/2010	1.850	18.39	0.1	13.63	7.80	-	8.9	-
3/10/2010	1.805	22.13	3.5	12.00	7.70	-	83.9	-
6/2/2010	1.580	-	25.0	6.58	8.00	26.5	57.3	75.0

Table F-2 (cont). Water Quality Monitoring Results From Samples Collected at Site W-M422.7E

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
6/15/2010	2.085	-	23.3	6.08	7.90	24.5	113.0	150.0
6/29/2010	3.165	-	24.8	5.71	7.80	22.0	46.0	58.0
7/13/2010	2.910	-	24.9	6.06	7.80	35.5	28.6	43.0
7/27/2010	3.970	-	26.3	5.15	7.50	27.5	53.2	46.0
8/11/2010	2.615	-	27.1	6.32	8.00	23.5	79.1	125.0
8/24/2010	2.620	-	26.3	6.33	7.70	21.0	48.1	-
9/8/2010	1.610	-	20.7	7.48	7.80	27.0	51.2	-
12/21/2010	2.045	11.82	0.1	14.12	7.90	-	8.0	-
2/14/2011	2.090	11.40	0.1	13.32	7.60	-	4.3	-
3/2/2011	2.150	24.71	2.0	13.04	7.70	25.3	39.3	-
6/7/2011	3.120	52.11	25.1	7.29	7.90	19.0	32.4	54.0
6/21/2011	2.720	40.55	23.9	7.16	7.90	15.0	55.0	65.0
7/6/2011	2.680	49.14	27.6	7.01	-	19.8	41.5	69.0
7/19/2011	1.780	18.40	30.5	11.67	8.21	20.2	24.9	37.0
8/2/2011	2.800	59.35	28.7	5.61	7.60	19.0	42.4	59.0
8/16/2011	1.940	28.62	25.5	7.20	7.90	28.0	38.9	50.0
8/30/2011	1.440	4.95	24.9	7.58	8.30	33.0	14.3	22.0
9/13/2011	1.430	0.52	22.4	4.67	7.90	16.0	56.8	85.0
12/21/2011	1.500	3.71	3.3	13.09	8.30	85.0	4.2	-
2/1/2012	1.420	2.69	1.0	15.99	8.60	-	2.1	-
3/13/2012	1.370	3.72	8.9	15.15	8.80	47.0	8.1	-
MIN.	**1.148**	**0.52**	**0.1**	**4.67**	**7.30**	**7.0**	**2.1**	**3**
MAX.	**3.970**	**89.68**	**30.7**	**18.57**	**9.30**	**85.0**	**603.0**	**150**
AVG.	**1.905**	**19.42**	**18.4**	**10.61**	**-**	**25.6**	**48.8**	**55**
MEDIAN	**1.685**	**11.40**	**24.2**	**10.74**	**8.00**	**23.5**	**39.7**	**51**

Table F-3. Water Quality Monitoring Results From Samples Collected at Site W-M422.2G

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
5/31/2006	1.240	20.03	25.4	7.55	8.20	42.0	25.3	61
6/13/2006	0.820	17.64	22.6	10.71	8.50	48.0	13.3	27
6/27/2006	0.670	19.8	25.3	10.28	8.50	43.0	26.6	38
7/11/2006	0.370	0.5	26.5	3.83	8.10	-	7.3	14
7/25/2006	0.630	0.32	28.7	8.48	8.40	28.0	11.2	15
8/8/2006	0.580	4.41	27.1	8.01	8.80	38.0	37.5	60
8/22/2006	0.485	1.75	23.7	8.90	8.70	33.0	29.7	42
9/6/2006	0.635	3.40	21.3	10.14	8.30	41.5	14.6	17
12/27/2006	0.730	17.44	3.0	16.77	8.40	58.0	10.3	13
2/12/2007	0.700	4.61	0.1	16.78	7.80	-	3.9	9
3/30/2007	2.010	54.42	12.6	9.03	7.40	28.0	27.9	-
6/12/2007	1.000	-	25.3	9.35	7.30	32.5	47.7	98
6/27/2007	0.975	-	26.7	7.51	8.00	20.0	68.9	120
7/10/2007	0.770	-	30.0	13.26	8.90	34.5	21.2	31
7/24/2007	0.710	-	29.0	15.78	9.00	33.0	17.0	23
8/7/2007	0.600	3.39	31.6	10.13	8.50	58.2	11.6	28
8/21/2007	0.890	30.92	26.4	7.09	8.10	32.0	31.2	94
9/5/2007	1.000	29.25	26.0	8.01	8.10	31.0	34.8	73
9/18/2007	0.750	9.6	22.9	14.17	8.80	34.0	21.1	24
12/20/2007	0.990	-	0.1	17.70	8.20	-	5.3	1
2/7/2008	1.080	15.81	0.1	17.78	8.00	-	7.8	4
3/26/2008	1.780	50.82	5.2	13.79	7.70	26.0	92.2	70
6/10/2008	2.650	58.13	22.3	6.50	7.70	23.5	75.0	71
7/2/2008	2.420	39.23	24.1	6.63	7.80	28.0	44.5	61
7/15/2008	1.835	52.40	26.0	6.51	7.80	19.0	99.8	120
7/29/2008	1.070	31.91	26.7	11.15	8.00	27.0	51.2	64
8/12/2008	0.540	8.30	26.6	18.47	9.10	42.0	26.2	32
8/26/2008	0.720	2.85	27.1	14.37	9.40	24.0	32.3	36
9/9/2008	0.670	5.21	21.4	10.30	-	28.0	28.5	20
9/23/2008	0.585	7.56	25.3	13.03	-	26.0	41.3	37
12/29/2008	1.545	29.92	0.0	15.14	8.00	-	49.7	-
1/29/2009	1.050	12.77	0.0	16.76	7.90	-	5.2	-
3/9/2009	1.750	51.95	4.1	13.82	7.70	4.0	860.0	-
6/2/2009	0.965	30.00	20.1	7.92	7.90	16.2	82.0	117
6/16/2009	1.128	24.90	21.7	-	8.00	18.4	79.6	129
6/30/2009	1.062	24.98	25.1	-	8.22	10.3	71.3	102

Table F-3 (cont). Water Quality Monitoring Results From Samples Collected at Site W-M422.2G

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
7/14/2009	0.966	15.31	24.4	-	8.25	22.6	40.5	56
7/28/2009	0.848	17.93	23.0	10.08	8.50	23.0	50.4	76
8/11/2009	0.904	18.61	28.5	11.42	8.70	30.8	32.0	51
8/25/2009	0.776	11.23	27.4	18.36	9.00	22.0	48.0	110
9/9/2009	0.776	6.56	24.6	15.92	8.90	25.0	44.8	55
MIN.	**0.370**	**0.32**	**0.0**	**3.83**	**7.30**	**4.0**	**3.9**	**1.0**
MAX.	**2.650**	**58.13**	**31.6**	**18.47**	**9.40**	**58.2**	**860.0**	**129**
AVG.	**1.016**	**20.38**	**20.4**	**11.62**	**-**	**30.0**	**56.8**	**54**
MEDIAN	**0.890**	**17.54**	**24.6**	**10.51**	**8.20**	**28.0**	**32.0**	**51**

Table F-4. Water Quality Monitoring Results From Samples Collected at Site W-M422.3I

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
12/27/2006	0.800	43.13	2.4	15.35	8.20	35.0	23.7	45
2/12/2007	0.750	20.02	0.0	16.08	7.80	-	3.6	8
3/30/2007	2.210	71.5	12.5	9.57	7.50	31.0	46.3	98
6/12/2007	1.160	-	24.1	8.92	7.20	28.0	48.6	98
6/27/2007	1.240	-	25.8	7.13	8.00	22.0	80.0	160
7/10/2007	0.870	-	28.7	11.86	8.80	39.5	15.8	51
7/24/2007	0.580	-	27.0	16.39	9.20	29.5	24.2	55
8/7/2007	0.598	1.86	30.2	13.45	9.00	32.6	26.6	62
8/21/2007	1.115	62.63	26.1	6.56	8.10	29.0	48.7	120
9/5/2007	1.350	60.49	25.7	7.96	8.10	35.0	39.6	80
9/18/2007	0.950	30.79	21.3	12.41	8.80	43.0	24.5	50
12/20/2007	1.050	-	0.1	16.68	8.20	-	5.9	5
2/7/2008	1.245	31.1	0.0	16.58	8.00	-	9.9	5
3/26/2008	1.850	63.2	5.0	13.82	7.80	27.0	102.0	88
6/10/2008	2.660	71.4	22.1	6.50	7.70	20.0	106.0	110
7/2/2008	2.490	63.71	25.0	6.72	7.80	25.0	54.9	82
7/15/2008	1.880	64.86	25.7	6.61	7.90	17.5	113.0	130
7/29/2008	1.220	41.39	26.4	10.41	8.00	32.0	51.6	73
8/12/2008	0.940	34.8	25.8	13.48	8.90	31.0	48.8	71
8/26/2008	0.670	23.1	25.7	15.02	9.50	28.0	37.7	62
9/9/2008	0.810	21.86	21.5	10.31	-	23.0	46.3	60
9/23/2008	0.740	28.59	22.6	11.28	-	25.5	53.8	80
12/29/2008	1.810	51.83	-0.1	15.07	8.00	-	73.1	-
1/29/2009	1.320	34.36	-0.1	16.94	7.90	-	5.9	-
3/9/2009	1.820	63.19	4.0	13.80	7.70	3.0	950.0	-
6/2/2009	1.290	48.74	20.3	8.18	8.00	15.6	84.0	128
6/16/2009	1.262	49.52	21.6	-	8.00	15.2	95.4	139
6/30/2009	1.226	40.06	25.2	-	8.18	12.4	79.9	131
7/14/2009	0.986	26.46	24.1	-	8.17	13.6	87.8	115
7/28/2009	1.172	36.66	25.3	8.58	8.30	21.0	69.6	112
8/11/2009	1.060	40.17	27.2	9.53	8.50	22.0	47.2	78
8/25/2009	0.934	24.40	24.4	12.63	8.60	20.0	59.6	110.0
9/9/2009	0.718	24.42	22.8	12.03	8.60	29.8	37.3	68.0
MIN.	**0.580**	**1.86**	**-0.1**	**6.50**	**7.20**	**3.0**	**3.6**	**5**
MAX.	**2.660**	**71.48**	**30.2**	**16.94**	**9.50**	**43.0**	**950.0**	**160**
AVG.	**1.236**	**41.94**	**18.7**	**11.66**	**-**	**25.2**	**78.8**	**82**
MEDIAN	**1.160**	**40.12**	**24.1**	**11.95**	**8.10**	**26.3**	**48.7**	**80**

Table F-5. Water Quality Monitoring Results From Samples Collected at Site W-M422.4E

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
12/21/2009	0.850	0.57	1.2	20.25	8.50	-	6.5	-
2/4/2010	1.160	0.79	0.3	12.46	7.60	-	14.4	-
3/10/2010	0.920	0.44	1.1	16.97	9.00	-	3.7	-
6/2/2010	0.855	-	25	5.65	7.90	21.0	57.6	60
6/15/2010	1.260	-	25.1	6.04	8.00	29.5	37.1	47
6/29/2010	2.210	-	24.8	5.82	7.80	33.0	31	41
7/13/2010	2.035	-	25.4	5.70	7.80	35.0	24.9	32
7/27/2010	2.880	-	26.3	5.32	7.50	31.0	43.2	48
8/11/2010	1.560	-	27.5	8.33	8.20	39.5	21.4	22
8/24/2010	1.590	-	25.9	6.26	7.70	20.0	29.9	38
9/8/2010	0.750	-	20.0	6.78	7.90	22.0	39.5	60
12/21/2010	1.065	0.11	0.3	13.92	7.70	-	7.2	-
2/14/2011	1.160	0.31	0.1	12.56	7.60	-	23.2	-
3/2/2011	1.200	0.19	2.4	8.06	7.30	21.0	32.9	-
6/7/2011	1.980	2.72	25.1	6.79	7.80	21.0	32.9	42
6/21/2011	1.630	4.28	23.6	6.20	7.70	26.0	59	124
7/6/2011	1.710	3.77	28.2	8.26	8.10	26.6	27.1	30
7/19/2011	1.000	2.41	31.1	8.40	8.08	15.0	42.8	60
8/2/2011	1.900	4.88	28.4	5.20	7.60	22.0	47.1	52
8/16/2011	1.120	-	25.7	6.64	8.00	18.0	57.4	66
8/30/2011	0.600	0.46	25.1	6.13	8.10	14.5	57.5	100
9/13/2011	0.480	-	23.2	5.17	7.80	13.0	237	344
12/21/2011	0.540	1.08	4.2	-	8.5	46.0	6.6	-
2/1/2012	0.480	0.79	2.9	26.34	9.0	-	4.2	-
3/13/2012	0.690	1.21	11.9	15.88	8.9	13.0	29.1	-
MIN.	**0.480**	**0.11**	**0.1**	**5.17**	**7.30**	**13.0**	**3.7**	**22**
MAX.	**2.880**	**4.88**	**31.1**	**26.34**	**9.00**	**46.0**	**237.0**	**344**
AVG.	**1.265**	**1.60**	**17.4**	**9.55**	**-**	**24.6**	**38.9**	**73**
MEDIAN	**1.160**	**0.79**	**24.8**	**6.79**	**7.90**	**22.0**	**31.0**	**50**

Table F-6. Water Quality Monitoring Results From Samples Collected at Site W-M422.7F

Date	Water Depth (M)	Velocity (CM/SEC)	Water Temp (°C)	Dissolved Oxygen (MG/L)	pH (SU)	Secchi Disk Depth (CM)	Turbidity (NTU)	Suspended Solids (MG/L)
12/21/2009	1.310	0.16	2.7	18.83	7.80	-	7.4	-
2/4/2010	1.600	0.55		13.84	8.10	-	16.2	-
3/10/2010	1.290	0.45	0.7	6.15	7.00	-	3.7	-
6/2/2010	1.320	2.35	24.4	6.74	8.00	29.5	35.7	44
6/15/2010	1.710	-	25.1	5.53	7.90	37.0	35.7	36
6/29/2010	2.605	-	25.0	5.72	7.80	26.5	30	41
7/13/2010	2.505	-	24.9	5.56	7.70	34.5	24.6	32
7/27/2010	3.370	-	26.2	4.73	7.40	36.5	56.1	51
8/11/2010	2.020	-	27.8	8.13	8.10	39.5	22.4	24
8/24/2010	2.070	-	26.2	6.88	7.60	27.2	19.6	22
9/8/2010	1.210	-	21.5	7.92	7.70	26.0	38.5	44
12/21/2010	1.555	0.40	2.3	12.11	7.50	-	7.9	-
2/14/2011	1.650	0.26	0.8	12.09	7.60	-	6.3	-
3/2/2011	1.660	0.26	3.5	8.06	7.20	-	4.6	-
6/7/2011	2.480	7.96	25.0	6.63	7.90	24.6	24.7	41
6/21/2011	2.120	6.19	24.7	7.72	7.70	21.0	37	39
7/6/2011	2.200	2.43	27.8	10.10	-	34.2	23.9	34
7/19/2011	1.600	2.38	30.9	9.19	8.03	31.0	21.4	31
8/2/2011	2.330	5.49	28.4	4.68	7.50	19.0	24.2	42
8/16/2011	1.630	-	25.4	8.34	8.20	32.0	25.9	27
8/30/2011	1.095	-	25.1	6.80	8.10	20.0	33.8	53
9/13/2011	0.970	0.28	23.8	5.09	8.00	23.0	34.9	52
MIN.	**0.970**	**0.16**	**0.7**	**4.68**	**7.00**	**19.0**	**3.7**	**22**
MAX.	**3.370**	**7.96**	**30.9**	**18.83**	**8.20**	**39.5**	**56.1**	**53**
AVG.	**1.832**	**2.24**	**20.1**	**8.22**	**-**	**28.8**	**24.3**	**38**
MEDIAN	**1.655**	**0.55**	**25.0**	**7.30**	**7.80**	**28.4**	**24.4**	**40**

FIGURE F-1. PRE-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M422.5C FROM 1/29/09-3/9/09

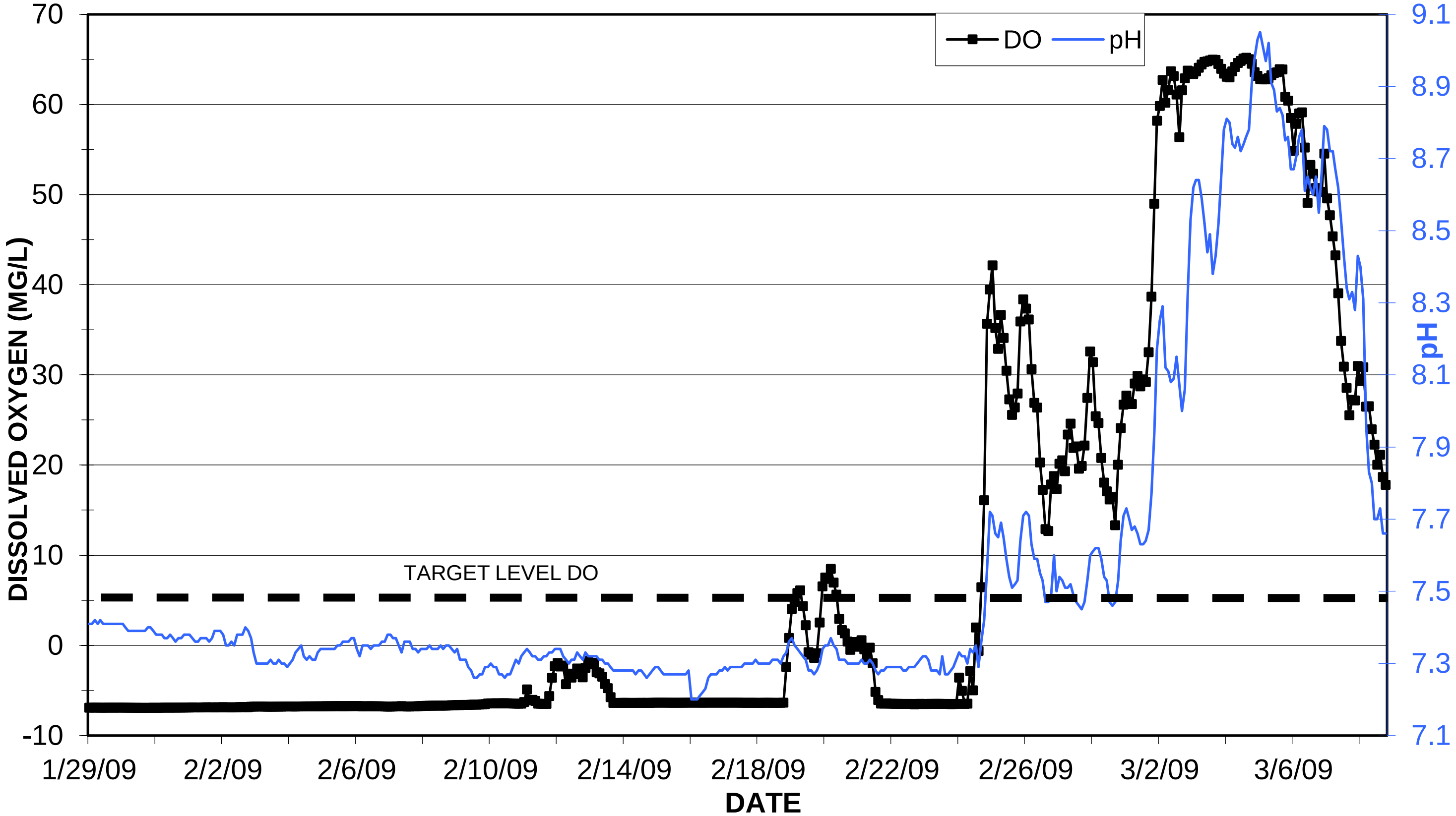


FIGURE F-2. PRE-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M422.5C FROM 6/15/10-6/29/10

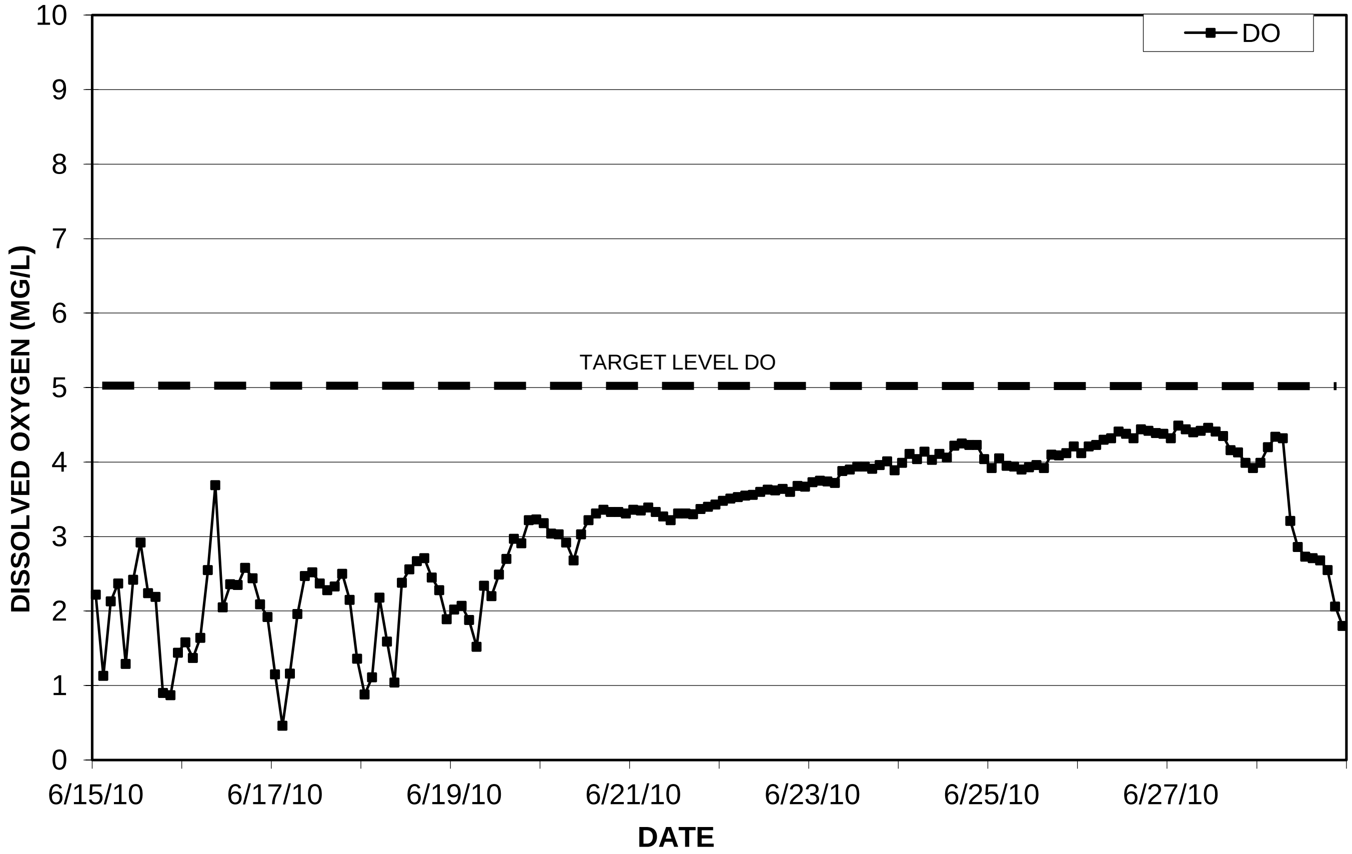


FIGURE F-3. PRE-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M422.7E FROM 8/30/11-9/13/11

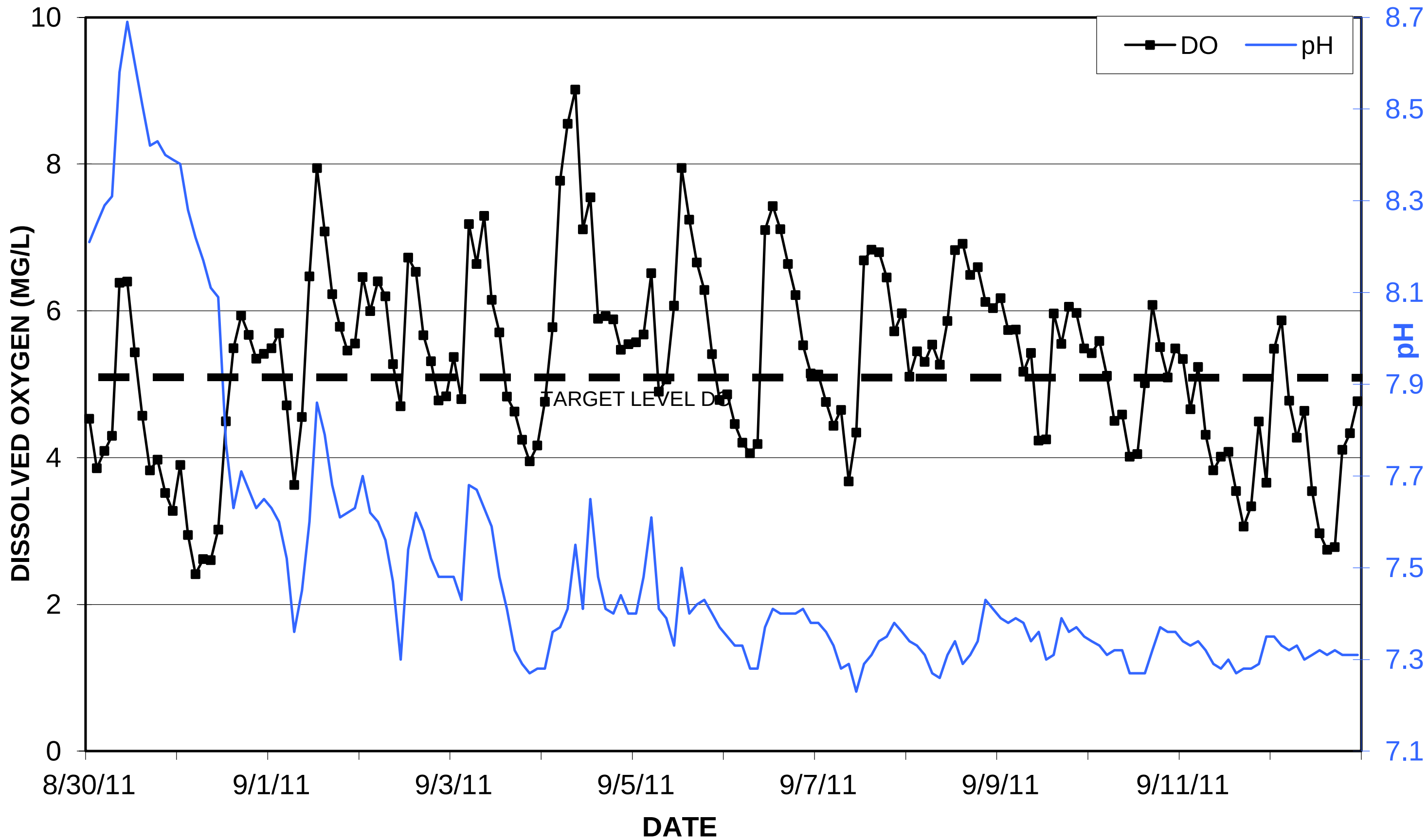


FIGURE F-4. PRE-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M422.2G FROM 7/11/06-7/25/06

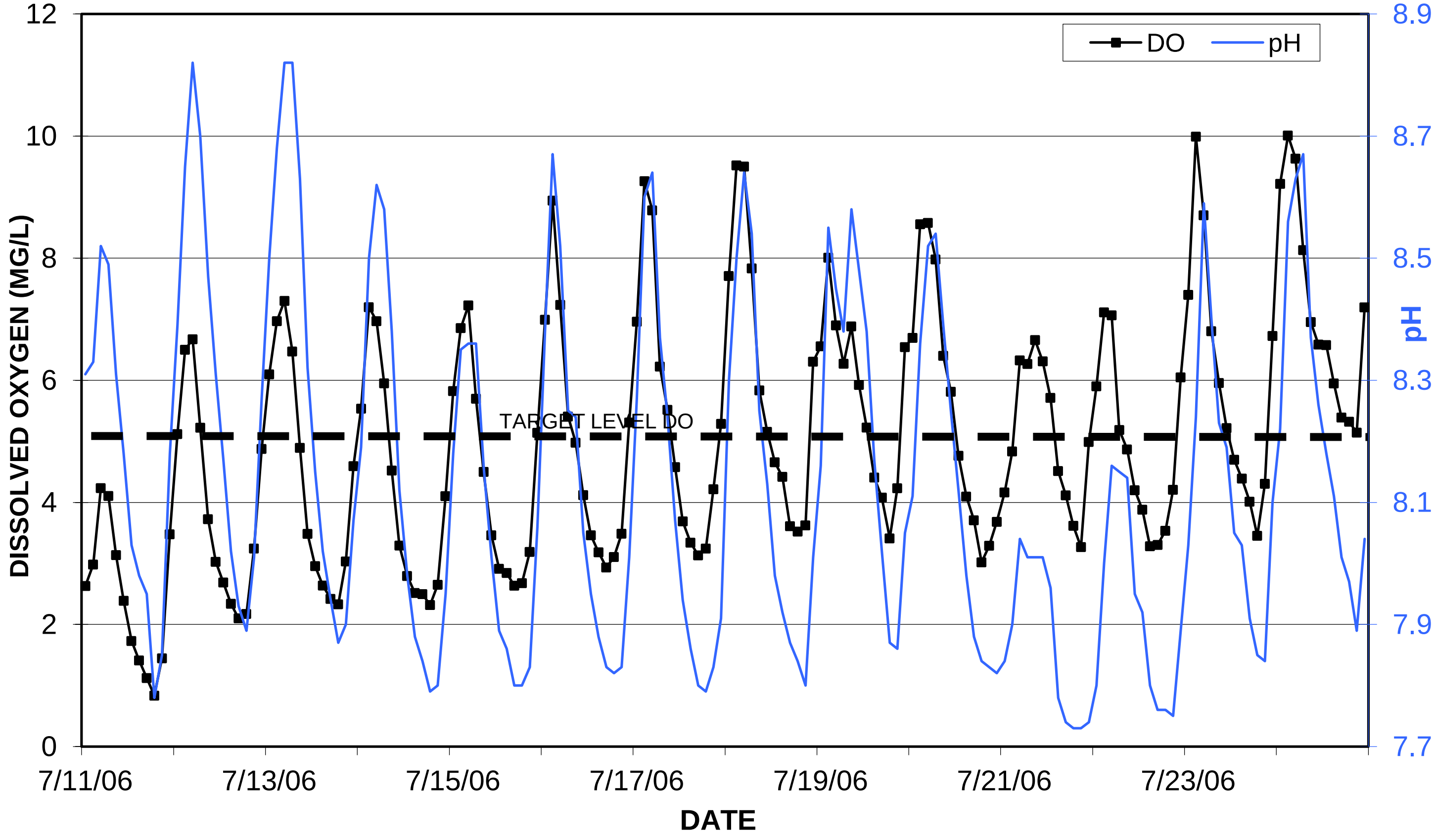


FIGURE F-5. PRE-PROJECT DISSOLVED OXYGEN VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITES W-M422.3I AND W-M422.5C FROM 6/27/07-7/10/07

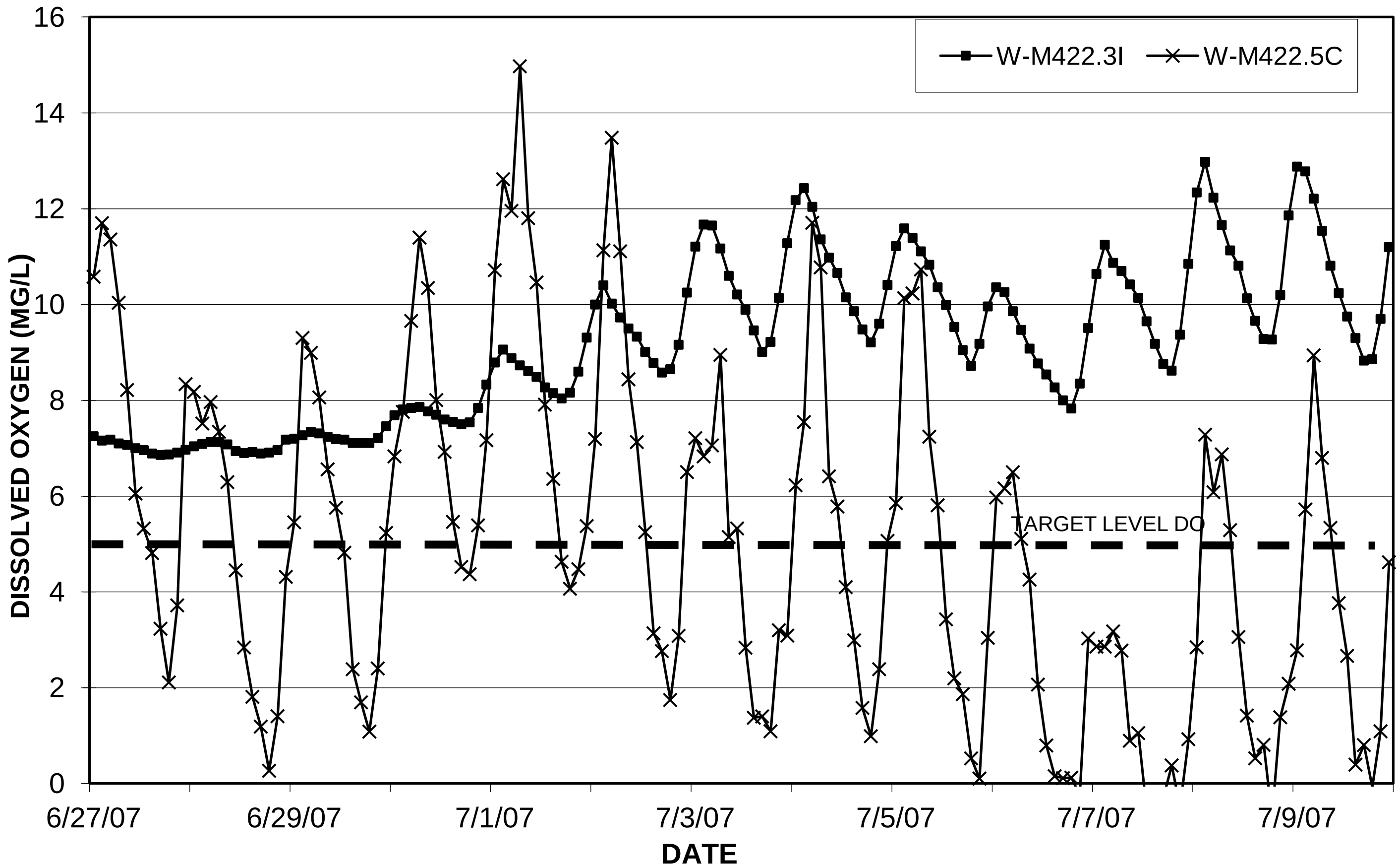


FIGURE F-6. PRE-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M422.4E FROM 2/14/11-3/2/11

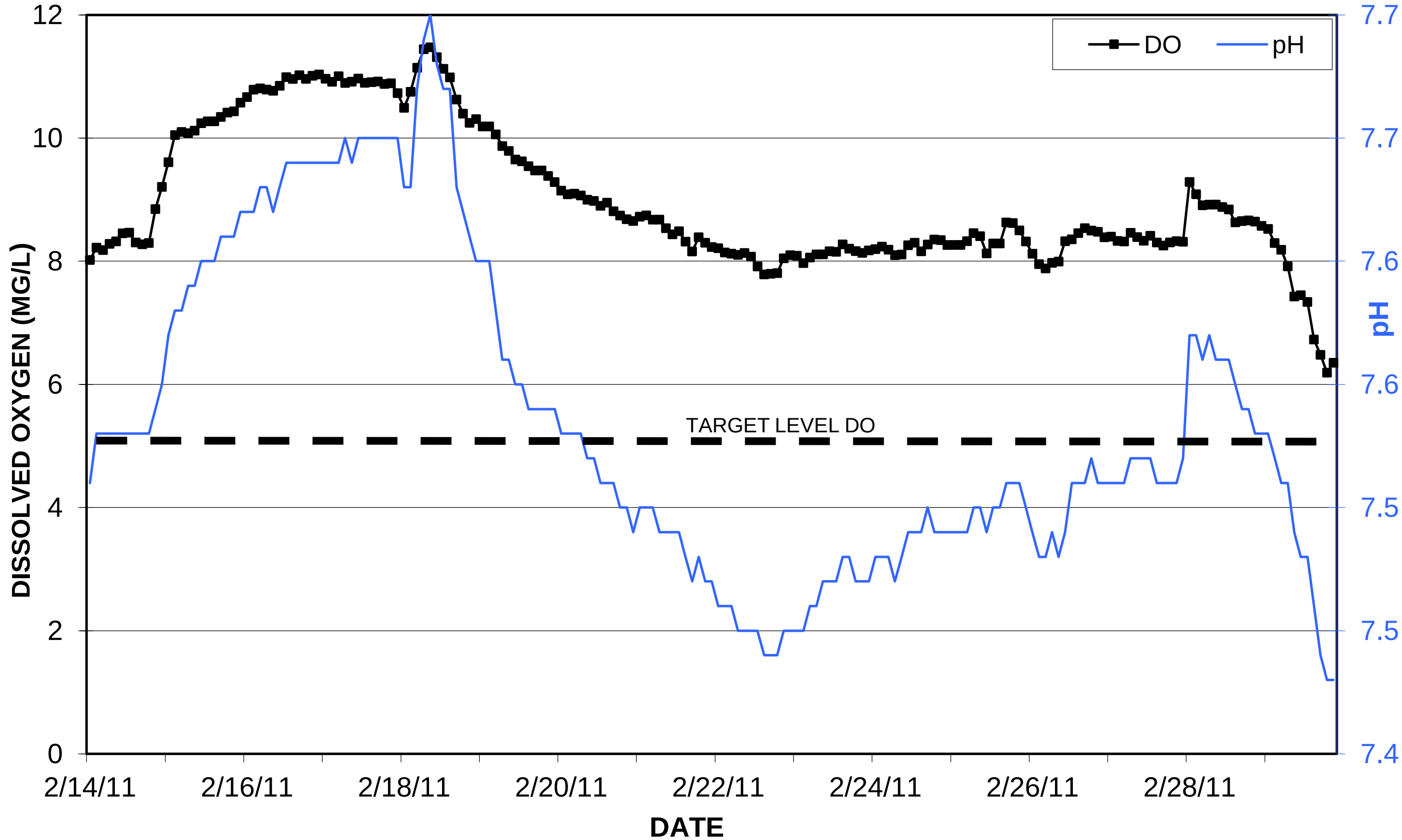


FIGURE F-7. PRE-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M422.7F FROM 7/27/10-8/11/10

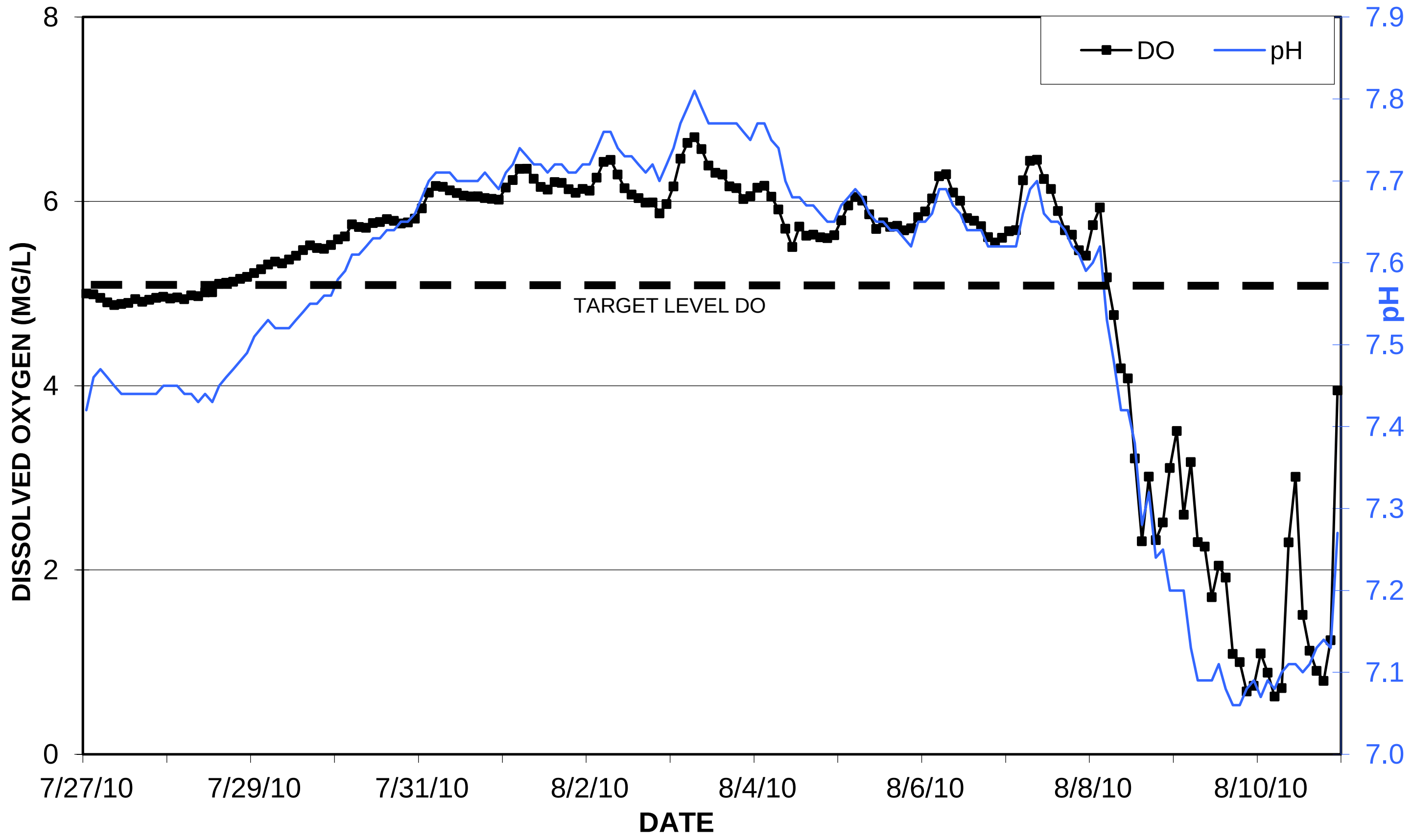
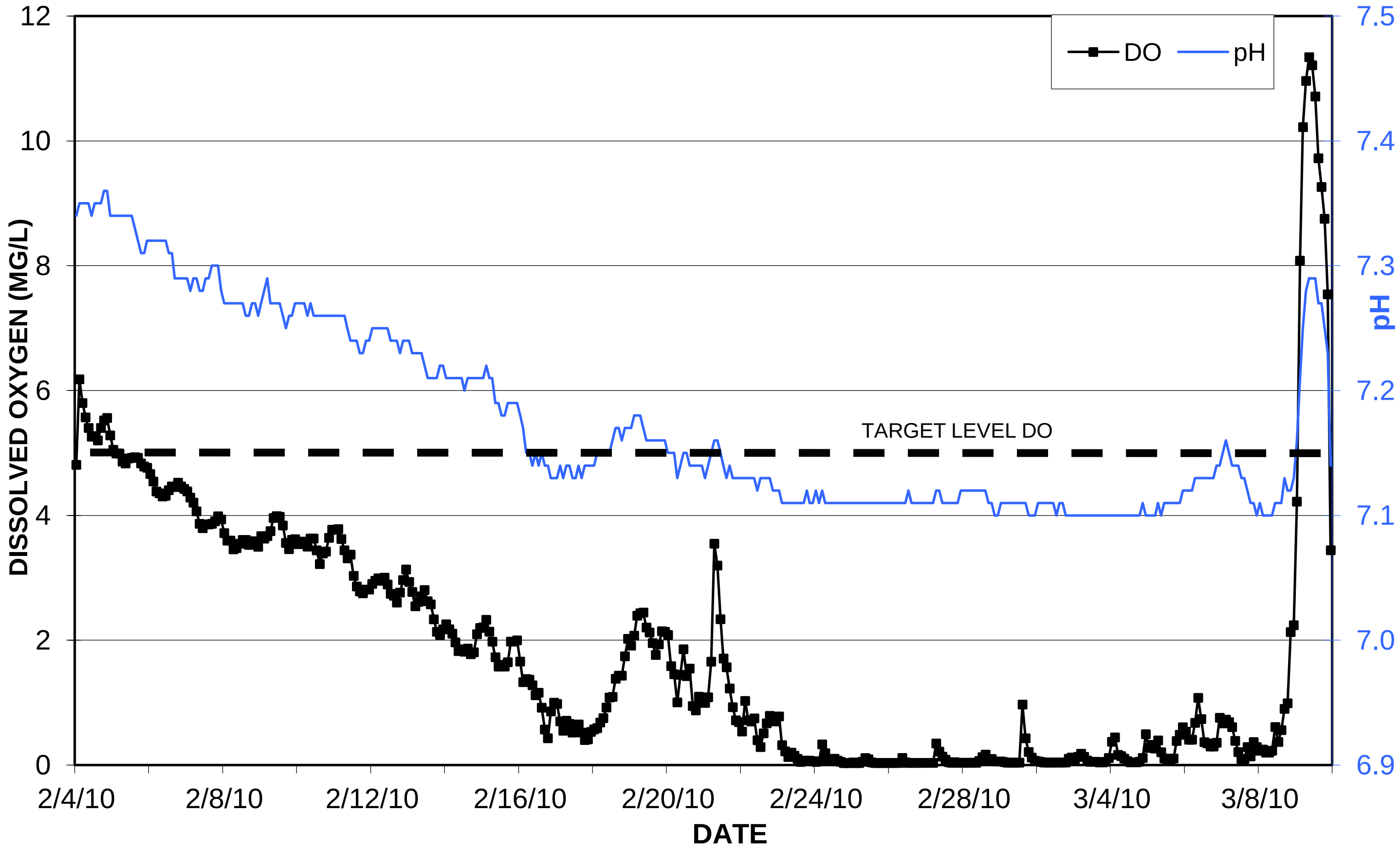


FIGURE F-8. PRE-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M422.7F FROM 2/4/10-3/10/10



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APPENDIX G

GEOTECHNICAL CONSIDERATIONS

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APPENDIX G

GEOTECHNICAL CONSIDERATIONS

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2.2. Dredge Pool G-1
2.3. Topographic Diversity Area G-1
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APPENDIX G-A SOFTWARE OUTPUT

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APPENDIX G

GEOTECHNICAL CONSIDERATIONS

1. PURPOSE AND SCOPE

This appendix presents the general geology and specific geotechnical analysis pertinent to the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project). Geologic information was obtained from publications produced by the Iowa Geological Survey. Detailed soils information was obtained from borings collected under the direction of the U.S. Army Corps of Engineers, Rock Island District (District) which also performed the laboratory interpretation of the samples. Additional soils information was obtained from a pre-published county soil survey obtained from the Illinois Department of Natural Resources in Des Moines County.

2. DESCRIPTION OF PROJECT GEOTECHNICAL FEATURES

2.1. Dredged Channel. Dredging a channel develops diversity in fisheries, allows flow of water to into dredge pools/restored areas. Channels current depth stands between 1.5 to 2.5 feet from normal pool, proposed dredge cuts will extend the bottom down to 15 feet from normal pool.

2.2. Dredge Pool. Dredging a pool provides diversity in ecosystem, borings were taken at proposed locations to describe the foundation material present.

2.3. Topographic Diversity Area. This feature allows for different types of trees species to develop within selected area.

2.4. Bank Protection. Bank protection is proposed and designed in order to control erosion of the islands in the Project area.

2.5. Water Control Structure. This feature allows water to flow into the restored channels and other dredged areas.

3. LOCATION

The Huron Island is located in Des Moines County, Iowa, southeast of Oakville, Iowa. The site is located on the Mississippi River approximately from river mile 422.0 to 425.0.
.

4. PHYSIOGRAPHY

The Project area is situated within the Dissected Till Plains Section of the Central Lowlands Province of the Interior Plains. The Project area has little topographic relief and consists of shallow backwaters, bottomland, and islands that are subject to permanent high water tables and annual flooding

5. GEOLOGY

The Project lies entirely within the Mississippi River flood plain which consists of alluvial soils at and near the surface and glacial deposits at depths. The surface stratum is usually clay varying in thickness from about 3 to 20 feet. This is underlain by a sand and gravel stratum which extends to an intermittent glacial till clay at a depth of 40 to 80 feet or to bedrock at a depth of 120 to 160 feet.

6. SURFICIAL SOILS

The United States Department of Agriculture (USDA) publishes soil surveys for most counties in the United States. Information contained in these reports pertains to soil within 5 feet of the surface. These soils are mapped by soil series. A soil series is a group of soils having almost identical profiles. All soils of a particular series have horizons that are similar in compositions, thickness, and arrangement. Information in a pre-published soil survey indicated that the types of soils that are present in and around Huron Island generally classify as fluvaquent soil series, which is described as an alluvium product in the USDA classification system. This series is described as frequently flooded and water table is said to vary between ground surface and 1 foot deep.

7. SUBSURFACE EXPLORATIONS

The District conducted an extensive subsurface exploration to characterize the composition and engineering properties of soils present at Huron Island. Borings were taken at locations shown on sheet B-101 in Appendix P, *Plates*. .

On each boring, samples were taken at sufficient intervals to classify all the strata encountered. Representative samples were taken for visual classification, moisture content on enough samples to verify classifications. Boring logs can be found on sheets B-301 and B-302 in Appendix P, *Plates*. .

Borings HI-11-01 through HI-11-08 were hand-augers taken from a boat to characterize soils that have been deposited in the proposed dredge areas and channels. Borings were approximately 12.5 feet deep. Borings throughout the proposed dredge areas showed similar types of materials, below ground surface, a combination of soft lean clays (CL) and soft silts (MH) showing gradual change into firm fat clay (CH) with increased depth. Underlying this clay layer down to bottom of the hole is clayey sand approximately 4-9 feet down from ground elevation. For borings performed in channels the soft fat clay strata is thinner, as clayey sand was found as shallow as 4 feet below ground surface. Clays throughout the site consistently classify as fat clay with liquid limits ranging between 82 and 61, and plastic limits between 29 and 15.

Borings HI-11-09 through HI-11-12 were taken throughout Cody Chute in order to determine how much sediment material was deposited in this area in order to potentially include dredging in this area as an added feature in order to restore the chute. The majority of these borings showed coarse grain soils in the immediate bottom of the chute and beyond, although in HI-11-12 a thin layer of clay was found in the fine grain sand. After documenting the findings in Cody Chute it was determined by the team that the average water velocities throughout the chute did not grant enough time for the fine grain sediment to settle before being moved downstream, hence only coarse grain soils were present. Plans for any kind of action on Cody Chute have ceased, and are not detailed in the current proposal. The soil characterization of Cody Chute was made possible with the use of a sand tube, coupled with a check valve, this allowed coarse grain soil samples in water to be taken.

Borings HI-12-13 through HI-12-16 were performed in the proposed topography diversity area. This area is characterized by a top layer of clay, with several arrangements throughout the site as several minor stratification breaks were noted averaging approximately 10 feet in depth before getting into sand. This top layer, a combination of firm lean clays and fat clay constitute a proper foundation for the proposed loading arrangement, therefore no major settlement issues are expected. Similar borings were performed on the areas expected to be used as dredged material disposal. These borings, HI-12-17 through HI-12-20 revealed similar materials to the one encountered in the proposed topography diversity area, with mostly clayey soils on the top layer with some minor variations in the strata and properties. The difference being the presence of some sand mixed in the varied minor stratifications of the clay top layer. Underlying this clay strata, which varied from 6 to 10 feet in depth, is fine sand.

Borings HI-12-21 through HI-12-23 were performed in the general area were embankment protection is being proposed, in order to identify the underlying soils and what kind of interaction can be expected once the load of the reinforcing stone is in place. These borings showed a very thin layer of clay material in contrast to previous inland explorations, the top clay layer varying from 2 feet to 8 feet. Tests on the sampled clay material exhibit liquid limits (42) close to its natural moisture content (40), denoting that some consolidation will be taking place, but due to the nature of the load no major issues are expected.

Borings HI-12-24 through HI-12-26 were performed in Huron Chute each located upstream of different island for which protection from erosion is being designed and proposed. All exploration showed no fine grained material, sand was found in all of them which were to be expected due to the high velocities of Huron Chute. The soil characterization of Huron Chute was made possible with the use of a sand tube, coupled with a check valve that allowed sampling of coarse grain soil under water.

8. SETTLEMENT

Settlement analysis was performed utilizing information gathered for this Project in order to determine future ultimate settlement amounts caused primarily due to stresses induced by the proposed topographic and forest diversity structures. The dimensions used capture the geometry where the fill material will be placed. Borings used to obtain the settlement parameters can be found in sheets B-301 & B-302.

The USACE software CSETT was used to do the modeling of the settlement; this tool utilizes stress induced equations derived from Boussinesq point load formulae integrated over general-shaped regions, for calculating vertical stress due to imposed loads, the stress induction equations are based on theory of elasticity. Ultimate settlement calculated by CSETT for a soil layer of a certain thickness and loading parameter is dependent on the stress-volume parameters of the soil. CSETT uses those parameters as input in terms of stress and void ratio, in addition the software takes in consideration Compression Index (c_c), Recompression index (c_r), Coefficient of Consolidation (c_v), Void Ratio (e), Pre-consolidation Pressure (σ'_p)of the subject soil layer in order to complete the modeling of settlement.

Parameters for settlement analysis were obtained from commonly used correlations by the engineering community. Such correlations were used due to the high cost involved in the performance of additional testing in order to obtain more accurate results in addition with the fact that the structure is one of low risk. Correlations used are as follows:

- $C_c = 0.009(LL - 10)$
- $C_r = 0.2Cc$
- (C_v) varies due to type of material
- Void ratio, *e*, were estimated from values as published in "Principles of Geotechnical Engineering" (Das, 2006, Table 3.2)

Results of the settlement analysis show 1 feet of settlement in the critical location (area with the most fill), this combined with a usual overbuilt of 0.5 feet means the designed cross section can be taken to 538.5 feet in order to compensate for expected settlement other potential issues brought by possible difference in materials than the one tested. Settlement throughout the section is depicted in figure G-1.

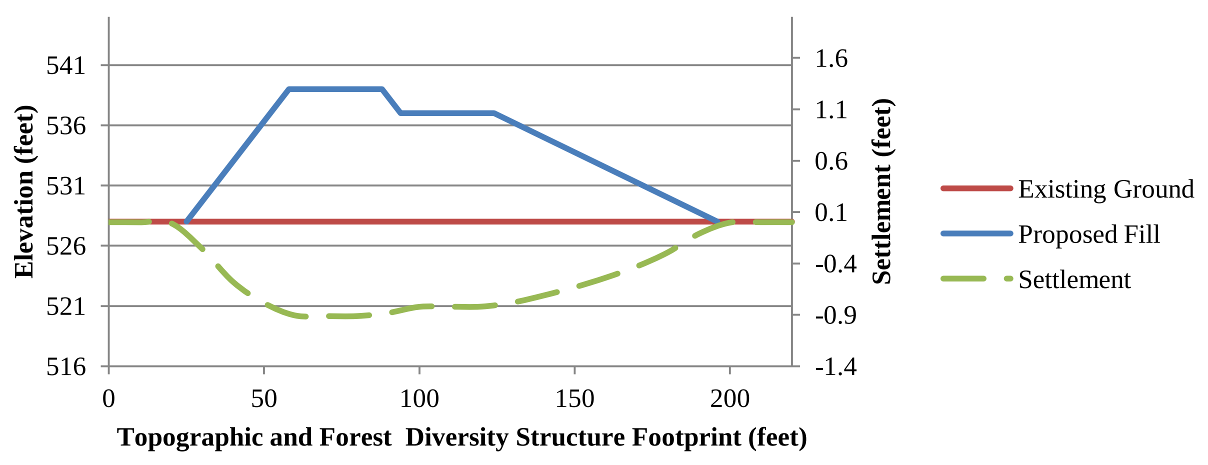

Figure G-1. Settlement Along the Topographic and Forest Diversity Structure

9. STABILITY ANALYSIS

The purpose of the stability analyses was to confirm the proposed design will provide adequate factors of safety under static loading conditions. Minimum factors of safety required on the cases analyzed obtained from Table 6-1b of the EM 1110-2-1913, January 2000 is summarized in table G-1

Table G-1. Minimum Required Factors of Safety for Stability Analysis

Analysis Condition	Required Minimum Factor of Safety (Spencer's Method)
End-of-Construction	1.3
Long-Term (Steady Seepage)	1.4

Analysis of the topographic and forest diversity structures was performed, built from dredge material with a height of approximately 7 feet throughout the entirety footprint of the structure, is important that such structure performs as design in order to keep the dredge material from sloughing back to the dredge cut. There were two different static loading conditions that were taken into consideration, still water level (flat pool) which is 528 feet, and water to the top of structure, which is 537 feet. Geometry used for the stability analysis is shown in figure G-2, taken from sheet C-301 in Appendix P, *Plates*. Underlying soils characteristics were derived from the explorations described on paragraph 7 of this document.

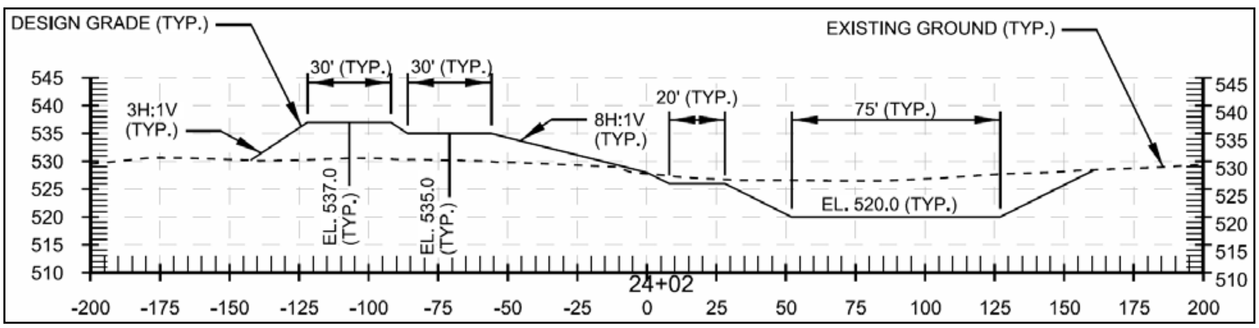

Figure G-2. STA 24-02, Geometry Used in the Performed Stability Analysis

Stability analyses were performed using Slope/W limit equilibrium software based on Spencer's method. Analyses were performed using the exit and entry method with the optimization feature turn on in order to determine the elevation of the failure surface producing the lowest factor of safety. Then it was later run and crossed checked with block specified surface again using the optimization feature to determine the lowest factor of safety (table G-2). Analyses were performed for water to Top of Structure/Project Grade (WPG), Still Water Level/Flat Pool (SWL) complying with Table 6-1b of the EM 1110-2-1913 January 2000. Shear strength and friction angle inputs in Slope/W were applied with the use of the non-spatial Mohr-Coulomb feature. Appendix G-A includes a screen capture and a detailed report on the software output.

Table G-2. Factors of Safety Obtained from Stability Analysis

Analysis Condition	Factor of Safety
End-of-Construction (WPG)	5.3
Long-Term/Steady Seepage (SWL)	3.5

10. MATERIALS

Riprap – 400 pound stone, gradations shall be Class A for IADOT or RR-5 for ILDOT.

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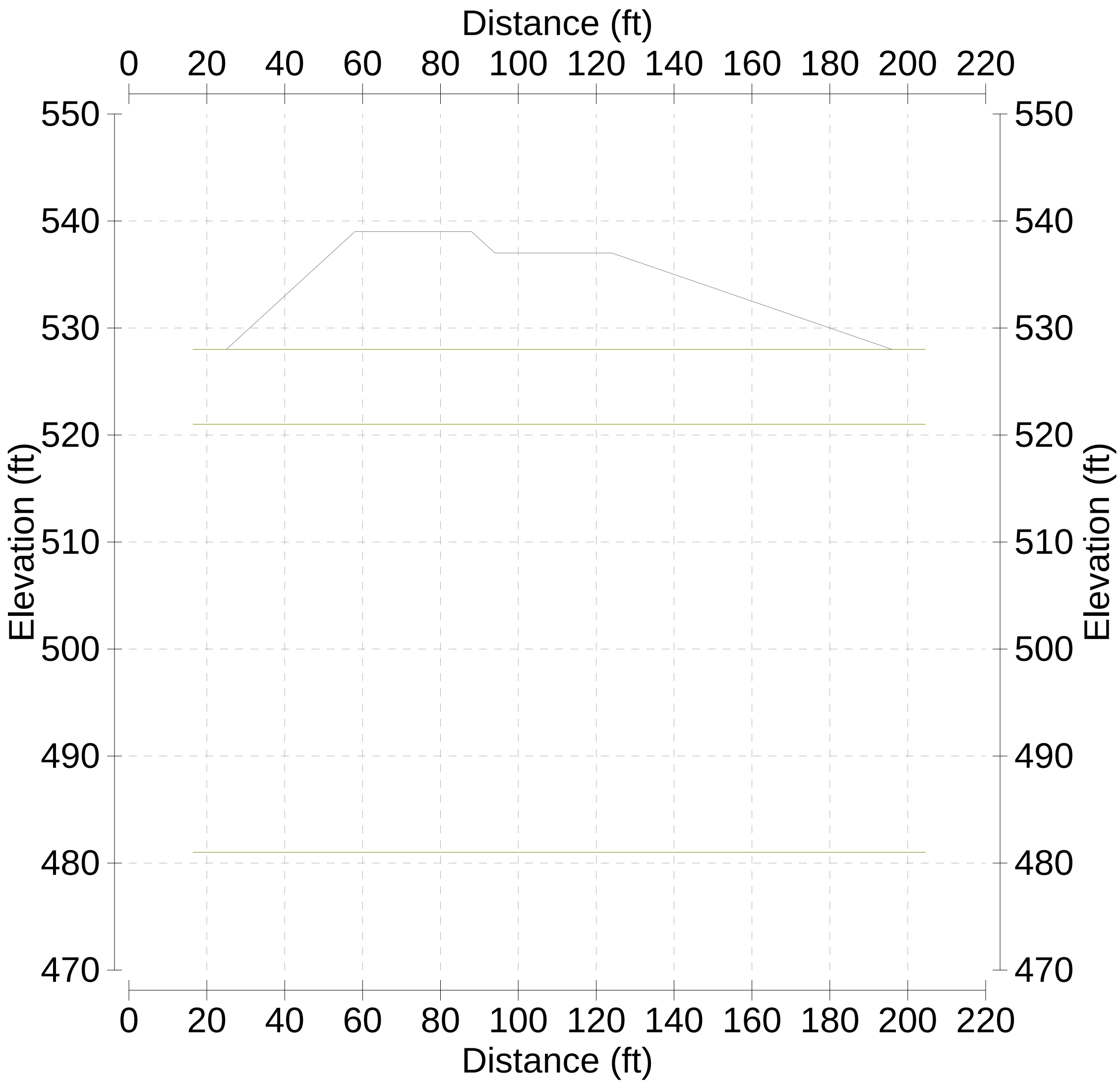
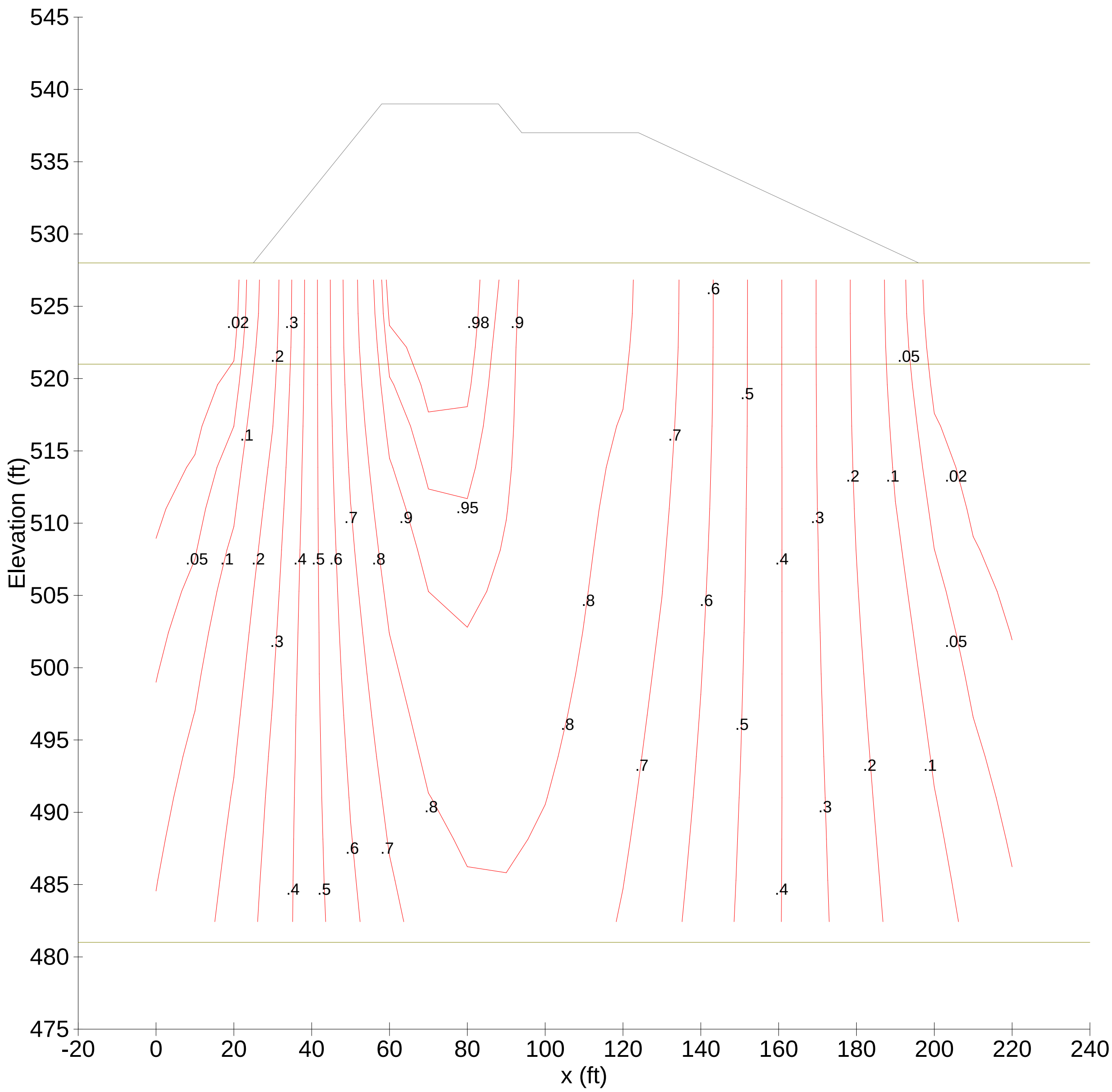
APPENDIX G-A

SOFTWARE OUTPUT

Plot of Input
Huron Settlement Calculation



Contours of Induced Vertical Stresses
Huron Settlement Calculation



Analysis Results

```
PROGRAM CSETT - VERTICAL STRESS INDUCTION AND SETTLEMENT PROGRAM
DATE: 26-SEP-2012                                  TIME: 15.01.09



I.  INPUT DATA



1. TITLE - Huron Settlement Calculation



2. BOUSSINESQ SOLUTION WILL BE USED TO COMPUTE INDUCED STRESSES.
   THE MAXIMUM DEPTH TO WHICH THE ANALYSIS WILL BE EXTENDED
   IS   47.00 FEET.



3. 2-DIMENSIONAL PRESSURE LOAD DATA
   NONE



4. 2-DIMENSIONAL SOIL LOAD DATA

  PROFILE NUMBER  1 :NUMBER OF POINTS=  6
                     BEGINNING TIME OF APPLICATION = 0.0000 YRS.
                     ENDING TIME OF APPLICATION =50.0000 YRS.
                     EFFECTIVE UNIT WEIGHT OF SOIL LOAD=  110.00 PCF


                     POINT NO.    X         Y
                                (FT.)     (FT.)


                         1      25.00    528.00
                         2      58.00    539.00
                         3      88.00    539.00
                         4      94.00    537.00
                         5     124.00    537.00
                         6     196.00    528.00



5. 3-DIMENSIONAL RECTANGULAR LOAD DATA
   NONE
```

6. 3-DIMENSIONAL IRREGULAR LOAD DATA
   NONE

7. EXCAVATION DATA
   NONE

8. SOIL DATA

STRATA NO.	EL. OF TOP OF STRATUM (FEET NGVD)	DRAINAGE CONDITION	EFF UNIT WEIGHT (PCF)	RECOMPR. INDEX	COEF.OF CONSOL. (SQFT/YR)	POISSON'S RATIO
1	528.00	D	115.00	0.08500	40.20000	0.32000
2	521.00	S	120.00	0.00010	0.00010	0.32000

9. STRESS-STRAIN DATA

```
            STRATUM NO.  1
            --------------
       COMPRESSION INDEX= 0.42300
     RECOMPRESSION INDEX= 0.08500
       INSITU VOID RATIO= 1.20000
       INSITU OVERBURDEN=  182.00 PSF

            STRATUM NO.  2
            --------------
       COMPRESSION INDEX= 0.00100
     RECOMPRESSION INDEX= 0.00010
       INSITU VOID RATIO= 0.50000
       INSITU OVERBURDEN= 2582.00 PSF
```

10. TIME SEQUENCE FOR CONSOLIDATION CALCULATIONS

A GEOMETRIC PROGRESSION WITH AN INITIAL TIME PERIOD OF 0.0192 YEARS AND A MULTIPLICATIVE FACTOR OF 2.0000 WILL BE USED IN THE TIME RATE OF CONSOLIDATION CALCULATIONS.

11. OUTPUT CONTROL DATA

XXL=   0.0000 FT.
XUL= 221.0000 FT.

DELX= 10.0000 FT.

.
1
PROGRAM CSETT - VERTICAL STRESS INDUCTION AND SETTLEMENT PROGRAM
DATE: 26-SEP-2012 TIME: 15.01.09

II. OUTPUT SUMMARY.

1. TITLE- Huron Settlement Calculation

POSITION: X= 0.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	0.37	0.000
2	27.00	3205.00	57.56	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.000	0.000	0.000	0.000

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000

2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.000	0.000	0.000	0.000

POSITION: X= 10.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	1.13	0.001
2	27.00	3205.00	98.37	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.001	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.001	0.000	0.000	0.000	0.000	0.000	0.000

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.000	0.000	0.000	0.000	0.000	0.001	0.001
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.000	0.000	0.001	0.001

POSITION: X= 20.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	7.50	0.009
2	27.00	3205.00	177.99	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.009	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.009	0.000	0.000	0.000	0.000	0.000	0.000

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.000	0.000	0.001	0.002	0.003	0.006	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.001	0.002	0.003	0.006	0.009

POSITION: X= 30.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	190.67	0.257
2	27.00	3205.00	334.36	0.000

3. TIME-SETTLEMENT SUMMARY.

STRATA NO	ULT	(SETTLEMENT IN FEET AT SPECIFIED TIMES) 0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.257	0.000	0.000	0.000	0.000	0.001	0.003
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.257	0.000	0.000	0.000	0.000	0.001	0.003

STRATA NO	(SETTLEMENT IN FEET AT SPECIFIED TIMES) 1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.006	0.013	0.025	0.050	0.100	0.202	0.257
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.006	0.013	0.025	0.050	0.100	0.202	0.257

POSITION: X= 40.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	550.33	0.580
2	27.00	3205.00	558.53	0.000

3. TIME-SETTLEMENT SUMMARY.

STRATA NO	ULT	(SETTLEMENT IN FEET AT SPECIFIED TIMES) 0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.580	0.000	0.000	0.000	0.000	0.003	0.006
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.580	0.000	0.000	0.000	0.000	0.003	0.006

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.013	0.027	0.056	0.113	0.229	0.455	0.580
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.013	0.027	0.056	0.113	0.229	0.455	0.580

POSITION: X= 50.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	913.20	0.786
2	27.00	3205.00	789.61	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.786	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.786	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.018	0.038	0.076	0.152	0.309	0.619	0.786
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.018	0.038	0.076	0.152	0.309	0.619	0.786

POSITION: X= 60.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	1191.20	0.907
2	27.00	3205.00	965.75	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.907	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.907	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.020	0.043	0.087	0.177	0.357	0.714	0.907
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.020	0.043	0.087	0.177	0.357	0.714	0.907

POSITION: X= 70.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)

1	3.50	402.50	1207.77	0.913
2	27.00	3205.00	1050.74	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.913	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.913	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.021	0.044	0.088	0.178	0.359	0.719	0.913
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.021	0.044	0.088	0.178	0.359	0.719	0.913

POSITION: X= 80.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	1207.00	0.913
2	27.00	3205.00	1072.81	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)

1	0.913	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.913	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.021	0.044	0.088	0.178	0.359	0.719	0.913
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.021	0.044	0.088	0.178	0.359	0.719	0.913

POSITION: X= 90.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	1127.60	0.882
2	27.00	3205.00	1043.39	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.882	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.882	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)

1	0.020	0.041	0.085	0.172	0.347	0.694	0.882
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.020	0.041	0.085	0.172	0.347	0.694	0.882

POSITION: X= 100.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	993.77	0.823
2	27.00	3205.00	992.30	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.823	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.823	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.019	0.038	0.079	0.160	0.323	0.648	0.823
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.019	0.038	0.079	0.160	0.323	0.648	0.823

POSITION: X= 110.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	989.93	0.822
2	27.00	3205.00	953.45	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.822	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.822	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.018	0.038	0.079	0.160	0.323	0.647	0.822
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.018	0.038	0.079	0.160	0.323	0.647	0.822

POSITION: X= 120.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	986.33	0.821
2	27.00	3205.00	907.84	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.821	0.000	0.000	0.000	0.001	0.004	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.821	0.000	0.000	0.000	0.001	0.004	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.018	0.038	0.079	0.159	0.323	0.645	0.821
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.018	0.038	0.079	0.159	0.323	0.645	0.821

POSITION: X= 130.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	905.30	0.782
2	27.00	3205.00	833.38	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.782	0.000	0.000	0.000	0.001	0.003	0.009
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.782	0.000	0.000	0.000	0.001	0.003	0.009

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.018	0.038	0.076	0.152	0.308	0.615	0.782
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.018	0.038	0.076	0.152	0.308	0.615	0.782

POSITION: X= 140.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	769.63	0.713
2	27.00	3205.00	730.74	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.713	0.000	0.000	0.000	0.001	0.003	0.007
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.713	0.000	0.000	0.000	0.001	0.003	0.007

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.016	0.034	0.068	0.139	0.281	0.560	0.713
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.016	0.034	0.068	0.139	0.281	0.560	0.713

POSITION: X= 150.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	632.37	0.633
2	27.00	3205.00	614.82	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.633	0.000	0.000	0.000	0.000	0.003	0.006
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.633	0.000	0.000	0.000	0.000	0.003	0.006

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.014	0.030	0.061	0.123	0.248	0.498	0.633
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.014	0.030	0.061	0.123	0.248	0.498	0.633

POSITION: X= 160.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)

1	3.50	402.50	495.00	0.540
2	27.00	3205.00	493.86	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.540	0.000	0.000	0.000	0.000	0.003	0.006
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.540	0.000	0.000	0.000	0.000	0.003	0.006

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.013	0.026	0.052	0.106	0.213	0.425	0.540
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.013	0.026	0.052	0.106	0.213	0.425	0.540

POSITION: X= 170.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	357.63	0.431
2	27.00	3205.00	373.09	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)

1	0.431	0.000	0.000	0.000	0.000	0.002	0.004
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.431	0.000	0.000	0.000	0.000	0.002	0.004

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.010	0.020	0.042	0.084	0.169	0.339	0.431
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.010	0.020	0.042	0.084	0.169	0.339	0.431

POSITION: X= 180.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	220.40	0.294
2	27.00	3205.00	257.86	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.294	0.000	0.000	0.000	0.000	0.001	0.003
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.294	0.000	0.000	0.000	0.000	0.001	0.003

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)

1	0.006	0.014	0.029	0.057	0.115	0.232	0.294
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.006	0.014	0.029	0.057	0.115	0.232	0.294

POSITION: X= 190.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	84.73	0.113
2	27.00	3205.00	156.95	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.113	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.113	0.000	0.000	0.000	0.000	0.000	0.000

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.003	0.005	0.011	0.022	0.045	0.088	0.113
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.003	0.005	0.011	0.022	0.045	0.088	0.113

POSITION: X= 200.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	3.77	0.004
2	27.00	3205.00	86.30	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.004	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.004	0.000	0.000	0.000	0.000	0.000	0.000

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.000	0.000	0.000	0.001	0.002	0.003	0.004
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.001	0.002	0.003	0.004

POSITION: X= 210.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	0.53	0.000
2	27.00	3205.00	49.16	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.000	0.000	0.000	0.000

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.000	0.000	0.000	0.000

POSITION: X= 220.0
****

2. SUMMARY OF ULTIMATE SETTLEMENTS.

STRATA NO.	MID-DEPTH OF STRATA (FEET)	IN-SITU OVERBURDEN (LB/SQ FT)	DELTA SIGMA (LB/SQ FT)	ULTIMATE SETTLEMENT (FEET)
1	3.50	402.50	0.17	0.000
2	27.00	3205.00	29.73	0.000

3. TIME-SETTLEMENT SUMMARY.

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

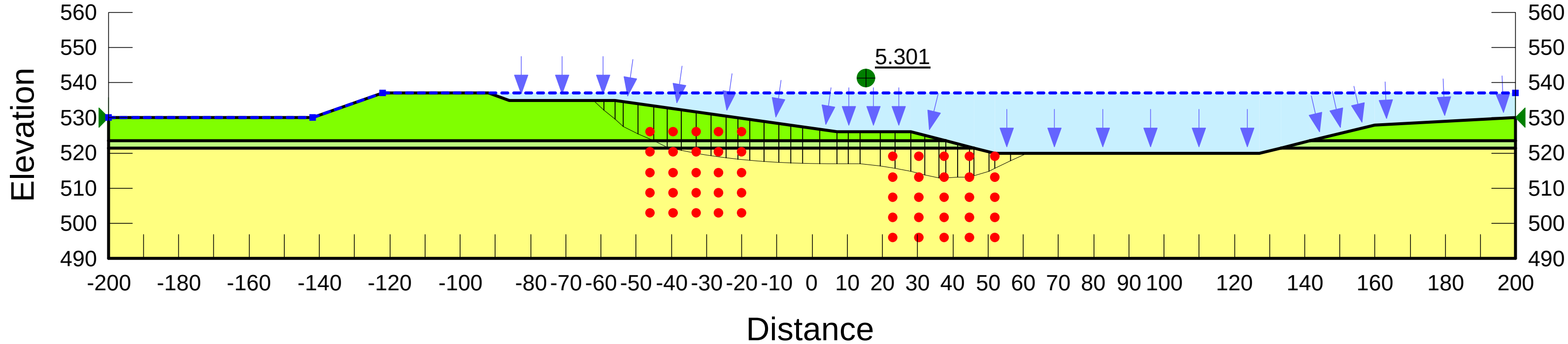
STRATA NO	ULT	0.02 (YRS.)	0.04 (YRS.)	0.08 (YRS.)	0.15 (YRS.)	0.31 (YRS.)	0.61 (YRS.)
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Analysis Results

(SETTLEMENT IN FEET AT SPECIFIED TIMES)

STRATA NO	1.23 (YRS.)	2.46 (YRS.)	4.92 (YRS.)	9.83 (YRS.)	19.66 (YRS.)	39.32 (YRS.)	78.64 (YRS.)
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTALS:	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Huron Island Habitat Rehabilitation and Enhancement Project
Des Moines County, IA
STA 24+02



Stability Analysis
Top of Structure (537 ft.)

Name: Soft Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 260 psf Phi: 0 ° Piezometric Line: 1
Name: Medium Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 460 psf Phi: 0 ° Piezometric Line: 1
Name: Sand Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1

Last Edited By: Castro, Felix R MVR
Date: 9/25/2012
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File Name: 20120925 24+02 Stability Analysis.gsz

SLOPE/W Analysis (H2O@537ft.)

File Information

Created By: Castro, Felix R MVR
Revision Number: 55
Last Edited By: Castro, Felix R MVR
Date: 9/24/2012
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File Name: 20120925 24+02 Stability Analysis.gsz
Directory: P:\(1) Geotech Work\FY 12\20101020 Huron Island\
Last Solved Date: 9/24/2012
Last Solved Time: 1:12:18 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis (H2O@537ft.)

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Left to Right
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
  - Tension Crack
    - Tension Crack Option: (none)
- FOS Distribution
  - FOS Calculation Option: Constant
- Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Soft Clay

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 260 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Medium Clay

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 460 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-98, 537) ft
Left-Zone Right Coordinate: (-14, 529) ft
Left-Zone Increment: 16
Right Projection: Range

Right-Zone Left Coordinate: (-4, 527.57143) ft
Right-Zone Right Coordinate: (111, 520) ft
Right-Zone Increment: 16
Radius Increments: 16

Slip Surface Limits

Left Coordinate: (-200, 530) ft
Right Coordinate: (200, 530) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-200	530
	-142	530
	-122	537
	200	537

Regions

	Material	Points	Area (ft²)
Region 1	Sand	5,6,3,2,19,15,16,21	12478.344
Region 2	Medium Clay	2,1,20,19	484
Region 3	Soft Clay	20,1,7,8,9,10,11,12,13,14	1908
Region 4	Soft Clay	22,17,18,4	261.73129
Region 5	Medium Clay	21,22,4,5	125.33985

Points

	X (ft)	Y (ft)
Point 1	-200	523.5
Point 2	-200	521.5
Point 3	-200	490
Point 4	200	523.5
Point 5	200	521.5
Point 6	200	490
Point 7	-200	530
Point 8	-142	530
Point 9	-122	537
Point 10	-92	537
Point 11	-86	535
Point 12	-56	535
Point 13	7	526

Point 14	28	526
Point 15	52	520
Point 16	127	520
Point 17	160	528
Point 18	200	530
Point 19	46	521.5
Point 20	38	523.5
Point 21	133.20739	521.5
Point 22	141.45276	523.5

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	5.367	(18.94, 692.296)	49.95153	(-61.9982, 535)	(61.9705, 520)
2	1908	5.773	(18.94, 692.296)	179.023	(-66.5429, 535)	(67.5561, 520)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-60.02452	533.15955	239.63634	286.10363	0	260
2	Optimized	-57.025395	530.48145	406.74338	594.50015	0	260
3	Optimized	-54.38656	528.32575	541.28556	826.25607	0	260
4	Optimized	-51.05023	526.13075	678.24666	1071.6835	0	260
5	Optimized	-47.60445	524.3769	787.67548	1245.4868	0	260
6	Optimized	-43.94321	522.5134	903.95922	1412.307	0	460
7	Optimized	-40.393295	521.14715	989.2038	1581.0168	341.6834	0
8	Optimized	-37.227095	520.4013	1035.7559	1645.9522	352.29698	0
9	Optimized	-33.32581	519.58315	1086.8194	1718.7208	364.82845	0
10	Optimized	-28.63251	518.6793	1143.2055	1791.4265	374.25055	0
11	Optimized	-24.145755	517.91235	1191.0747	1854.5447	383.05457	0
12	Optimized	-19.86554	517.28225	1230.3919	1897.93	385.40329	0
13	Optimized	-15.594895	516.7745	1262.0651	1933.4275	387.61128	0
14	Optimized	-11.333825	516.3891	1286.1158	1947.8252	382.03812	0
15	Optimized	-6.8453425	516.1062	1303.7835	1954.3191	375.58691	0
16	Optimized	-2.1294475	515.92585	1315.035	1940.7155	361.23677	0
17	Optimized	1.921375	515.79945	1322.9191	1927.4619	349.03296	0
18	Optimized	5.307125	515.727	1327.437	1910.8372	336.82627	0
19	Optimized	9.488	515.63755	1333.0145	1906.5769	331.14636	0
20	Optimized	14.18342	515.37635	1349.3199	1930.0322	335.27438	0
21	Optimized	18.59826	514.9605	1375.2762	1979.6445	348.93221	0
22	Optimized	22.60426	514.42975	1408.3721	2033.1934	360.74074	0

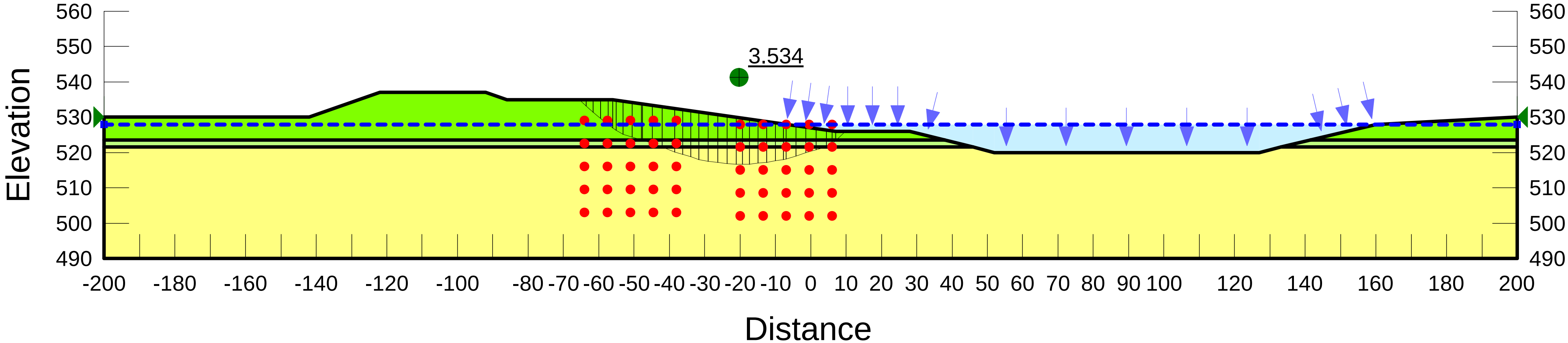
23	Optimized	26.20142	513.78405	1448.677	2109.7535	381.67271	0
24	Optimized	30.803385	512.95805	1500.2186	2175.7716	390.03072	0
25	Optimized	35.803385	512.4081	1534.5361	2196.1769	381.99851	0
26	Optimized	39.29095	512.33375	1539.1758	2159.547	358.17149	0
27	Optimized	43.29095	512.78525	1510.9931	2075.0097	325.63514	0
28	Optimized	47.078725	513.455	1469.2035	1941.2437	272.53255	0
29	Optimized	50.078725	514.5467	1401.0791	1789.5019	224.25604	0
30	Optimized	54.000945	516.38605	1286.3127	1524.0462	137.25548	0
31	Optimized	58.986185	518.6622	1144.2813	1239.3604	54.893908	0

Slices of Slip Surface: 1908

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	1908	-63.907205	533.6238	210.66891	257.60194	0	260
2	1908	-58.635735	530.9801	375.64922	560.55897	0	260
3	1908	-53.45051	528.58525	525.08941	817.02298	0	260
4	1908	-48.35153	526.4236	659.96051	1027.8592	0	260
5	1908	-43.252545	524.44465	783.45019	1218.1159	0	260
6	1908	-37.705555	522.5	904.80554	1390.8011	0	460
7	1908	-32.390945	520.80645	1010.485	1558.819	316.58079	0
8	1908	-27.756715	519.48675	1092.8364	1683.2818	340.8938	0
9	1908	-23.122485	518.30045	1166.8468	1792.3238	361.11934	0
10	1908	-18.488255	517.24485	1232.7136	1886.167	377.2715	0
11	1908	-13.854025	516.3176	1290.5785	1964.9937	389.3738	0
12	1908	-9.2197975	515.5167	1340.5625	2028.9785	397.45714	0
13	1908	-4.585571	514.8404	1382.7614	2078.2172	401.52158	0
14	1908	0.0486575	514.2873	1417.2621	2112.8467	401.59593	0
15	1908	4.682886	513.85625	1444.1607	2132.9112	397.65032	0
16	1908	9.1	513.5555	1462.9276	2152.3598	398.04386	0
17	1908	13.3	513.3737	1474.2916	2176.8712	405.63453	0
18	1908	17.5	513.2906	1479.4759	2189.6196	410.00164	0
19	1908	21.7	513.3061	1478.491	2190.5493	411.10703	0
20	1908	25.9	513.4202	1471.3867	2179.6127	408.89448	0
21	1908	30.5	513.66365	1456.1942	2124.1571	385.64855	0
22	1908	35.5	514.0577	1431.5947	2013.5285	335.97966	0
23	1908	40	514.5269	1402.3189	1899.4675	287.02886	0
24	1908	44	515.0466	1369.9013	1785.2457	239.7992	0
25	1908	49	515.84045	1320.3618	1620.4059	173.23056	0
26	1908	54.59269	516.87845	1255.5862	1446.0464	109.96227	0
27	1908	59.77807	518.0129	1184.7923	1309.0922	71.764593	0

28	1908	64.963445	519.3102	1103.8511	1151.5983	27.566857	0

Huron Island Habitat Rehabilitation and Enhancement Project
Des Moines County, IA
STA 24+02



Stability Analysis
Flat Pool (528 ft.)

Name: Soft Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 260 psf Phi: 0 ° Piezometric Line: 1
Name: Medium Clay Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 460 psf Phi: 0 ° Piezometric Line: 1
Name: Sand Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1

Last Edited By: Castro, Felix R MVR
Date: 9/25/2012
Time: 1:24:57 PM
File Name: 20120925 24+02 Stability Analysis.gsz

SLOPE/W Analysis (H2O@528ft.)

File Information

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Revision Number: 55
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Date: 9/24/2012
Time: 1:11:54 PM
File Name: 20120925 24+02 Stability Analysis.gsz
Directory: P:\(1) Geotech Work\FY 12\20101020 Huron Island\
Last Solved Date: 9/24/2012
Last Solved Time: 1:12:06 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis (H2O@528ft.)

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Soft Clay

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 260 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Medium Clay

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 460 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-99, 537) ft
Left-Zone Right Coordinate: (-35, 532) ft
Left-Zone Increment: 16
Right Projection: Range

Right-Zone Left Coordinate: (-29, 531.14286) ft
Right-Zone Right Coordinate: (43, 522.25) ft
Right-Zone Increment: 16
Radius Increments: 16

Slip Surface Limits

Left Coordinate: (-200, 530) ft
Right Coordinate: (200, 530) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	-200	528
	200	528

Regions

	Material	Points	Area (ft²)
Region 1	Sand	5,6,3,2,19,15,16,21	12478.344
Region 2	Medium Clay	2,1,20,19	484
Region 3	Soft Clay	20,1,7,8,9,10,11,12,13,14	1908
Region 4	Soft Clay	22,17,18,4	261.73129
Region 5	Medium Clay	21,22,4,5	125.33985

Points

	X (ft)	Y (ft)
Point 1	-200	523.5
Point 2	-200	521.5
Point 3	-200	490
Point 4	200	523.5
Point 5	200	521.5
Point 6	200	490
Point 7	-200	530
Point 8	-142	530
Point 9	-122	537
Point 10	-92	537
Point 11	-86	535
Point 12	-56	535
Point 13	7	526
Point 14	28	526
Point 15	52	520

Point 16	127	520
Point 17	160	528
Point 18	200	530
Point 19	46	521.5
Point 20	38	523.5
Point 21	133.20739	521.5
Point 22	141.45276	523.5

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	3.201	(-29.969, 589.639)	23.84194	(-62.7247, 535)	(-6.04542, 527.864)
2	2402	3.497	(-29.969, 589.639)	66.037	(-67.0557, 535)	(-6.47025, 527.924)

Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-61.63704	533.9113	-368.86234	46.67556	0	260
2	Optimized	-59.810385	532.15335	-259.16875	242.52406	0	260
3	Optimized	-58.33241	530.8148	-175.63937	385.90211	0	260
4	Optimized	-56.79671	529.4887	-92.89368	537.42066	0	260
5	Optimized	-55.600135	528.5023	-31.342926	637.55864	0	260
6	Optimized	-55.067985	528.08635	-5.3870926	696.37486	0	260
7	Optimized	-53.914865	527.3338	41.571096	760.58494	0	260
8	Optimized	-52.15782	526.30415	105.8231	868.53259	0	260
9	Optimized	-50.685395	525.57725	151.18021	925.65527	0	260
10	Optimized	-49.23731	524.97745	188.61007	994.3125	0	260
11	Optimized	-47.813575	524.5048	218.10081	1024.4432	0	260
12	Optimized	-45.821175	524.0281	247.84578	1069.5698	0	260
13	Optimized	-43.75572	523.7165	267.2872	1087.6226	0	260
14	Optimized	-42.12803	523.64385	271.82435	1084.3429	0	260
15	Optimized	-40.442495	523.64095	272.00234	1056.9925	0	260
16	Optimized	-38.75696	523.6381	272.18032	1029.6422	0	260
17	Optimized	-37.071425	523.63525	272.36424	1002.2919	0	260
18	Optimized	-35.07766	523.60035	274.54149	969.18453	0	260
19	Optimized	-32.720765	523.53185	278.81161	938.40714	0	260
20	Optimized	-30.283445	523.5305	278.89767	907.34894	0	260

21	Optimized	-27.8789	523.5963	274.7922	860.1609	0	260
22	Optimized	-25.834985	523.637	272.24988	819.2128	0	260
23	Optimized	-24.0934	523.65425	271.1762	788.61003	0	260
24	Optimized	-22.351815	523.6715	270.09678	758.00725	0	260
25	Optimized	-20.610225	523.68875	269.0231	727.34706	0	260
26	Optimized	-18.86864	523.70605	267.94368	696.74428	0	260
27	Optimized	-17.127055	523.7233	266.87	666.1415	0	260
28	Optimized	-15.481725	523.8523	258.81623	643.69168	0	260
29	Optimized	-13.932655	524.0931	243.78762	589.85403	0	260
30	Optimized	-12.30505	524.529	216.58774	539.15775	0	260
31	Optimized	-10.59891	525.16	177.21615	435.44587	0	260
32	Optimized	-8.37292	526.36155	102.23928	284.93706	0	260
33	Optimized	-6.5227125	527.5556	27.730663	112.4806	0	260

Slices of Slip Surface: 2402

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	2402	-65.95011	534.2814	-391.97396	38.135649	0	260
2	2402	-63.738975	532.90475	-306.05496	193.51795	0	260
3	2402	-61.52784	531.64505	-227.45158	336.90101	0	260
4	2402	-59.316705	530.4948	-155.6765	468.92952	0	260
5	2402	-57.10557	529.4478	-90.34144	590.11365	0	260
6	2402	-54.8323	528.4747	-29.61976	685.16842	0	260
7	2402	-52.65015	527.62895	23.154033	749.922	0	260
8	2402	-50.621255	526.92385	67.1512	801.23591	0	260
9	2402	-48.59236	526.29155	106.60789	844.4461	0	260
10	2402	-46.563465	525.7299	141.65775	879.79128	0	260
11	2402	-44.53457	525.23705	172.41139	907.43849	0	260
12	2402	-42.50567	524.8114	198.97043	927.46728	0	260
13	2402	-40.476775	524.45165	221.41642	940.05753	0	260
14	2402	-38.44788	524.15675	239.81895	945.23752	0	260
15	2402	-36.418985	523.92585	254.22744	943.12551	0	260
16	2402	-34.39009	523.7582	264.69171	933.67954	0	260
17	2402	-32.361195	523.6533	271.23541	916.99015	0	260
18	2402	-30.3323	523.61095	273.87889	893.03405	0	260

19	2402	- 28.303405	523.63095	272.62815	861.77121	0	260
20	2402	-26.27451	523.71335	267.48481	823.09833	0	260
21	2402	-24.24561	523.85845	258.43101	777.04599	0	260
22	2402	- 22.216715	524.06665	245.44009	723.48636	0	260
23	2402	-20.18782	524.33855	228.47859	662.33591	0	260
24	2402	- 18.158925	524.6749	207.48773	593.36245	0	260
25	2402	-16.13003	525.07675	182.41157	516.43921	0	260
26	2402	- 14.101135	525.5453	153.17126	431.39611	0	260
27	2402	-12.07224	526.08205	119.67968	337.96013	0	260
28	2402	- 10.043343	526.6888	81.819348	235.86264	0	260
29	2402	-8.014448	527.36755	39.463727	124.77618	0	260
30	2402	-6.735127	527.82475	10.934426	53.450243	0	260

UPPER MISSISSIPPI RIVER RESTORATION
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HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX H

HYDROLOGY AND HYDRAULICS

UPPER MISSISSIPPI RIVER RESTORATION
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POOL 18, UPPER MISSISSIPPI RIVER
RIVER MILES 421.2 THROUGH 425.4
DES MOINES COUNTY, IOWA

APPENDIX H
HYDROLOGY AND HYDRAULICS

This appendix presents the hydrologic and hydraulic assessment of the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project) and summarizes the hydrologic and hydraulic evaluations of various Project features considered.

1. INTRODUCTION AND LOCATION

Huron Island is a backwater island complex located on the west bank of the Mississippi River approximately between river miles (RM) 421.2 and 425.4 (midpoint is RM 423.3). Located within Pool 18, Huron Island is situated between Keithsburg, IL to the north and Oquawka, IL to the south. The Mississippi River borders the eastern edge of the island and Huron Chute flows along the western edge. The Two Rivers Levee and Drainage District is located along the right descending bank of Huron Chute. The island is located on the right descending bank of the Mississippi River in Des Moines County, IA, approximately 20 miles upstream of Burlington, IA. The Iowa River enters the Mississippi River approximately 12 miles upstream of the Project area (~RM 434). All elevations used in this appendix are expressed using the Mean Sea Level 1912 Vertical Datum (MSL1912), unless otherwise stated.

The interior of the island is made up of a network of backwater lakes and channels. Some of the areas considered as part of the complex include Buffalo Slough, Gun Slough, Cody Chute, Beaver Chute and areas associated with Garner Island (figure H-1). Garner Island is a smaller island located immediately to the north and west of Huron Island. Some of the channels convey water throughout much of the year and others only convey water and sediment when the river stage is high enough to provide connectivity. At the 50 percent exceedance probability (2-yr flood) water surface elevation, nearly 99 percent of the island is inundated.

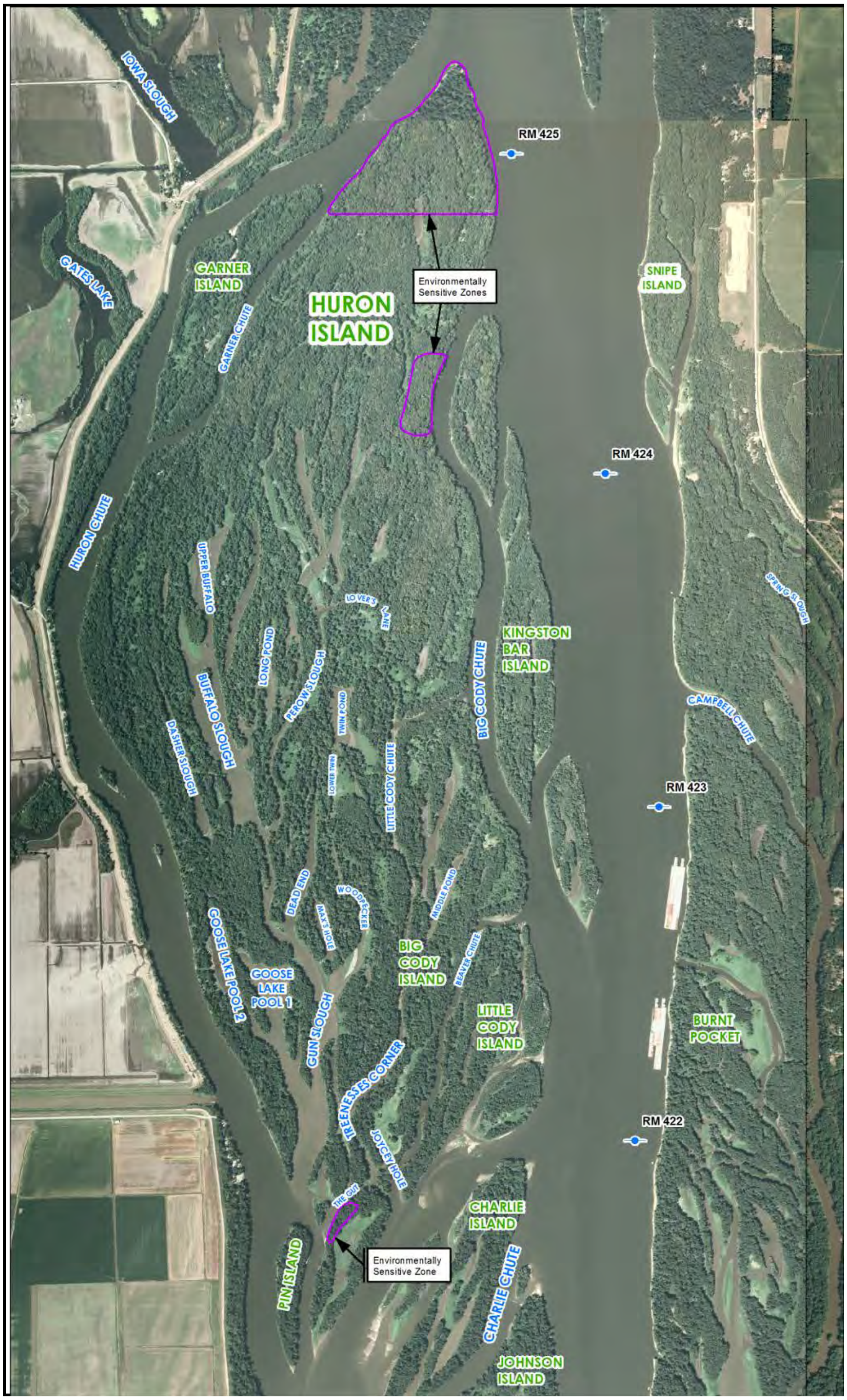

Figure H-1. Map of Areas Within and Surrounding Huron Island

2. CLIMATE

Annual climate data for the Burlington, IA Airport U.S. Cooperative Network Station (gage #131063) provides precipitation and snowfall data used for the Project site (table H-1). The period of record for the average values reported at the airport gage begins in 1971 and continues through 2000. Minimum and maximum precipitation and snowfall values at the airport gage include the period of record between 1897 and 2001.

Table H-1. Average and Extremes of Monthly Precipitation and Snowfall (COOP Gage # 131063).

	Precipitation					Snow		
	Average	Maximum		Minimum		Average	Maximum	
Month	**(in)**	**(in)**	**Year**	**(in)**	**Year**	**(in)**	**(in)**	**Year**
Jan	1.13	5.30	1907	0.17	1956	6.8	14.6	1957
Feb	1.51	3.71	1908	0.17	1917	5.8	17.3	1962
Mar	2.87	6.62	1921	0.30	1918	1.6	25.7	1960
Apr	3.69	7.38	1929	1.06	1988	0.1	3.4	1961
May	4.37	11.96	1996	0.92	1992	0.0	-	-
Jun	3.87	13.91	1924	0.32	1991	0.0	-	-
Jul	4.29	10.81	1915	0.18	1913	0.0	-	-
Aug	3.94	10.62	1902	0.36	1901	0.0	-	-
Sep	3.93	14.30	1926	0.15	1940	0.0	-	-
Oct	2.75	15.10	1941	0.06	1964	0.0	1.0	1954
Nov	2.48	6.43	1934	0.08	1917	1.1	3.8	1991
Dec	2.11	4.39	1909	0.20	1919	5.3	15.6	1961
Annual	**36.94**					**20.7**		

Temperature data was obtained from the Burlington, IA Radio Station U.S. Cooperative Network Station (gage #131060) (table H-2). The period of record for the average values reported at the radio station gage begins in 1971 and continues through 2000. Minimum and maximum temperature values at the radio station gage include the period of record between 1965 and 2001.

Table H-2. Average and Extremes of Monthly Temperature (COOP Gage # 131060).

	Temperature		
	Average	Maximum	Minimum
Month	**(°F)**	**(°F)**	**(°F)**
Jan	22.8	30.4	15.1
Feb	28.4	36.3	20.5
Mar	40.1	48.8	31.4
Apr	52.3	61.7	42.8
May	63.0	72.4	53.6
Jun	72.2	81.6	62.7
Jul	76.3	85.4	67.1
Aug	74.3	83.3	65.2
Sep	66.5	76.2	56.8
Oct	55.1	64.6	45.6
Nov	40.6	48.5	32.6
Dec	27.8	35.0	20.6
Annual	**51.6**		

The average annual daily minimum temperature was 42.8 degrees Fahrenheit (F), while the average annual daily maximum temperature was 60.4 degrees F. However, fluctuation of temperatures in southeastern Iowa can be extreme. Average monthly temperatures range from a maximum of 85.4 degrees F in July to a minimum of 15.1 degrees F in January. The precipitation is moderate, with an average annual value of 36.9 inches (in). The average annual snowfall is 20.7 in.

3. TOPOGRAPHY

Sediment transects extending from bank to bank across the Mississippi River at RM424 were taken in 1938 and 2004 (figure H-2). This transect suggests that Huron Island may be aggrading both across the uplands and within interior channels. The Iowa River confluence is located approximately 12 miles upstream of Huron Island. Pool 18 is one of the Rock Island District's (District) most heavily dredged pools. Considering the consistent management of Pool 18 and agricultural practices within the Iowa River watershed, an aggrading environment within Huron Island could likely persist and fish overwintering habitat within the island complex may continue to become more isolated and decrease overall. A more detailed discussion of sedimentation rates at the Huron Island Complex is included in Section 5.3.6.4. LiDAR data for the Project was available through the State of Iowa's collection effort. Huron Island LiDAR collection was flown on May 4, 2010 during a river elevation of 532.8 feet. Elevations throughout the Huron Island Complex range from 471 feet to 546 feet with a mean elevation of 529 feet and a standard deviation of 4.85 feet (figure H-3). The highest elevations occur along the perimeter of the upstream portion of the island where deposition of sediment occurs as the island is overtopped. The lowest elevations occur immediately downstream of the Huron Chute closing dam and within other reaches of Huron Chute. The 50 percent exceedance probability (2-yr flood stage) water surface elevation is 536.1 feet at the upstream end of the island (RM 425.4) and 534.2 feet at the downstream end of the island (RM 421.2). Under 50 percent exceedance probability conditions, ~35 acres are above water and ~2,633 acres are below water within the 2,668 acre complex.

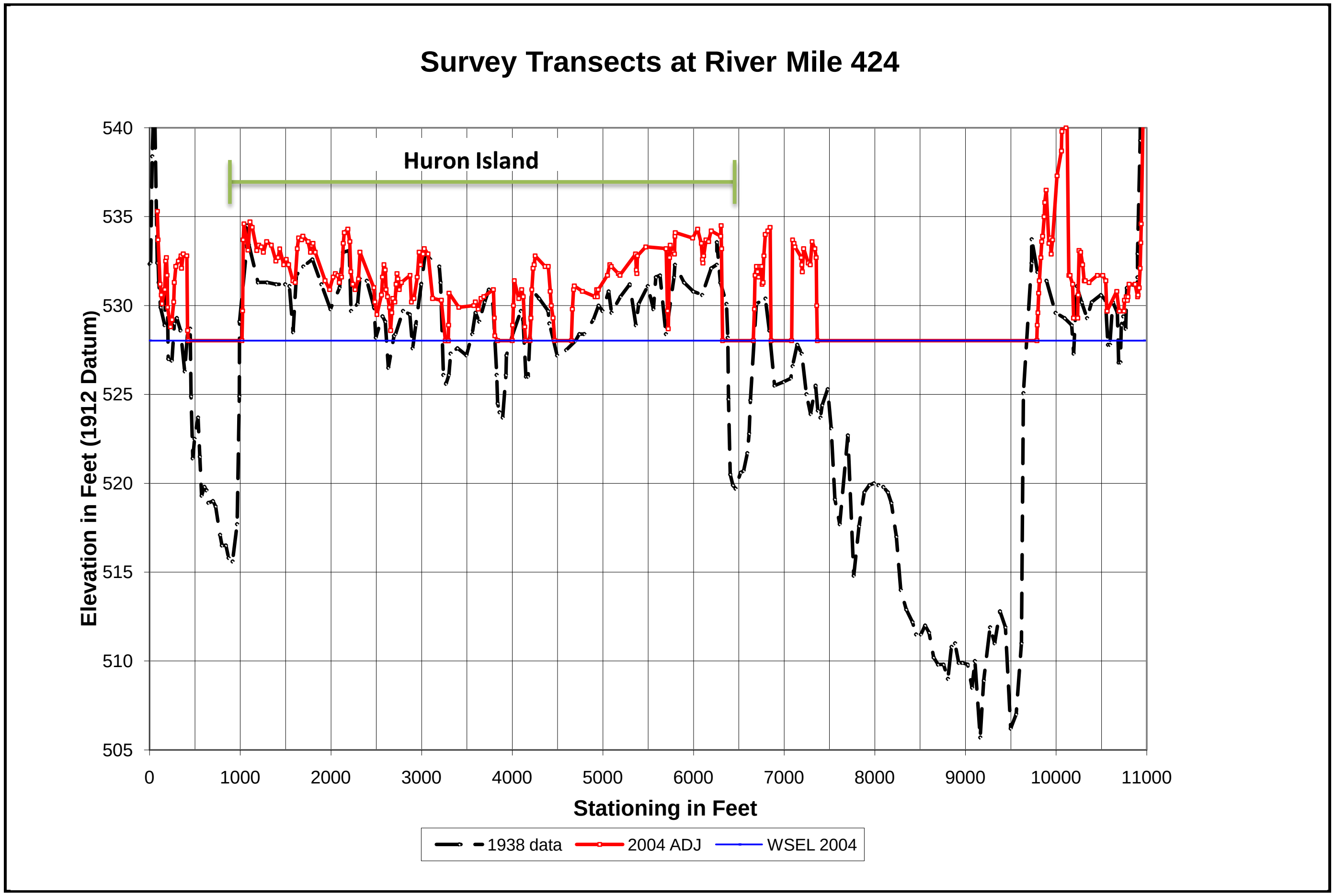

Figure H-2. Huron Island Elevation Transects at RM 424

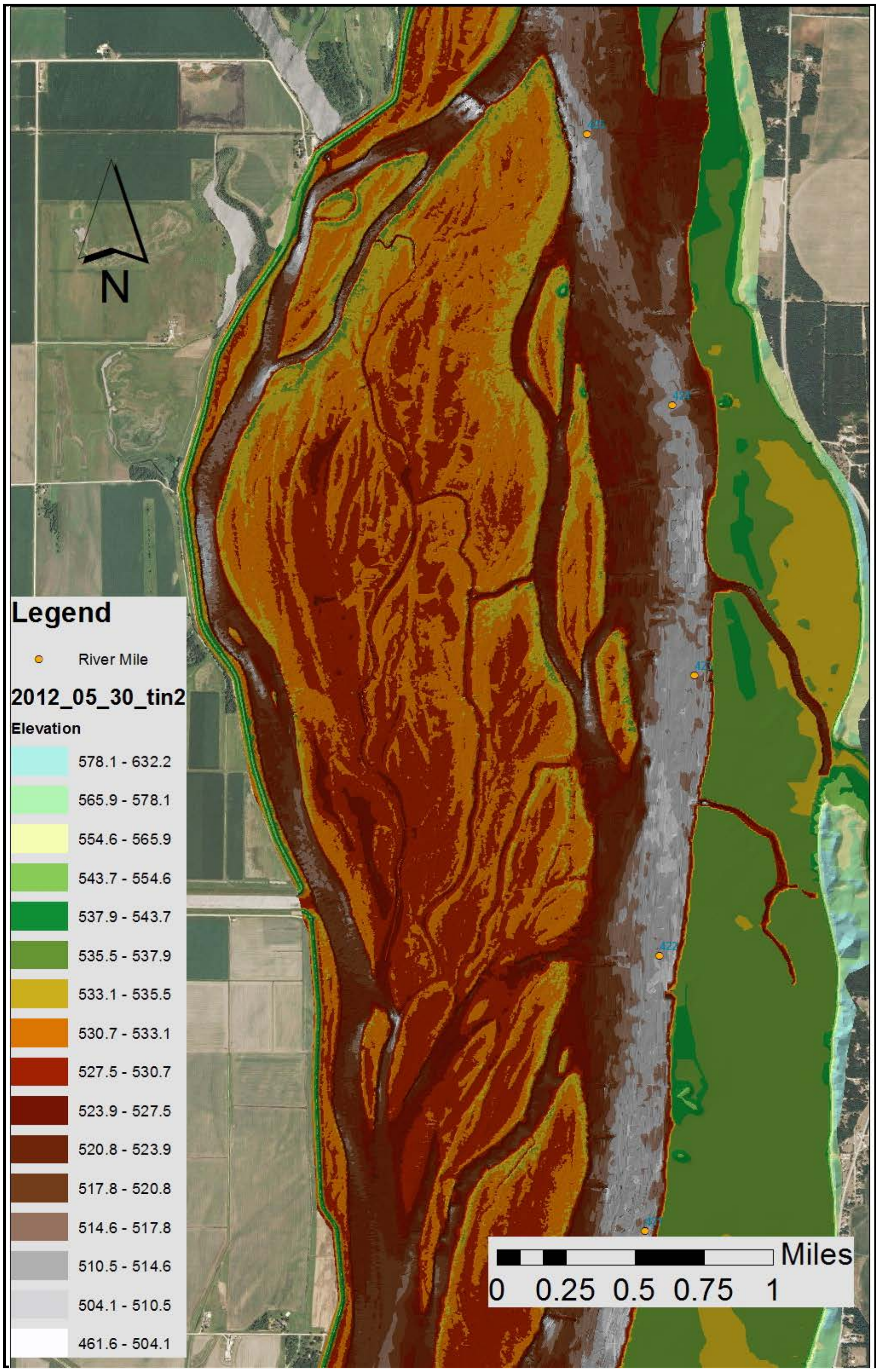

Figure H-3. Topographic and Bathymetric Elevation Map for Huron Island

4. MISSISSIPPI RIVER

4.1. Historic and Current Mississippi River. The Upper Mississippi River System (UMRS) has undergone numerous and extensive modifications in the interest of navigation, the most recent of which is the 1930 9-foot navigation channel project. Lock and Dam 17, located approximately 14 miles upstream of the Project, was placed into operation in May 1939. Lock and Dam 18, located approximately 13 miles downstream of the Project was placed into operation in September 1937.

Lock and Dam 18 provides navigable channel depths by maintaining a water surface elevation of 528 feet MSL 1912 (flat pool) or higher. Pool 18 is regulated using a dam control point. 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, thereby limiting overall fluctuations in river stage. However, the degree of influence of the impounding dam diminishes as you move upstream of the dam, where greater variation in river stage occurs (figure H-4). The Project is located approximately 2 miles downstream of the Keithsburg gage and therefore does experience some annual fluctuation in river stage.

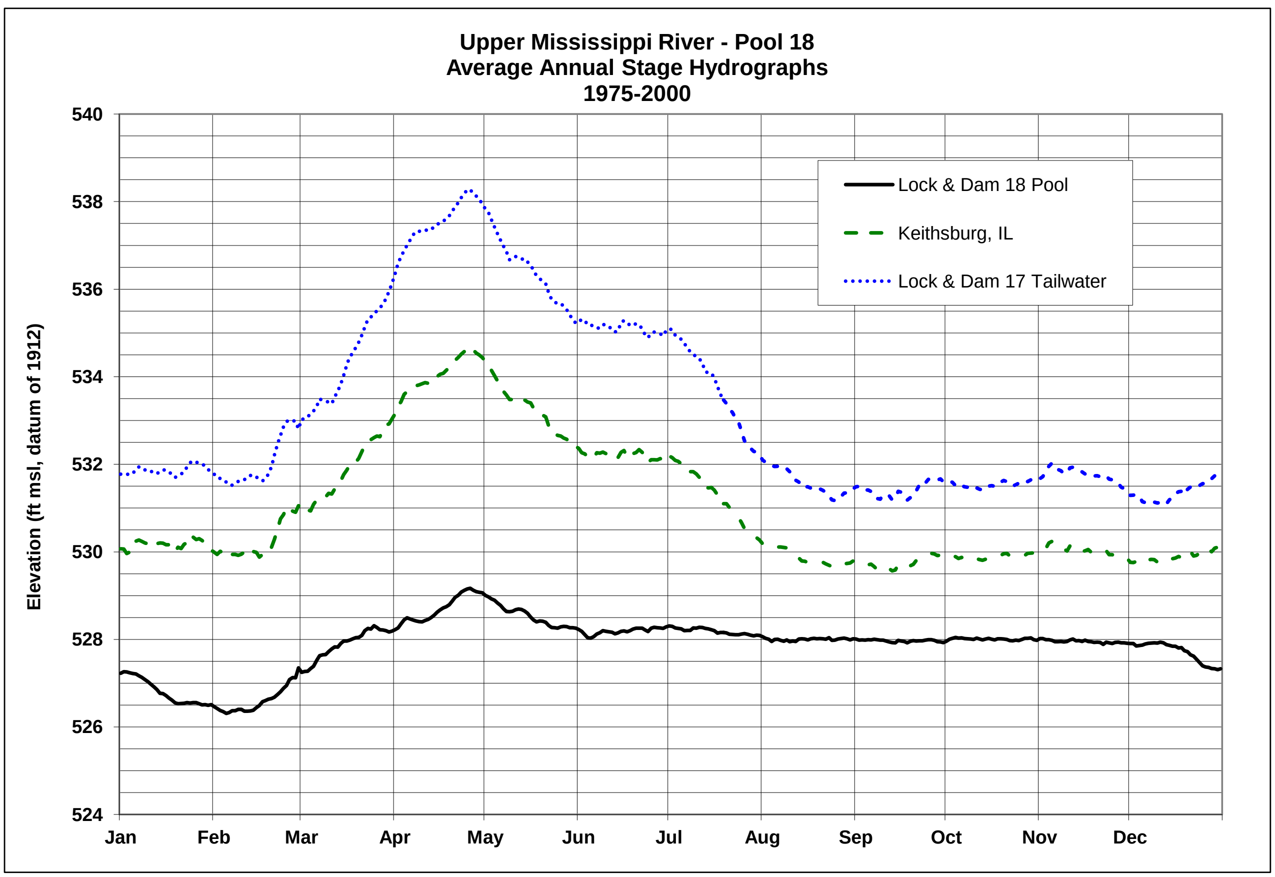

Figure H-4. Average Annual Elevation Hydrographs for the Upper, Middle, and Lower Portions of Pool 18 (1975-2000)

Maintaining a minimum water surface elevation necessary for navigation prevents the natural variation in river stage that much of the river habitat depends on. For example periods of successful native fish reproduction have been correlated to periods with more nature-like hydrology and similarly the success of exotic fish species was correlated to periods of more altered hydrology (Koel and Sparks, 2002).

Pool 18 drains 113,600 square miles. The Iowa River is the biggest tributary within the Pool 18 reach, entering the Mississippi River approximately 12 miles upstream of the Project. The Iowa-Cedar River basin is over 12,500 sq miles and 93 percent of land use in the basin is agricultural (http://iowacedarbasin.org/watershed, accessed 11-8-11). Row crop production is the dominant agricultural practice, contributing to the watershed's distinction as the primary contributor of total phosphorus and total dissolved phosphorus in the Upper Mississippi River Basin. The extensive soil erosion that serves as the principle transport mechanism for the phosphorus also presents persistent dredging problems within Pool 18. A map of dredge cut locations within the Huron Island modeling reach is shown in figure H-5.

Within the 15 mile reach for the Huron Island AdH model, described in Section 5.3, there are over 70 regulating structures and closing dams. Most all of these structures were built in the 1920s, however others were constructed as early as the 1890s. Many of these structures have been repaired over time and many of these structures are covered in sediment. A survey of wing dams within the UMRS was completed in 2009-2010 as part of the Long Term Resource Monitoring Plan (LTRMP)-led effort; therefore many of these wing dams are well described and appear in the bathymetric dataset. However, more than 20 of these structures were not surveyed; therefore the current wing dam database maintained by Operations Branch was used to supplement the surveyed dataset.

4.2. Flood Conditions. The 2004 *Upper Mississippi River System Flow Frequency Study* (2004 UMRS Flow Frequency Study) includes several cross sections through the Huron Island reach (Reference 2). Results from the 2004 UMRS Flow Frequency Study that pertain to Huron Island (RM 421.2 to RM 425.4) are shown on figure H-6 and table H-3.

Figure H-5. Historic Dredging Locations and Regulating Structures Throughout the Model Reach

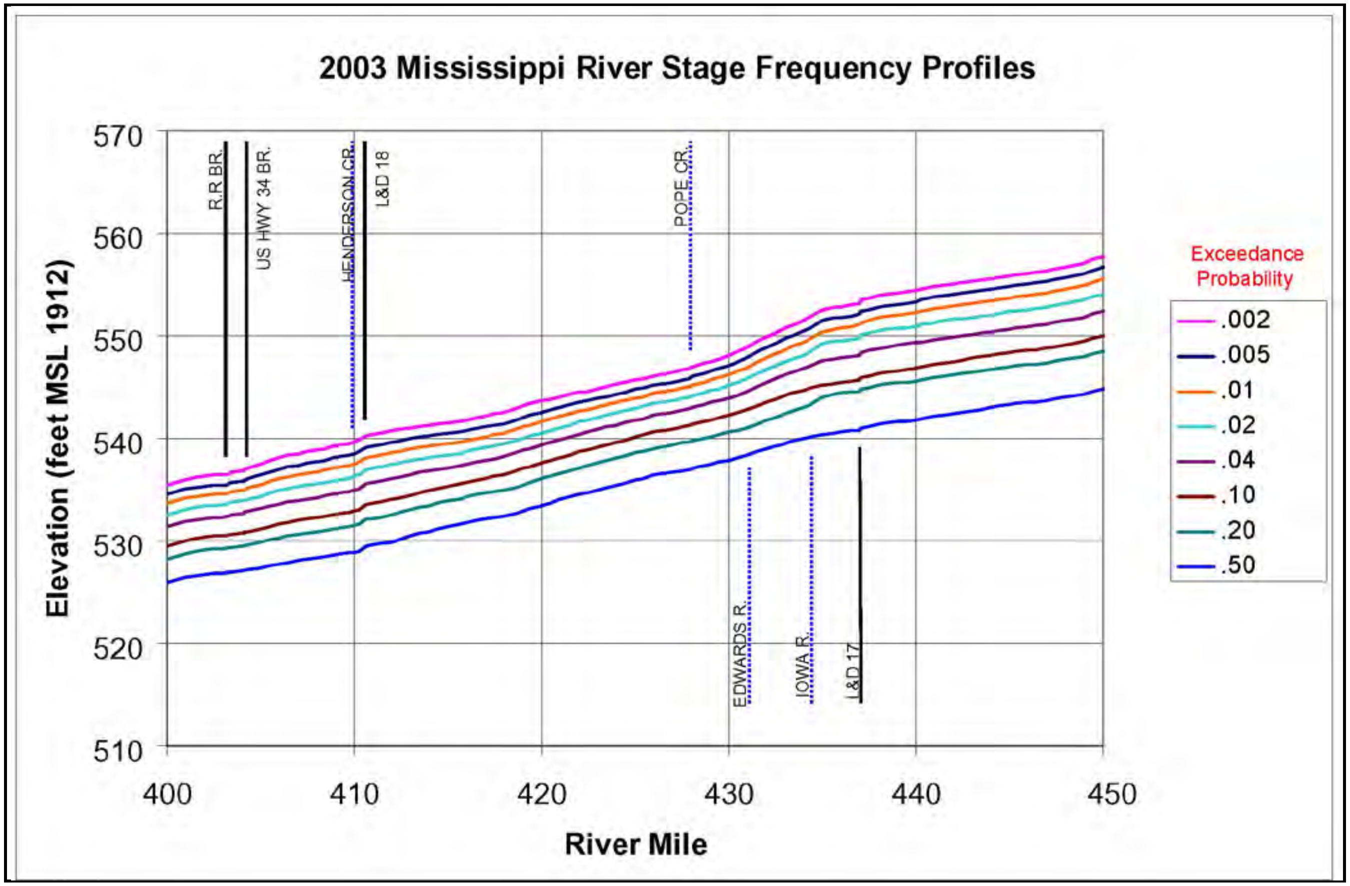

Figure H-6. Mississippi River Water Surface Profiles

Table H-3. 2004 Upper Mississippi River System Flow Frequency Study

River	Exceedance Probability															
	0.5		0.2		0.1		0.04		0.02		0.01		0.005		0.002	
Mile	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs
404.3	527.2	170,000	529.6	221,000	530.9	253,000	532.9	291,000	534.1	320,000	535.1	349,000	536.1	377,000	537.1	414,000
405	527.4	170,000	529.8	221,000	531.2	253,000	533.1	291,000	534.3	320,000	535.4	349,000	536.4	377,000	537.5	414,000
405.5	527.6	170,000	530.1	221,000	531.4	253,000	533.4	291,000	534.6	320,000	535.8	349,000	536.7	377,000	537.8	414,000
406	527.8	170,000	530.3	221,000	531.7	253,000	533.6	291,000	534.9	321,000	536.0	349,000	537.0	377,000	538.1	414,000
406.4	527.9	170,000	530.5	221,000	531.8	253,000	533.8	292,000	535.1	321,000	536.2	349,000	537.2	377,000	538.3	413,000
407	528.1	170,000	530.6	221,000	532.0	253,000	533.9	292,000	535.3	321,000	536.4	349,000	537.4	377,000	538.5	413,000
407.5	528.2	170,000	530.8	221,000	532.2	253,000	534.1	292,000	535.4	321,000	536.6	349,000	537.6	377,000	538.7	413,000
408	528.3	170,000	530.9	221,000	532.3	253,000	534.2	292,000	535.5	321,000	536.7	349,000	537.7	377,000	538.8	413,000
408.5	528.5	170,000	531.0	221,000	532.4	253,000	534.4	292,000	535.7	321,000	536.9	349,000	537.9	377,000	539.0	413,000
408.9	528.7	170,000	531.2	221,000	532.6	253,000	534.6	292,000	535.9	321,000	537.1	350,000	538.1	378,000	539.2	414,000
409.2	528.7	170,000	531.3	221,000	532.7	253,000	534.6	292,000	536.0	321,000	537.2	350,000	538.2	378,000	539.4	413,000
409.7	528.9	170,000	531.4	221,000	532.8	253,000	534.8	292,000	536.1	321,000	537.3	350,000	538.3	378,000	539.5	413,000
410	528.9	170,000	531.5	221,000	532.9	253,000	534.9	292,000	536.3	321,000	537.5	350,000	538.5	378,000	539.7	413,000
410.3	529.0	169,000	531.6	219,000	533.1	252,000	535.1	290,000	536.5	319,000	537.7	347,000	538.7	376,000	539.9	412,000
410.6	529.5	169,000	532.1	219,000	533.5	252,000	535.6	290,000	536.9	319,000	538.1	346,000	539.1	373,000	540.3	406,000
411	529.6	169,000	532.2	219,000	533.7	252,000	535.7	290,000	537.1	319,000	538.3	347,000	539.3	373,000	540.4	406,000
411.4	529.7	169,000	532.3	219,000	533.8	252,000	535.9	290,000	537.2	319,000	538.4	347,000	539.4	373,000	540.5	406,000
412	529.9	169,000	532.5	219,000	534.0	252,000	536.0	290,000	537.4	319,000	538.6	347,000	539.6	373,000	540.7	406,000
412.4	530.1	169,000	532.7	219,000	534.2	252,000	536.2	290,000	537.6	319,000	538.7	347,000	539.7	373,000	540.8	406,000
413	530.5	169,000	533.0	219,000	534.5	252,000	536.5	290,000	537.8	319,000	539.0	347,000	540.0	373,000	541.1	407,000
413.5	530.7	169,000	533.3	219,000	534.7	252,000	536.7	290,000	538.0	319,000	539.1	347,000	540.1	373,000	541.2	407,000
414	530.9	169,000	533.4	219,000	534.9	252,000	536.8	290,000	538.1	319,000	539.2	347,000	540.2	373,000	541.3	407,000
414.4	531.2	169,000	533.6	219,000	535.1	252,000	536.9	290,000	538.2	319,000	539.3	347,000	540.3	373,000	541.4	407,000
415	531.4	169,000	533.9	219,000	535.3	252,000	537.1	290,000	538.4	319,000	539.5	347,000	540.5	373,000	541.5	407,000
415.7	531.7	169,000	534.1	219,000	535.5	252,000	537.3	290,000	538.5	319,000	539.6	347,000	540.6	373,000	541.7	407,000
416	531.8	169,000	534.3	219,000	535.7	252,000	537.5	290,000	538.7	319,000	539.8	347,000	540.7	373,000	541.8	407,000
416.6	532.0	169,000	534.5	219,000	536.0	252,000	537.7	290,000	539.0	319,000	540.0	347,000	541.0	373,000	542.0	407,000
417	532.2	168,000	534.7	219,000	536.1	252,000	537.9	290,000	539.1	319,000	540.2	347,000	541.1	373,000	542.2	407,000
417.4	532.3	168,000	534.8	219,000	536.3	252,000	538.0	290,000	539.3	319,000	540.3	347,000	541.3	373,000	542.4	407,000
418	532.4	168,000	534.9	219,000	536.4	252,000	538.2	290,000	539.4	319,000	540.5	347,000	541.4	373,000	542.5	407,000
418.6	532.7	168,000	535.2	219,000	536.8	252,000	538.6	290,000	539.8	319,000	540.9	347,000	541.8	373,000	542.9	407,000
419	532.9	168,000	535.5	219,000	537.0	252,000	538.8	290,000	540.0	319,000	541.1	347,000	542.0	373,000	543.1	407,000
419.4	533.1	168,000	535.7	219,000	537.2	252,000	539.0	290,000	540.3	319,000	541.3	347,000	542.3	373,000	543.4	407,000
420	533.4	168,000	536.0	219,000	537.5	251,000	539.3	290,000	540.5	319,000	541.6	347,000	542.5	373,000	543.6	407,000
420.5	533.7	168,000	536.3	219,000	537.8	251,000	539.6	290,000	540.8	319,000	541.8	347,000	542.8	373,000	543.8	407,000
421	534.1	168,000	536.6	219,000	538.2	251,000	539.9	290,000	541.1	319,000	542.2	347,000	543.1	373,000	544.1	407,000
421.5	534.3	168,000	536.8	219,000	538.4	251,000	540.1	290,000	541.3	319,000	542.4	347,000	543.3	373,000	544.3	407,000
422	534.6	168,000	537.1	219,000	538.7	251,000	540.4	290,000	541.6	319,000	542.7	347,000	543.5	373,000	544.5	407,000

Table H-3 (cont). 2004 Upper Mississippi River System Flow Frequency Study

	Exceedance Probability															
River	0.5		0.2		0.1		0.04		0.02		0.01		0.005		0.002	
Mile	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs
422.4	534.7	168,000	537.3	219,000	538.9	251,000	540.6	290,000	541.8	319,000	542.8	347,000	543.7	373,000	544.6	405,000
423	535.0	168,000	537.6	219,000	539.2	251,000	540.9	290,000	542.1	319,000	543.1	347,000	543.9	373,000	544.9	405,000
423.5	535.2	168,000	537.8	219,000	539.4	251,000	541.1	290,000	542.2	319,000	543.2	347,000	544.1	373,000	545.0	406,000
424	535.5	168,000	538.1	219,000	539.6	251,000	541.3	290,000	542.5	319,000	543.5	347,000	544.3	373,000	545.3	406,000
424.4	535.6	168,000	538.2	219,000	539.8	251,000	541.5	290,000	542.6	319,000	543.6	347,000	544.5	373,000	545.4	406,000
425	535.9	168,000	538.5	219,000	540.1	251,000	541.8	290,000	542.9	319,000	543.9	347,000	544.7	373,000	545.7	406,000
425.5	536.1	168,000	538.7	219,000	540.3	251,000	542.0	290,000	543.1	319,000	544.1	347,000	544.9	373,000	545.9	406,000
426	536.4	168,000	539.0	218,000	540.6	251,000	542.3	290,000	543.4	319,000	544.4	347,000	545.2	373,000	546.1	406,000
427	536.7	168,000	539.3	218,000	540.9	251,000	542.6	290,000	543.7	319,000	544.7	347,000	545.5	373,000	546.5	406,000
427.6	536.9	168,000	539.6	218,000	541.1	251,000	542.8	289,000	543.9	319,000	544.9	346,000	545.8	373,000	546.7	406,000
427.95	537.0	168,000	539.7	218,000	541.3	251,000	542.9	289,000	544.1	319,000	545.1	347,000	545.9	373,000	546.8	406,000
428	537.0	167,000	539.7	218,000	541.3	250,000	543.0	289,000	544.1	318,000	545.1	346,000	545.9	372,000	546.9	406,000
428.05	537.1	167,000	539.8	218,000	541.4	250,000	543.1	289,000	544.2	318,000	545.2	346,000	546.0	372,000	547.0	406,000
428.7	537.4	167,000	540.0	218,000	541.6	250,000	543.3	289,000	544.5	318,000	545.5	346,000	546.3	372,000	547.3	406,000
429	537.5	167,000	540.2	218,000	541.8	250,000	543.5	289,000	544.7	318,000	545.7	346,000	546.6	372,000	547.5	406,000
429.5	537.7	167,000	540.3	218,000	542.0	250,000	543.7	289,000	544.9	318,000	545.9	346,000	546.8	372,000	547.8	406,000
430	537.9	167,000	540.6	218,000	542.2	250,000	543.9	289,000	545.2	318,000	546.2	346,000	547.1	372,000	548.1	406,000
430.5	538.1	167,000	540.8	218,000	542.5	250,000	544.2	289,000	545.5	318,000	546.6	346,000	547.5	372,000	548.5	406,000
431	538.3	167,000	541.1	218,000	542.8	250,000	544.6	289,000	545.8	318,000	546.9	346,000	547.8	372,000	548.8	406,000
431.5	538.7	166,000	541.4	217,000	543.2	248,000	545.1	287,000	546.4	315,000	547.5	342,000	548.5	370,000	549.4	406,000
432	539.0	166,000	541.8	217,000	543.5	248,000	545.5	287,000	546.8	315,000	547.9	342,000	548.9	370,000	549.9	406,000
432.5	539.2	166,000	542.1	217,000	543.8	248,000	545.8	287,000	547.1	315,000	548.2	342,000	549.2	370,000	550.2	406,000
433	539.6	166,000	542.4	216,000	544.2	248,000	546.2	287,000	547.5	315,000	548.6	342,000	549.7	370,000	550.7	406,000
433.4	539.8	166,000	542.6	216,000	544.4	248,000	546.5	287,000	547.7	315,000	548.9	342,000	550.0	370,000	551.0	406,000
434	540.0	166,000	543.0	216,000	544.7	248,000	546.8	287,000	548.1	315,000	549.4	342,000	550.5	370,000	551.5	406,000
434.4	540.2	166,000	543.3	216,000	544.9	248,000	547.1	287,000	548.5	315,000	549.7	342,000	550.8	370,000	551.9	406,000
435	540.4	149,000	544.1	197,000	545.2	227,000	547.6	264,000	549.2	291,000	550.4	315,000	551.5	338,000	552.5	370,000
435.6	540.5	149,000	544.4	197,000	545.3	227,000	547.8	264,000	549.5	291,000	550.7	315,000	551.7	338,000	552.7	370,000
436	540.6	149,000	544.4	197,000	545.4	227,000	547.8	264,000	549.5	291,000	550.7	315,000	551.8	338,000	552.8	370,000
436.5	540.7	149,000	544.5	197,000	545.5	227,000	548.0	264,000	549.6	291,000	550.9	315,000	551.9	338,000	553.0	370,000
437	540.8	149,000	544.6	197,000	545.7	227,000	548.1	264,000	549.8	291,000	551.1	315,000	552.1	338,000	553.2	370,000
437.1	541.0	149,000	544.8	197,000	545.9	227,000	548.4	264,000	550.1	291,000	551.3	315,000	552.4	338,000	553.5	370,000
437.5	541.2	149,000	545.0	197,000	546.1	227,000	548.6	264,000	550.3	291,000	551.6	315,000	552.6	338,000	553.7	370,000
438	541.4	149,000	545.2	197,000	546.3	227,000	548.8	264,000	550.5	291,000	551.8	315,000	552.8	338,000	553.9	371,000
438.4	541.5	149,000	545.3	197,000	546.4	227,000	548.9	264,000	550.6	291,000	551.9	315,000	552.9	338,000	554.0	371,000
439	541.6	149,000	545.4	197,000	546.6	227,000	549.1	264,000	550.7	291,000	552.0	315,000	553.1	338,000	554.2	371,000
439.5	541.7	149,000	545.5	197,000	546.7	227,000	549.2	264,000	550.8	291,000	552.1	315,000	553.2	338,000	554.3	371,000
440	541.8	149,000	545.6	197,000	546.8	227,000	549.3	264,000	550.9	291,000	552.3	315,000	553.3	338,000	554.4	371,000

The highest water levels at the Keithsburg gage occurred in 2008, 1993, 2001, 1965, 1973 and 2011 (listed in order of decreasing magnitude) (table H-4). The highest flood on record occurred in June of 2008 at a river elevation of 547.68 feet MSL 1912. The 2008 event was higher than the 0.002 exceedance probability (500-yr flood) stage.

Table H-4. Record High Stages at Keithsburg Gage for the 1900-2011 Period of Record

Stage	Elevation	Date
24.49	547.68	06/17/2008
24.15	547.34	07/09/1993
20.72	543.91	05/12/2001
20.46	543.65	04/28/1965
19.35	542.54	04/25/1973
19.19	542.38	04/24/2011
19.10	542.29	04/25/1993
18.71	541.90	04/14/1998
17.99	541.18	04/20/1997
17.46	540.65	10/07/1986
17.35	540.54	05/08/1975
17.24	540.43	04/26/1969
17.10	540.29	04/29/1951
16.90	540.09	06/26/1974
16.90	540.09	04/06/1979

4.3. Stage Hydrographs and Elevation Duration. The nearest stream gage locations to the Project are Keithsburg (RM 427.4), Lock and Dam 18 Pool (RM 410.5), and Lock and Dam 17 Tailwater (RM 437.1). Lock and Dam 17 was placed into operation in May 1939 and Lock and Dam 18 was placed into operation in September 1937. According to the Lock and Dam 18 Regulation Manual, the flat pool elevation at Lock and Dam 18 is 528.02 and flat pool elevation at the Keithsburg gage is 527.99 (Reference 3). Therefore, estimated flat pool at Huron Island is 528 feet.

Average annual discharge at Lock and Dam 18 is approximately 80,650 cubic feet per second (cfs; period of record 1986-2005). The long term (post-impoundment) average annual elevation hydrograph (figure H-7) illustrates a spring to early summer flood followed by low summer flows from mid-July through September. Discharge frequently increases slightly during fall and is generally low and more stable during winter.

The annual elevation-duration curve at the Keithsburg gage indicates a median river elevation of 531.09 feet MSL 1912 (figure H-8; period of record 1980-2010). The period 1980-2010 represents the most recent 30-year period of record. A comparison of elevation duration curves for the full period of record (1938-2010) and the most recent 30-year period of record indicates river stages have increased over the last 30 years (figure H-9). Part of the reason for this stage increase is a change in the operation at the dam during the winter months that began in 1980 as an effort to limit the pool drawdown for environmental reasons. A comparison of pre- and post-impoundment average annual hydrographs illustrates the magnitude of the impact resulting from construction of the dam (figure H-10).

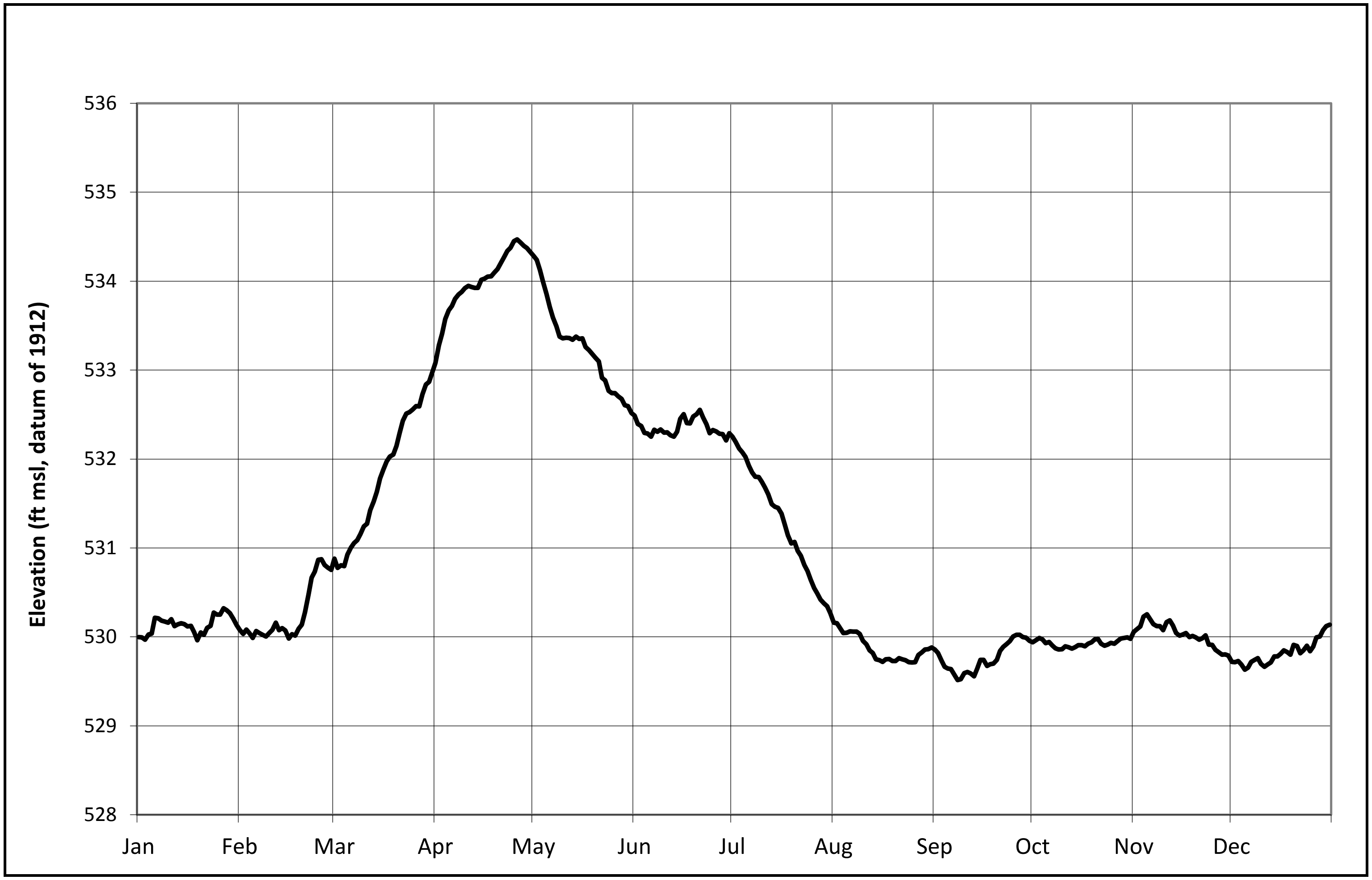

Figure H-7. Long Term Average Annual Elevation Hydrograph at the Keithsburg Gage (1938-2010)

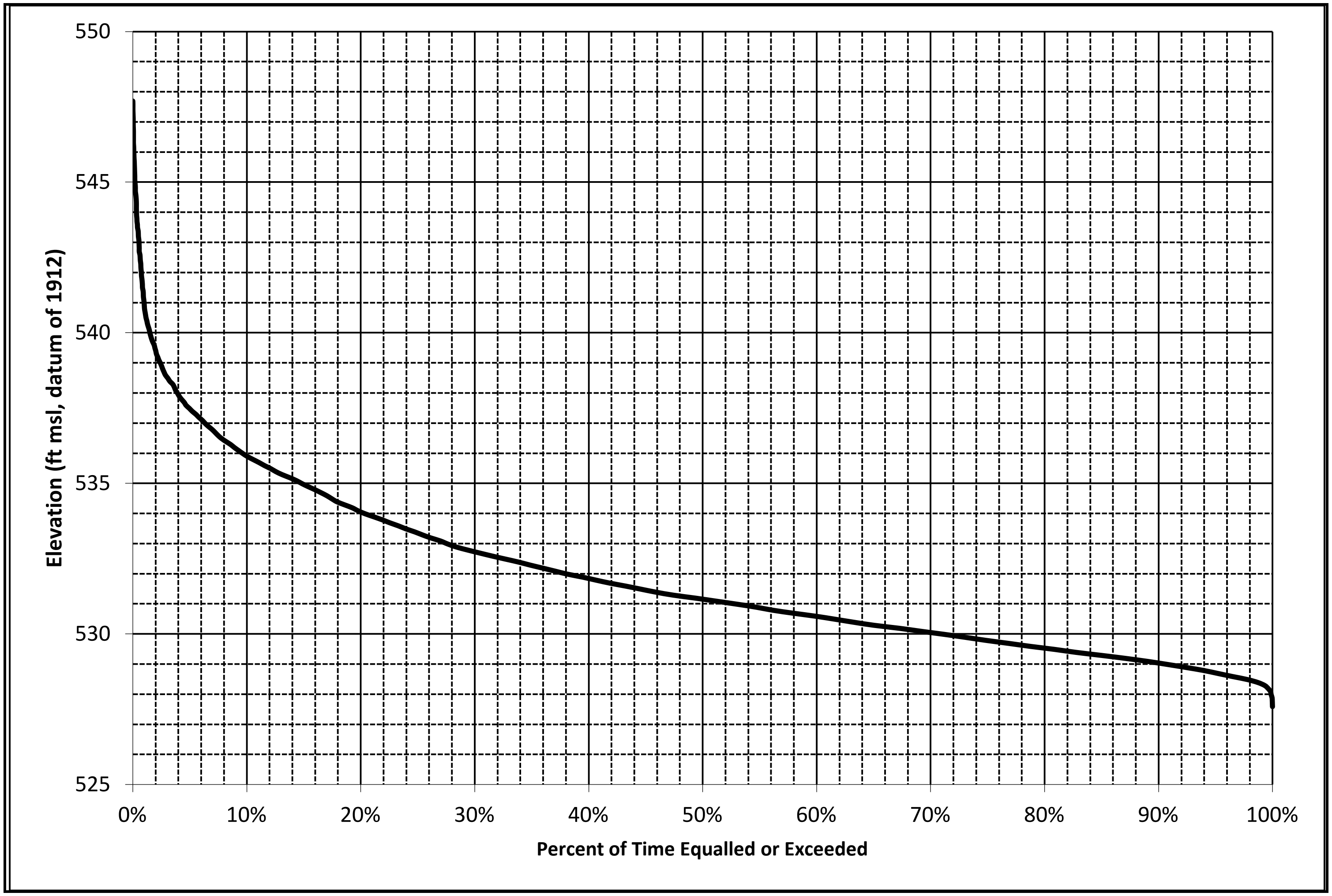

Figure H-8. Annual Elevation-Duration Curve at the Keithsburg Gage for the Period 1980-2010

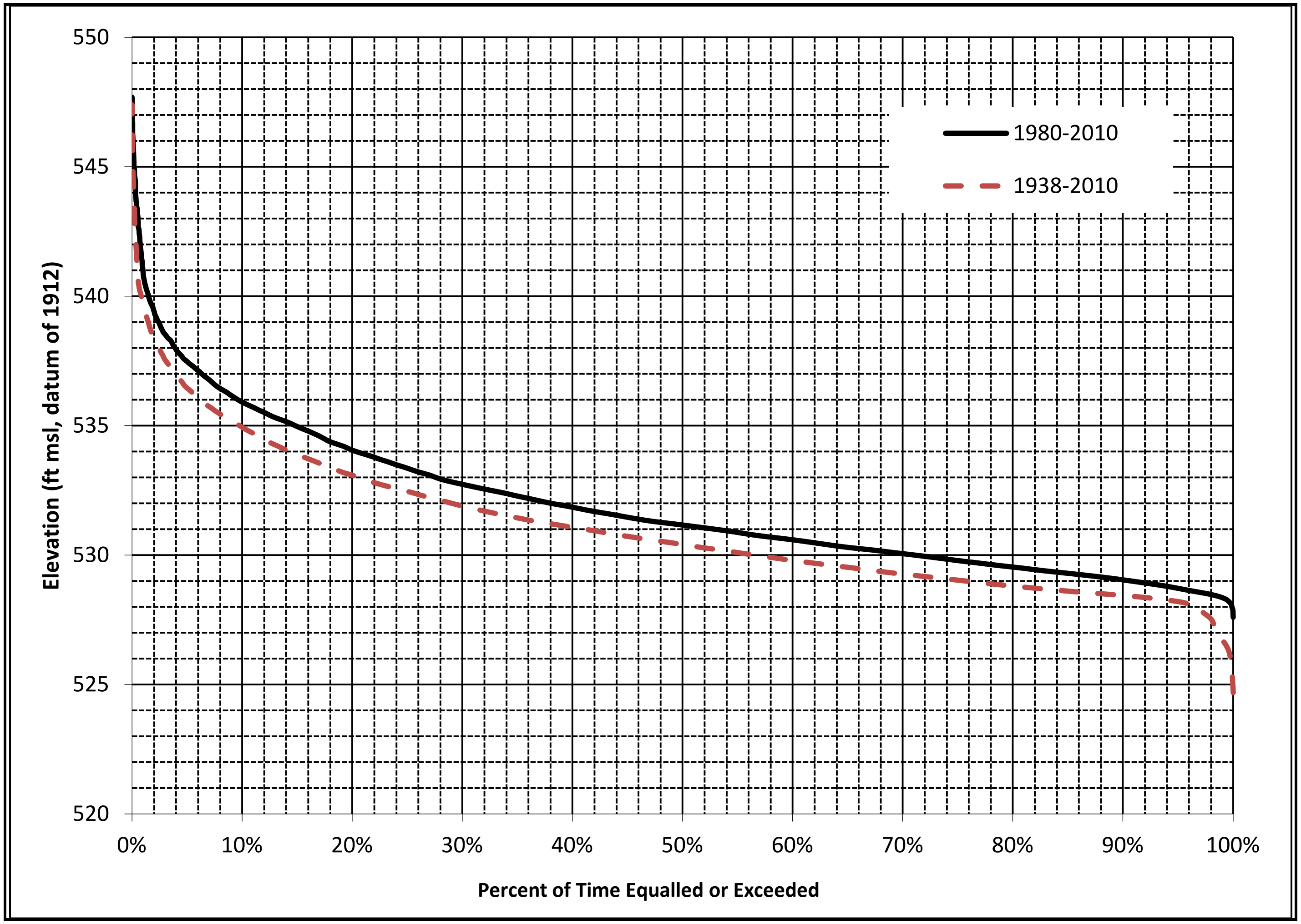

Figure H-9. Comparison of Annual Elevation-Duration Curves at the Keithsburg Gage for Long Term and More Recent Periods of Record

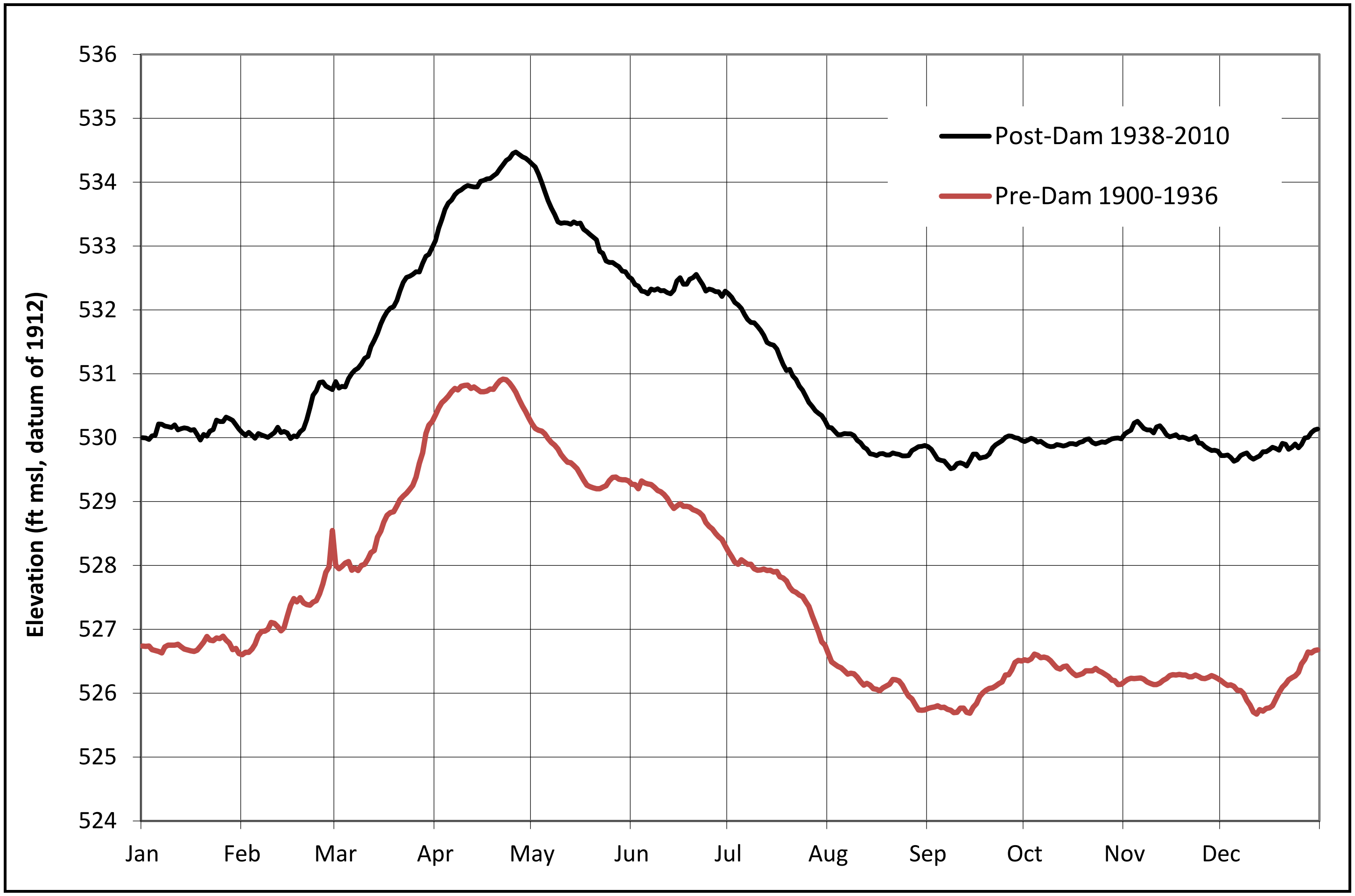

Figure H-10. Comparison of Long Term Average Annual Hydrographs at the Keithsburg Gage for Pre- and Post- Impoundment.

The period from 1980-2010 was selected to characterize the existing conditions (post impoundment) because this period represents the most recent period and still contains thirty years worth of data. Several seasonal duration curves for the post-impoundment record (1980-2010) at the Keithsburg gage were generated based on critical periods to the Huron Island floodplain forest and aquatic ecosystems (figures H-11 through H-13). Low water conditions which threaten dissolved oxygen concentrations and fish habitat occur during the winter (November through February) and summer (July through August) months. The period between November and the end of February present the most critical conditions, more so than the summer low water months (figure H-11). Sixty-four percent of the time during the months from November through February (71 percent of time throughout the year), the water surface elevation at the Keithsburg gage is greater than 530 feet. This water surface elevation of 530 feet at Keithsburg results in a water surface elevation of 529.6 feet at the upstream end of the island (RM 425.4), and a water surface elevation of 529.0 feet at the downstream end of the island (RM 421.2). Aquatic and floodplain habitat benefits at Huron Island were defined with respect to this reference water surface. Land below this reference water surface is eligible to contribute aquatic benefits, and land above this reference water surface is eligible to contribute floodplain benefits as a result of the proposed Project.

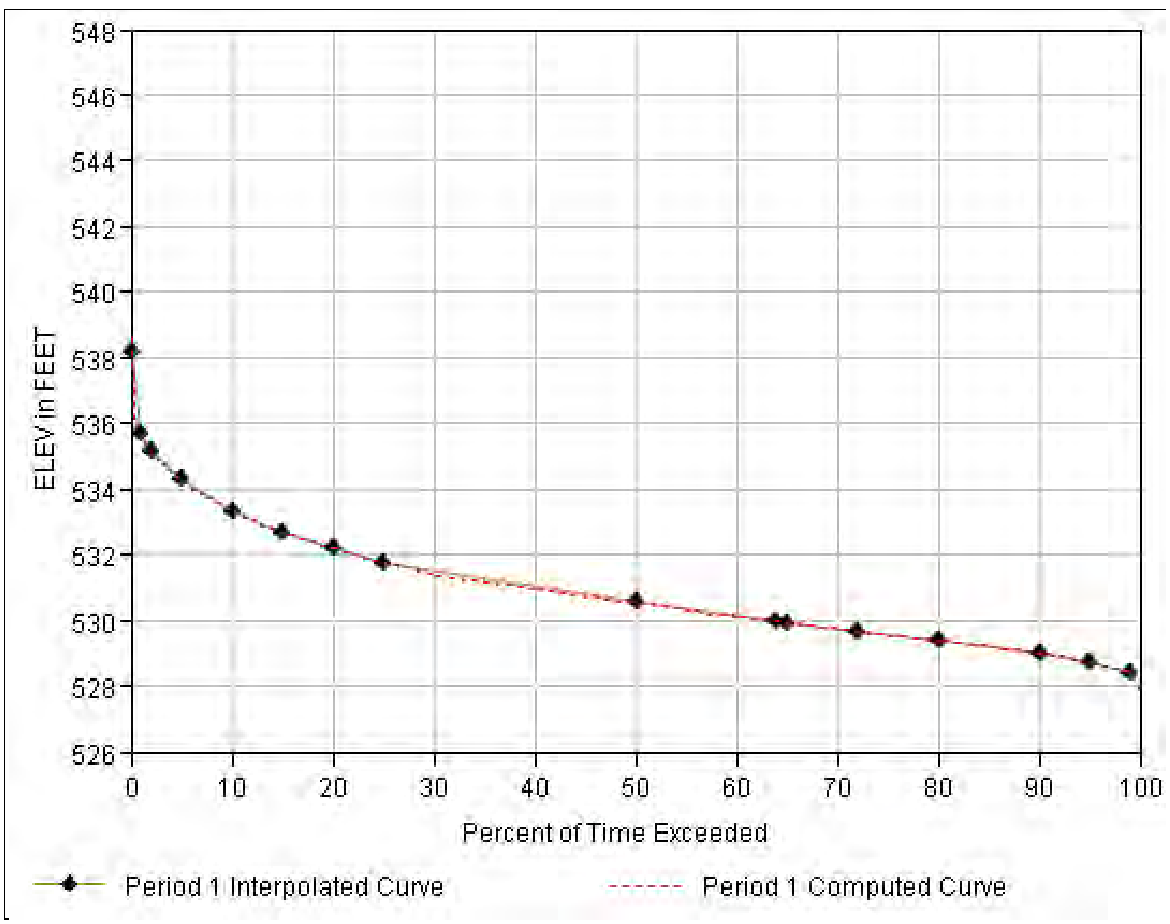

Figure H-11. Duration Curve at the Keithsburg Gage for Fall/Winter (November Through February) Low Water Season for the Period 1980-2010

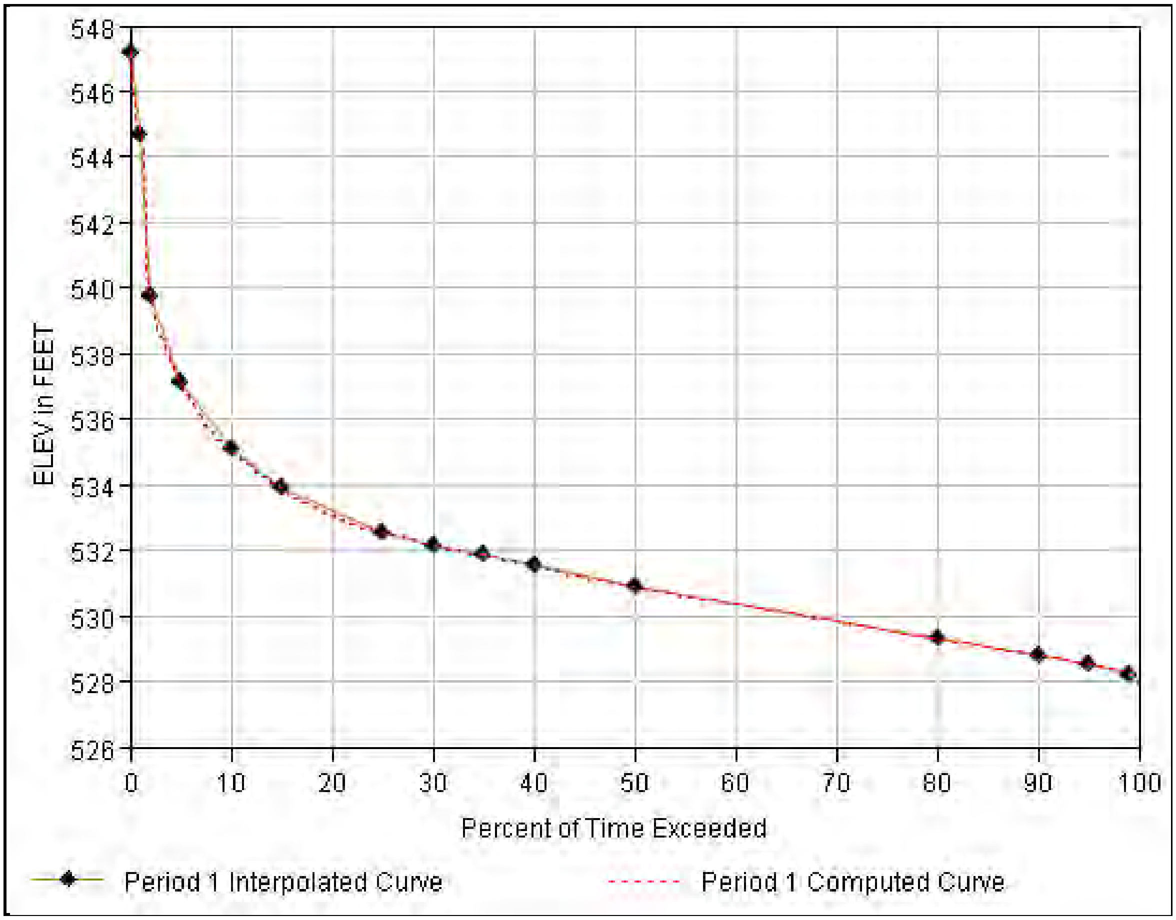

Figure H-12. Duration Curve at the Keithsburg Gage for the Summer (July Through August) Low Water Season for the Period 1980-2010

Floodplain forest diversity is dependent on river conditions during the growing season. The growing season for Pool 18 was defined as beginning April 10 through October 28. This seasonal duration curve is shown below (figure H-13).

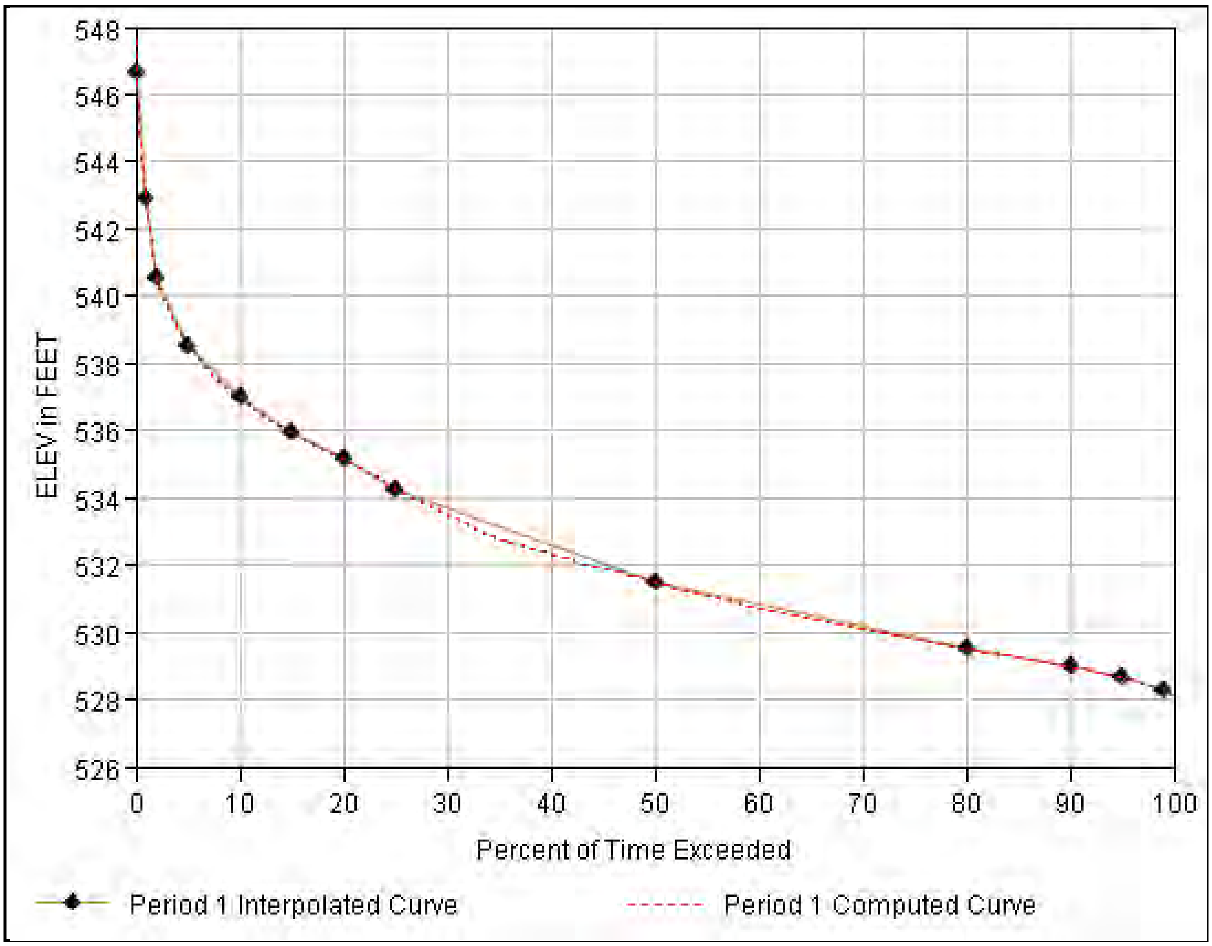

Figure H-13. Duration Curve at the Keithsburg Gage for the Growing Season (April 10-October 28) for the Period 1980-2010

In order to better illustrate the impacts of impoundment to floodplain forest diversity at Huron Island, the Hydrologic Engineering Center's Ecosystem Functions Model (HEC-EFM) was used to contrast pre-and post-impoundment stage duration and frequency relationships at the Keithsburg Gage (Reference 4). The results at Keithsburg were then interpolated downstream to Huron Island based on established water surface profiles for the given discharge.

The Project Development Team's (PDT) forester sorted key floodplain forest species into one of three different groups based upon their tolerance to sustained inundation. Tolerances to sustained inundation were established for each group: maximum tolerance; moderately tolerant; and minimal tolerance. 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. For each of the three tolerances, HEC-EFM was used to query the growing season portion to determine the elevation that 1) meets the specified inundation duration conditions and 2) meets a specified exceedance probability. For example the moderately tolerant species can withstand 35-45 consecutive days of inundation. For a given year EFM uses a moving 35-day window to identify each 35-day minimum that occurs within the growing season. EFM returns the maximum of all the 35-day minimum values in a given year, for every year included in the period of record. Finally an exceedance probability is specified, for example 50 percent, and EFM ranks each of the annual maximum values from the previous step and returns the value that has a 50 percent exceedance probability. This EFM analysis was performed for two different periods of record: pre-impoundment and post-impoundment. Comparison of the results for these two different periods of record indicate a significant difference in flood stages that occurred during the growing season prior to impoundment and those that occur presently. An example of these results for moderately tolerant species is shown below (table H-5). The less the exceedance probability, the lower the mortality risk for trees planted at that elevation.

Table H-5. Comparison of Results From HEC-EFM for the Moderately Tolerant Floodplain Forest Species Using Pre- and Post-Impoundment Keithsburg Gage Records

Period of Record	Low Flow (71% Annual Duration)	EFM 50% Exceedance Stage	EFM 33.3% Exceedance Stage	EFM 25% Exceedance Stage	EFM 10% Exceedance Stage
Pre-Dam (1900-1936)	525.7 (discharge unknown)	529.4 (discharge unknown)	530.4 (discharge unknown)	531 (discharge unknown)	532 (discharge unknown)
Post-Dam (1980-2010)	530 (~52,000 cfs)	534.5 (~120,000 cfs)	535 (~130,000 cfs)	535.3 (~140,000 cfs)	537.9 (~190,000 cfs)

As previously stated, EFM results computed at the Keithsburg gage (RM 427.4) were interpolated downstream to Huron Island using established water surface slopes. The pre-dam slopes were obtained from the Pool Operation Study for Pool 18 and the post-dam water surface slopes were obtained from an existing Pool 18 HEC-RAS model and 2004 flow frequency profiles (Reference 2). The EFM results at Huron Island were used as a guide to develop berm design elevation alternatives. This is discussed in greater detail in Section V, *Evaluation of Feasible Project Measures and Formulation of Alternatives,* of the main report.

5. HYDRAULIC MODELING

5.1. One-Dimensional (1-D) Hydraulic Modeling (HEC-6T). In 2007 a 1-D hydraulic model (HEC-6T) was developed to evaluate sedimentation within Perow Slough and Gun Slough. At the time this model was developed, the primary project objectives were to provide fish overwintering habitat throughout these sloughs and to increase sediment transport capacity. The design criteria necessary to meet this objective as specified by the PDT was a minimum flow of 50 cfs and a maximum velocity of 0.06 ft/s.

Several alternatives were evaluated to meet the overwintering objective including wing dams, a controlled inlet, and dredging a length of 1.3 miles of Perow and Gun Slough. Sediment modeling was performed to evaluate the sustainability of each of these alternatives. The results of the modeling indicated that there was not enough energy within Perow and Gun Slough to provide self-scouring conditions while meeting the maximum velocity conditions required for fish overwintering.

5.2. Two-Dimensional (2-D) Hydraulic Modeling (RMA2). In 2007 an existing hydraulic model mesh of Pool 18 was reduced in reach length to focus on the Huron Island model reach (RM 429.5 to RM 416.3) and adapted to include Huron Chute, Perow Slough and Gun Slough, Buffalo Slough, Little Cody Chute and Beaver Chute. At the time this modeling work was completed, channel bathymetric data available to support the modeling of these interior streams was very limited and broad coverage of overland elevation data such as LiDAR was not available. As a result of these data limitations the model was not capable of accurately simulating flows over the island. The model mesh was developed for use of the River Management Associates 2 (RMA2) 2-D numerical hydraulic model (Reference 5). Figure H-14 illustrates the coarse density of the RMA2 model mesh throughout Huron Island. Buffalo Slough is outlined in red for comparison with the AdH model mesh representation as later discussed. The RMA2 model was calibrated under a discharge of ~160,000 cfs, (slightly less than the 50 percent exceedance probability (2-yr) conditions), based on Acoustic Doppler Current Profiler (ADCP) measurements collected within the main channel and the Huron Island interior channels on April 17&18, 2007. With the current availability of LiDAR, it is now understood that much of the island is inundated at a discharge of 160,000 cfs. Therefore, the results from the RMA2 model must be viewed with caution.

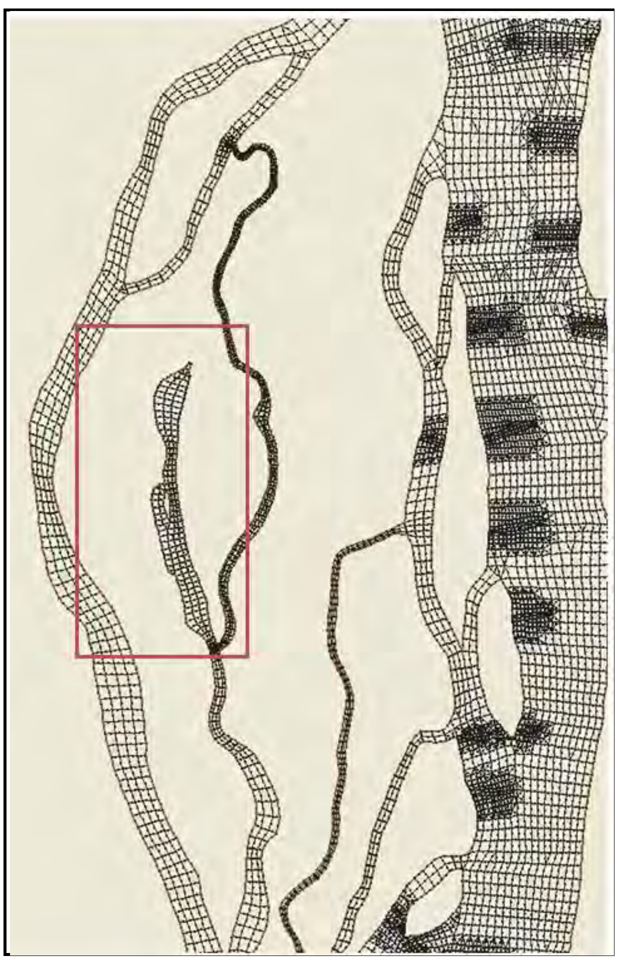

Figure H-14. 2007 RMA2 Model Mesh Depicting Huron Island

5.3. Two-Dimensional (2-D) Hydraulic Modeling (AdH). With the availability of LiDAR data in early 2011, the decision was made to develop a 2-D steady-state hydrodynamic model, using AdH, capable of simulating the island under inundation conditions. In addition to meeting the modeling needs of the HREP feasibility study, a second application of this new AdH model was to evaluate the design of a new regulating structure upstream of Huron Chute where a persistent shoaling problem was identified by the Committee to Assess Regulating Structures (CARS). In the event that the proposed structure would significantly impact flows down Huron Chute and thereby potentially impact the Huron Island HREP, the evaluation of proposed wing dam structures was undertaken concurrently with the HREP Feasibility Study.

The 2-D hydrodynamic code Adaptive Hydraulics (AdH) version 4.01 was chosen to simulate island inundation conditions due to its strength in modeling conditions where wetting and drying of nodes is occurring (Reference 6). AdH solves the 2-D vertically averaged form of the Navier-Stokes equation. AdH also models sediment transport of both cohesive and non-cohesive sediments; specifically erosion, entrainment, transportation, deposition and compaction. The river reach modeled in AdH begins several miles upstream of the Huron Island project at RM 430.8 and continues downstream to RM 416.15.

5.3.1. AdH Mesh Development and Supporting Elevation Data. The approach to developing the AdH mesh was to first create a surface elevation model using a triangulated irregular network (TIN) format in ArcMap and then digitize the mesh nodes using the Surface Water Modeling System (SMS) based upon resolution present in the TIN. Banklines created during the TIN development were loaded into SMS to consistently define banklines in the mesh. Once the mesh nodes had all been digitized, elevations at each of the mesh nodes were then extracted from the TIN in ArcMap.

In early 2011 LiDAR data collected under the statewide Iowa LiDAR Project became available for the Project area, providing high density elevation data for Huron Island as well as Des Moines and Louisa counties. The flight date for this LiDAR collection was May 4, 2010. The stage reading at the Keithsburg gage for that date was 9.61 feet, approximately 4.8 feet above flat pool. Although river stage and vegetation conditions during LiDAR collection were not ideal, this was the only high resolution data available for Huron Island at the time. LiDAR was not available for Mercer and Henderson counties in Illinois, therefore 1/3 arc second (10 meter) digital elevation model data available through the USGS Seamless Data Warehouse was used to generate the overbank mesh elevations on the Illinois side.

In support of the HEC-6T model, in 2008 cross-sections were surveyed along Perow Slough and Gun Slough. In 2010, survey cross-sections were collected along the northern portion of Little Cody Chute for development of the 2D hydraulic model. In 2011 additional cross-sections in the uppermost reach of Perow Slough (the primary western island inlet) and in Upper Buffalo Slough were surveyed as were cross-sections of Upper and Lower Goose Lake to define the model mesh in these areas. In 2012 survey data of the two small islands in Huron Chute were collected in addition to channel bankline and sideslope survey for evaluation of erosion.

Bathymetric data used for the Huron Island model mesh originated from various sources as well. The bathymetric surface was based primarily on a pool-wide terrain dataset from the District's Operations

Division (OD-T), which includes data as old as 2006 and more recent. This pool-wide surface includes the June 2006 and the March 2007 surveys within Gun Slough, Perow Slough, Little Cody Chute and Buffalo Slough. In 2008 bathymetric survey data was collected within Huron Chute by OD-T and in 2010 bathymetry of the Garner Island Chute, Little Cody Chute and channels on the eastern boundary of the island was collected by the Rock Island District's Survey Branch using a single beam echosounder. There were several issues with the results from the echosounder data that required adjustment and in some cases altogether exclusion of this data. For example, in some areas intersecting echosounder transects varied in elevation by 4 feet or more at the point of intersection.

As part of the LTRMP, a contract to collect "gaps" within the pool-wide bathymetric surface (i.e. gaps in the navigation channel survey coverage, backwater areas and side channels) throughout the UMRS was administered in 2010. This "gap" contract also included survey of the wing dams within the UMRS. Both of these datasets were included in the pool-wide bathymetric surface. Several wing dams within the Huron Island model reach (in Pool 18) were not captured in this dataset. These missing river training structures were defined using a compilation of numerous digital data sources including the 2011 digital navigation chart wing dam coverage, 2008 surveyed wing dam endpoints, the pool-wide bathymetric data coverage as described above, as well as feedback from OD-T's boat operators. Significant efforts were made to improve the accuracy of wing dam representation in this model.

Following merging and editing of the various channel and overbank elevation datasets for development of the TIN, banklines were defined using LiDAR and orthoimagery. A significant effort was made to include interior channels throughout Huron Island in the model. Given the limited bathymetry within the island, additional breaklines were necessary to improve the channel representation in some of the backwater channels where survey data was sparse.

The density of mesh nodes varied depending on the features within the model. Representing the large number of small streams located throughout the island resulted in a very dense mesh network throughout the island area. Within the navigation channel mesh node density was much less than around river training structures and within Huron Island. The complexity of the AdH model mesh from inclusion of so many of the island's backwater features resulted in a very large number of elements. The total number of mesh nodes was over 256,000 and the total number of elements exceeded 511,000. Without question the AdH mesh includes much greater detail than does the RMA2 mesh (figures H-14 & H-15). Buffalo Slough is outlined in red on both Figures H-14 and H-15 to better illustrate the detail included in the AdH mesh. The size of the AdH model required simulation to take place using the Engineering Research and Development Lab's (ERDC) High Performance Computing (HPC) resources for efficient simulation times. The version 4.01 executable was recompiled specifically for use with the Garnet HPC. Coordination with the AdH development team took place early on during model development and support from the team was provided throughout the modeling effort. Pre- and post- processing of AdH results was performed using the Surface Water Modeling System (SMS).

5.3.2. Parameterization. New material types were defined where a change in frictional parameters was anticipated based on channel morphology, bed material or vegetation density and type. Individual material types were defined for the main channel, shallow side slopes/bank areas, overbank areas and islands, urban areas, wing dams, channels within Huron Island, and areas within the Island where forest vegetation changed (figure H-16).

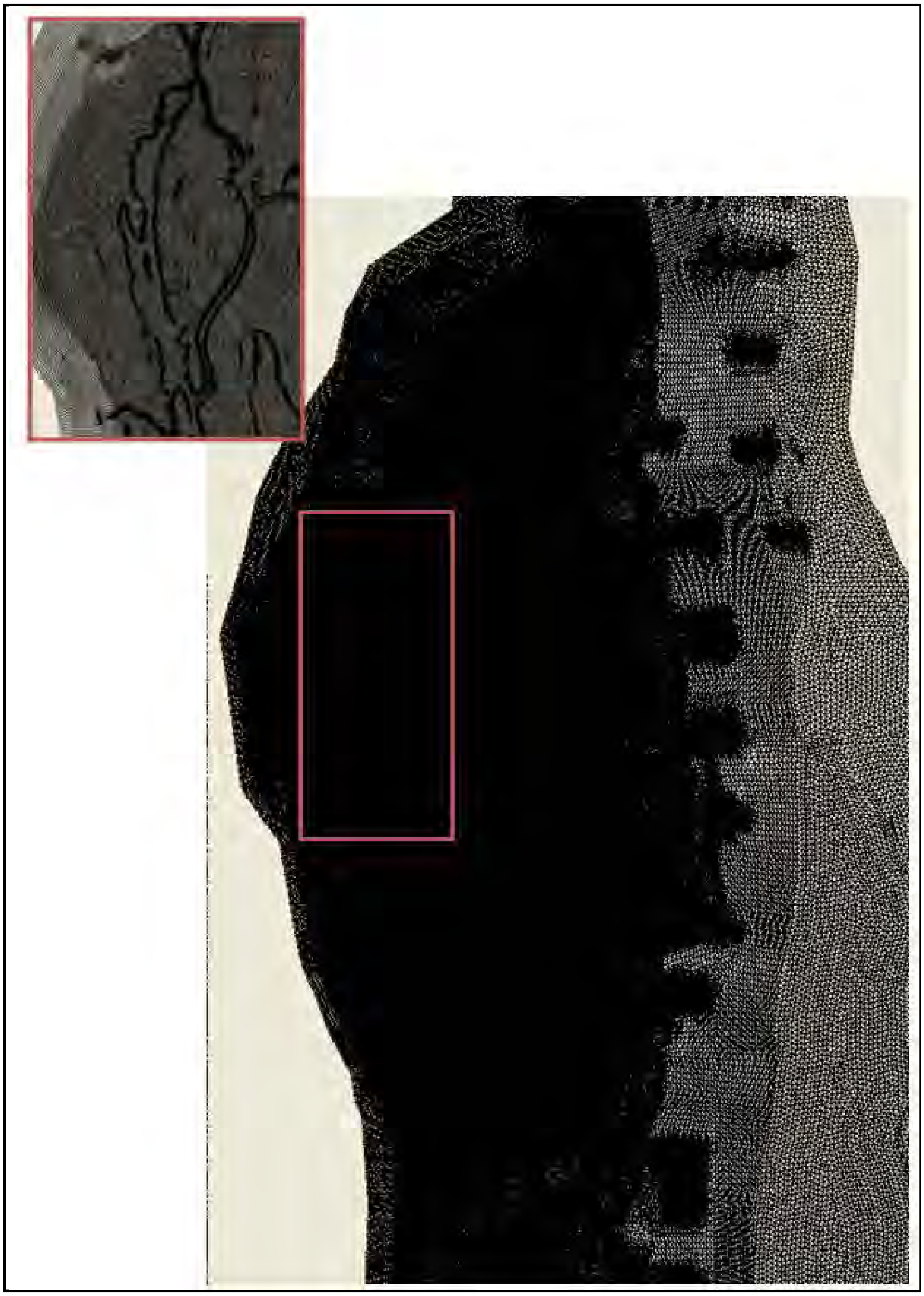

Figure H-15. AdH Model Mesh Depicting Huron Island

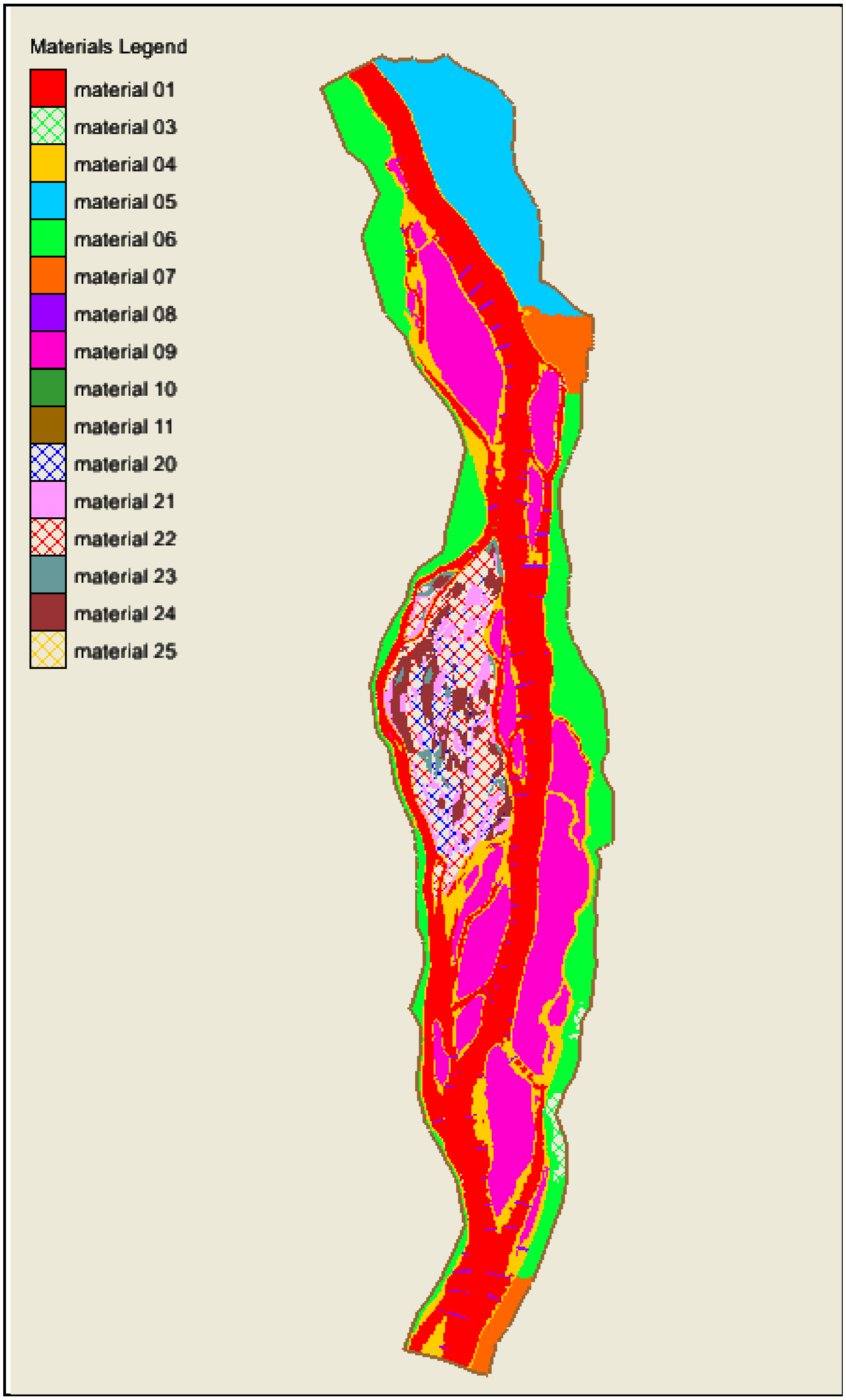

Figure H-16. AdH Material Type Map

Manning's roughness was the primary method used to represent frictional losses throughout the model domain. However, flow and sedimentation over the island is largely impacted by the forest and understory vegetation, therefore per ERDC's recommendation, roughness on the island was represented using the unsubmerged rigid vegetation (URV) card. Unlike Manning's roughness, the computations used with the URV card account for an increase in roughness associated with a rising water depth due to the presence of vegetation. (This is the inverse of the depth-roughness relationship used in Manning's roughness).

The URV card parameters include bed roughness height (understory height), average stem diameter, and average stem density. In order to identify areas of differentiable roughness throughout Huron Island, a multivariate analysis was performed on results from the 2011 forest inventory. The multivariate analysis identified four different groups, each with a unique combination of bed roughness height, average stem diameter and average stem density. Homogenous polygons were drawn throughout the island based upon forest inventory results and aerial photography interpretation. Material types throughout the island were defined according to these polygons. The final parameter values are discussed in Section 5.4.3.2. *Calibration Method and Results*, table H-9.

5.3.3. Hydrodynamic Simulation. ADCP measurements in Pool 18 and within Huron Island were collected under three different flow conditions (table H-6). On April 6th and 8th 1999 ADCP measurements were collected under a discharge value of ~91,000 cfs. This discharge corresponds to a river stage of ~532.3 feet at the Keithsburg gage which is exceeded 35 percent of the year. Collection of ADCP measurements under a discharge of ~160,000 cfs was made on April 17 and 18, 2007 at several main channel and side channel locations throughout the model reach, as well as much of Huron Island. This discharge is slightly less than the 50 percent exceedance probability flow, which is ~168,000 cfs at Huron Island. The 50 percent exceedance probability elevation at Keithsburg is 536.8 feet and 535.2 feet near the middle of Huron Island (RM 423.5). On May 6, 2011 ADCP measurements were collected throughout the Huron Island Complex under discharge conditions ~215,000 cfs. This discharge is slightly less than the 20 percent exceedance probability discharge which is 219,000 cfs at Huron Island. The 20 percent exceedance probability elevation at Keithsburg is 539.5 feet and 537.8 feet near the middle of Huron Island (RM 423.5).

Table H-6. Summary of ADCP Measurements for the Huron Island Model Calibration

ADCP Collection Date	Discharge (cfs)	Transect Locations
April 6 and 8, 1999	91,000(~35 percent annual exceedance duration)	Main channel and side channels
April 17 and 18, 2007	160,000 (<50 percent exceedance probability discharge of 168,000 cfs)	Main channel and side channels and at several locations within the Huron Island interior
May 6, 2011	215,000 (<20 percent exceedance probability discharge of 219,000 cfs)	Main channel and side channels and at several locations within the Huron Island interior

As previously mentioned the AdH model begins several miles upstream of the Huron Island project at RM 430.8 and continues downstream to RM 416.15. Downstream water surface elevation boundary conditions for each of the model simulations were based on water surface elevations from the Pool 18 Drawdown HEC-RAS model, and the 2004 UMRS Flow Frequency Study water surface profiles

(Reference 2) (table H-7). For the 91,000 cfs simulation the downstream water surface elevation (529.1 feet) was interpolated using the 80,000cfs and 100,000 cfs results from the HEC-RAS Pool 18 drawdown model. The downstream boundary (531.3 feet) for the 160,000 cfs simulation was estimated as an interpolation between the HEC-RAS Pool 18 drawdown model results at 147,000 cfs (under regulated conditions) and the 50 percent exceedance probability discharge (169,000 cfs) from the 2004 UMRS Flow Frequency Study. The downstream boundary (531.9 feet) for the 215,000 cfs simulation was estimated using an interpolation between the 50 percent exceedance probability discharge (169,000 cfs) and the 20 percent exceedance probability discharge (219,000 cfs) from the 2004 UMRS Flow Frequency Study.

Table H-7. Huron Island Model Boundary Conditions Summary

Discharge (cfs)	Downstream Boundary WSEL	WSEL Interpolation Sources
91,000	529.1 ft	HEC-RAS Pool 18 drawdown model-80,000 cfs and 100,000 cfs results
160,000	531.3 ft	HEC-RAS Pool 18 drawdown model results at 147,000 cfs (regulated conditions) and 50 percent exceedance probability discharge (169,000 cfs) from *2004 UMRS Flow Frequency Study*
215,000	531.9 ft	50 percent exceedance probability discharge (169,000 cfs) and the 20 percent exceedance probability discharge (219,000 cfs) from *2004 UMRS Flow Frequency Study*

The steady-state simulations began using a 10-second time step that increased to a 200-second time step by the end of the one day simulation. As discussed earlier, the large number of elements associated with this model required simulation of the AdH code using ERDC's HPC. The hydrodynamic simulations used 256 processors and ran for 3.5 to 12 hours, depending on the simulated discharge.

5.3.4. Hydrodynamic Calibration

5.3.4.1. Calibration Challenges. Errors inherent in calibrating the Huron Island model include data collected during many different times. For example, the bathymetric surface is comprised of data that was collected as long ago as 2006 and as recently as 2011 and the ADCP measurements were collected in 1999, 2007 and 2011. Errors during the collection of hydrosurvey data resulting from interpolation of water surfaces between gages, inherent uncertainty in measuring equipment, and infrequent water surface elevation observations (i.e. assumption of a static water surface elevation throughout the entire hydrosurvey data collection period) introduce additional error into the model calibration. Although these errors are not easily quantified, they are commonplace when data-intensive modeling is performed for large areas.

Calibration efforts in backwater areas presented even more challenges. Computed discharges are very sensitive to geometry and because most of the backwater channels are relatively narrow (~100 to 200 feet wide) geometry errors are generally more significant due to the physical limitations of the data collection instruments. For example, the proportion of a small channel that is inaccessible to the hydrosurvey boat is greater than that of a larger channel. This results in a greater percentage of channel geometry error in small channels. Another source of error associated with the channel geometry is due to the need for interpolation between existing bathymetric data. Bathymetric and conventional channel survey information throughout the backwater areas was much less abundant than bathymetric data in the main channel, therefore more linear interpolation was required to complete a hydraulically correct bathymetric surface throughout the backwater areas.

5.4.3.2. Calibration Method and Results. Model calibration utilized ADCP measurements for all three discharge conditions. The ability of a model to simulate a range of flows using the same input parameters proves it is a more robust model. Therefore all available ADCP observation records were used during calibration.

The sequence for calibration of hydrodynamic models begins with water surface slope across the model reach, followed by discharge and velocity at ADCP transects. The reference used to measure the model's water slope fitness was based upon the historical fall record from the Keithsburg gage and Lock and Dam 18 Pool. These historical observations were compared to the difference between the model's simulated stage at the Keithsburg gage (RM 427.4) and the estimated downstream water surface elevation at Lock and Dam 18 (RM 410.5). Because Lock and Dam 18 is downstream of the model boundary, a "simulated" water surface elevation was determined according to the same method used to determine the model downstream boundary condition for each flow. For the 91,000 cfs simulation, a water surface of 528 feet was determined based upon the regulation manual. For the 160,000 cfs condition a water surface of 528.9 feet was determined based upon an interpolation between the Pool 18 drawdown model stage and the 2-yr flow frequency stage, and for the 215,000 cfs simulation a water surface of 531.9 feet was determined based on an interpolation between the 2-yr and 5-yr flow frequency stages. The water surface slope tends to be most sensitive to roughness values for the main channel and wing dams, so these parameters were the only values adjusted during calibration (table H-9).

Manning's roughness values that resulted in a calibrated water surface profile included a roughness of 0.021 for the main channel, 0.025 for the side slopes and 0.05 for the wing dams. Table H-8 shows the final set of material type parameter values and the range of values simulated during calibration. The final parameter values show close agreement with past Pool 18 and other UMRS 2-D hydraulic model parameter values. Computed and observed fall in water surface between Keithsburg (RM 427.4) and L&D 18 (RM 410.5) under different Manning's roughness values and different simulated flows is shown in figure H-17. This figure illustrates how closely the calibrated model was able to simulate historical water surface profiles.

Table H-8. AdH Model Material Type Parameterization

Material Type	Material Type Map ID (figure H-14)	Final Manning's n (calibration range)	Unsubmerged Rigid Vegetation Parameters: Bed Roughness Height (ft)	Average Stem Diameter (ft)	Average Stem Density (stems/ft^2)
Main channel	1	0.021 (0.02-0.025)	N/A	N/A	N/A
Shallow side slopes/bank areas	4	0.025	N/A	N/A	N/A
Overbank areas and islands	3, 5, 6, & 9	0.035	N/A	N/A	N/A
Urban areas	7 & 25	0.045	N/A	N/A	N/A
Wing dams	8, 10, & 11	0.05 (0.045-0.06)	N/A	N/A	N/A
Huron Island channels	20	0.025	N/A	N/A	N/A
High stem density, no understory	21	N/A	0.01	1.79	0.001878
Larger trees, understory	22	N/A	10	2.15	0.001040
Larger trees, sparse, no understory	23	N/A	1	2.4	0.000661
High stem density, understory	24	N/A	20	1.82	0.001703

Table H-9. Summary of Discharge Calibration By Location

Discharge (cfs)	Year	Total # of ADCP Transects	Average Percent Error: Main Channel (# transects)	Side Channel (# transects)	Backwater (# transects)
91,045	1999	10	8 (4)	30 (6)	N/A (0)
160,000	2007	12	2 (5)	10 (3)	133 (4)
215,000	2011	21	3 (5)	9 (6)	41 (10)

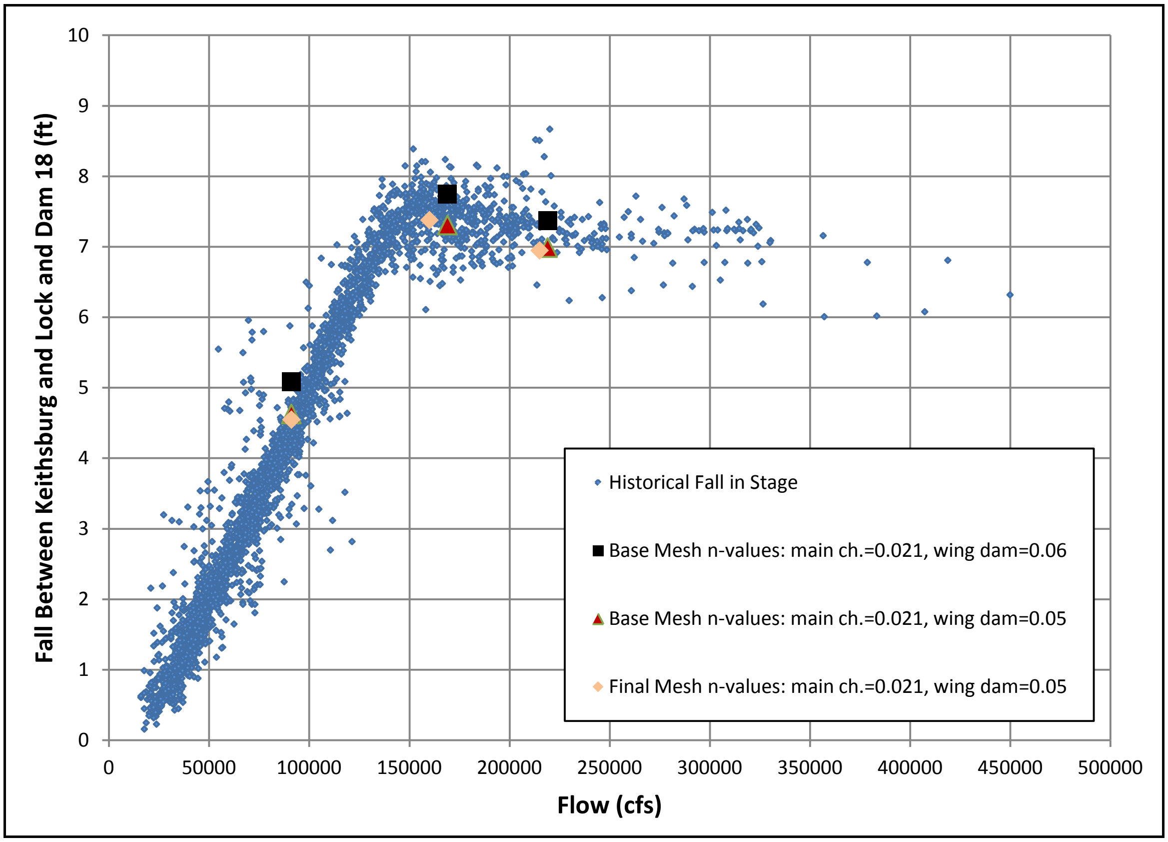

Figure H-17. AdH Water Surface Slope Calibration Results

Following calibration of water surface slope, the next step in the process is to calibrate discharge distribution. Discharge calibration of the Huron model was facilitated through use of observation coverages in SMS. GIS shapefiles of the different ADCP transects were loaded into SMS, and observation arcs were defined at the same location as the transects in order to determine the computed discharge at the same location as the measured discharge. A set of observation arcs was created for each of the three ADCP datasets (1999, 2007 and 2011). Discharge distribution is most sensitive to mesh geometry, therefore re-examination of hydrosurvey input and mesh improvements were required to improve discharge calibration at some locations. A summary of the discharge calibration results for different transect locations is shown below (table H-9). Average percentage error is computed as:

$$Average\ Percent\ Error = \left[1/n \sum_{i=1}^{n} \left(\frac{|(Q_m - Q_s)|}{Q_m} \right)_i \right] \ x\ 100$$

Where n = number of discharge observations
Q_m= ADCP measured discharge (cfs)
Q_s= simulated discharge (cfs)

The summary of discharge calibration results illustrates the difficulty calibrating in backwater channels (table H-10).

Table H-10. Huron Chute Existing Conditions Computed Discharge (all measurements in cfs)

Total Discharge	Huron Chute Q	Main Channel Q
60,000	7,385	53,069
91,045	13,386	78,506
160,000	25,010	134,374

The average percent error increases as the channel width decreases (i.e. from main channel to side channel and to backwater). Overall calibration focused on ADCP transects that were located upstream of and near Huron Island, (specifically within Huron Chute, the upstream side channels, and the Main Channel), so that the hydrodynamic solution near the Project area would be as accurate as possible. One ADCP transect located in a side channel, near a closing dam south of Huron Island was particularly difficult to calibrate to. However, because it was located downstream of the Project area unwarranted effort was not invested in resolving the discharge solution at this location. Although there exists a significant amount of error among the backwater ADCP transects, given the inherent challenges in calibrating discharge in narrow backwater channels and the accelerated schedule excessive resources were not applied to resolving the solution within these channels.

Calibration of velocity distribution is the final step in the calibration process. Velocity distribution across a channel is most affected by roughness values. Further adjustment of channel and/or wing-dam roughness may be warranted, however caution must be exercised when making localized changes to roughness values without good physical rationale. Calibration of velocities in the Huron model did not require any additional changes to roughness values.

5.3.5. AdH Hydrodynamic Results. Sections 5.3.5.1 through 5.3.5.3 present results from the AdH hydrodynamic modeling effort. Existing condition results are presented, followed by results for the evaluation of CARS regulating structures and lastly the HREP Tentatively Selected Plan (TSP) results.

5.3.5.1. Existing Conditions. Existing condition hydrodynamics are presented based on the following four discharge conditions: 1) median flow conditions during the over-wintering period (60,000 cfs); 2) 35% annual exceedance duration discharge (91,000 cfs); 3) near 50% exceedance probability discharge (160,000 cfs); and 4) near 20% exceedance probability discharge (215,000 cfs). These discharges were chosen because they represent a broad range of conditions under which to evaluate the Project. Computed discharges and velocities for existing conditions in the vicinity of the proposed Project features are summarized below for comparison to computed discharges and velocities with the proposed features in place.

Huron Chute is a large side channel that carries a significant amount of flow, though the proportion of the total river flow it carries varies as a function of discharge. Discharge in Huron Chute was computed just downstream of the closing dam under different flows and is reported along with main channel flow in table H-10. Generally, velocities found in Huron Chute are less than those in the navigation channel, however where the main channel is broad, often where a channel crossing occurs, velocities found within the main channel but outside of the navigation channel are similar to those found in Huron Chute. Typical computed velocities in Huron Chute under flow conditions of 160,000 cfs (near the 50% exceedance probability) are 2.5-4 ft/s (figure H-18). During 215,000 cfs flow conditions (near the 20% exceedance probability) velocities in Huron Chute are on the order of 2.5-4.5

ft/s (figure H-19). Main channel velocities under this flow are increased relative to the 160,000 cfs velocities. During over-wintering conditions (60,000 cfs) typical velocities in Huron Chute are 1-2.5 ft/s (figure H-20).

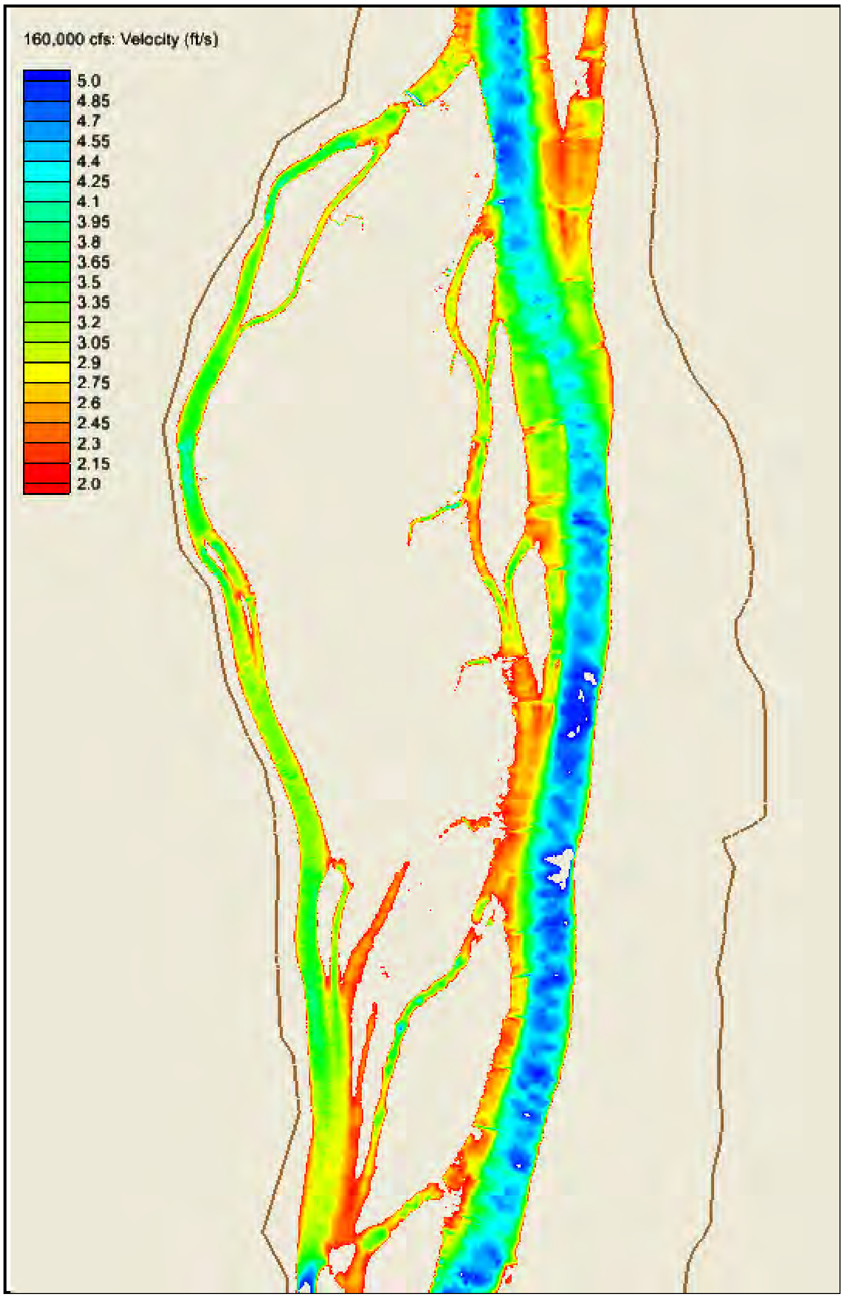

Figure H-18. Existing Condition Velocity Results for Huron Chute, Garner Chute and the Main Channel Under Discharge Conditions of 160,000 cfs

Note that velocity results above 5 ft/s and below 2 ft/s are not explicitly mapped.

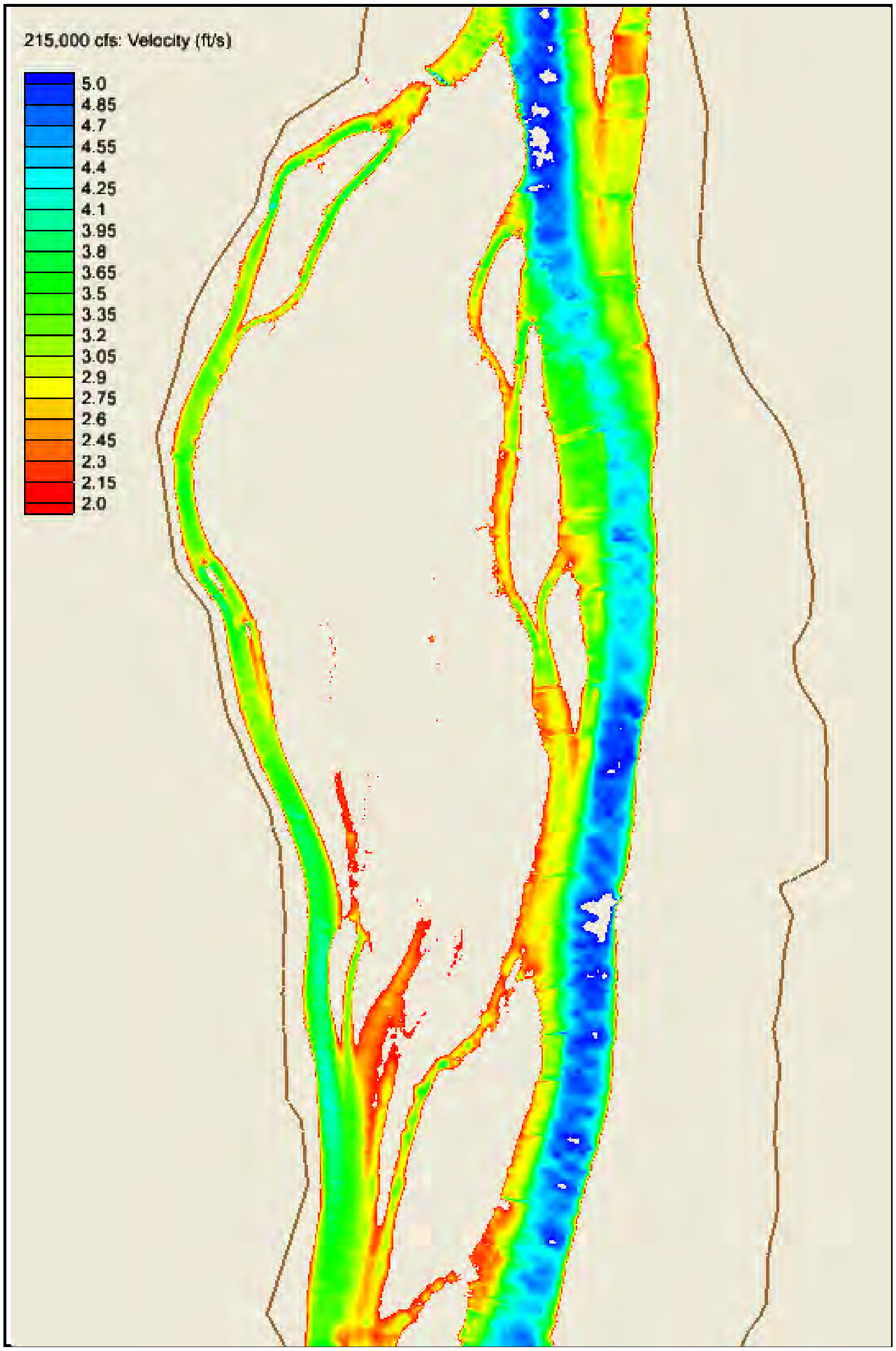

Figure H-19. Existing Condition Velocity Results for Huron Chute, Garner Chute and the Main Channel Under Discharge Conditions of 215,000 cfs

Note that velocity results above 5 ft/s and below 2 ft/s are not explicitly mapped.

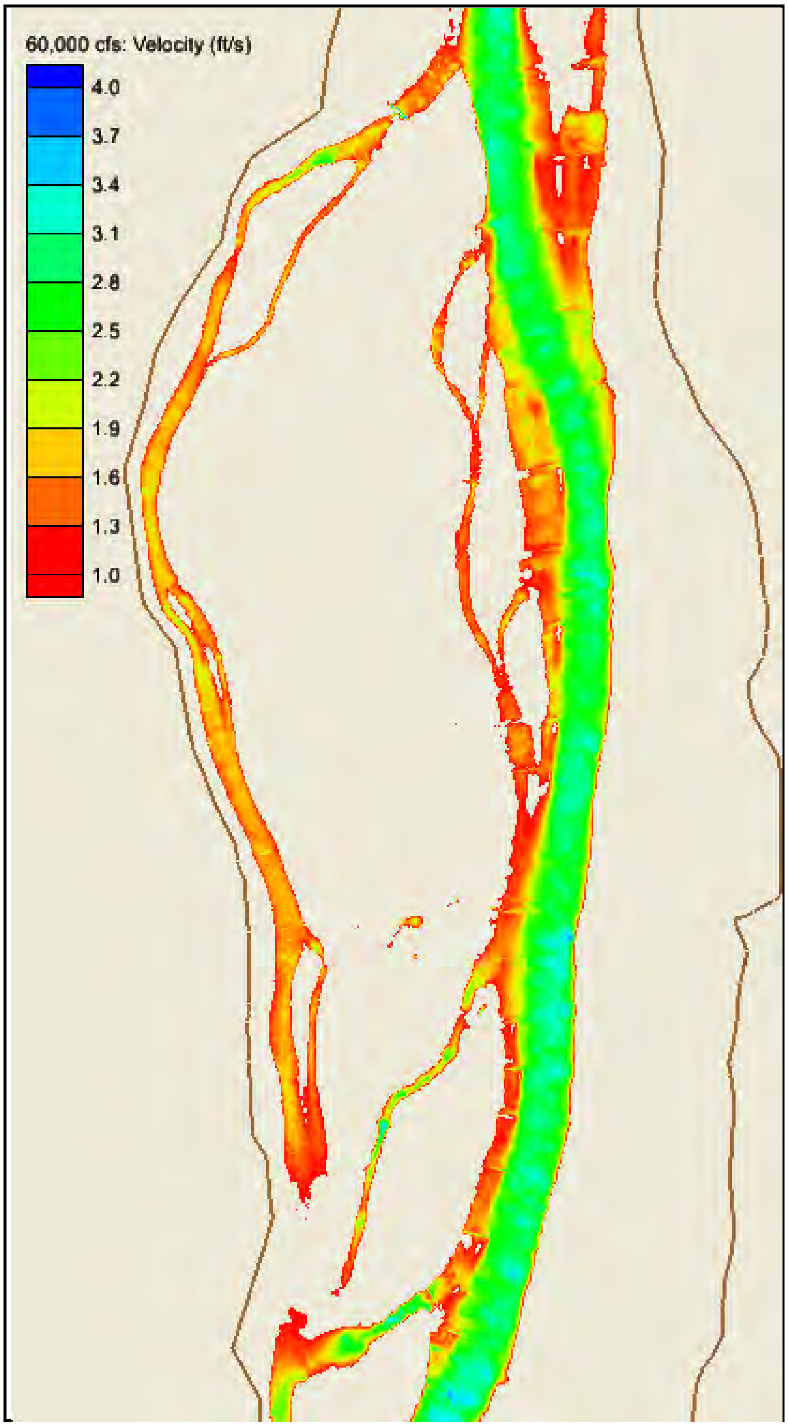

Figure H-20. Existing Condition Velocity Results for Huron Chute, Garner Chute and the Main Channel Under Discharge Conditions of 60,000 cfs.

Note that velocity results above 4 ft/s and below 1 ft/s are not explicitly mapped.

Garner Island is located within the upper reach of Huron Chute, with the upstream end located at approximately RM 424.9. Garner Chute is located on the left descending bank of Garner Island (figure H-1). The primary inlet to Huron Island is located at RM 424.6 and is fed by Garner Chute. A summary of computed discharges within Garner Chute, Huron Chute and the main channel under different flows is shown below (table H-11). Garner Chute was identified for a potential project feature designed for function during overwintering conditions. Typical computed velocities in Garner Chute under low flow overwintering conditions (60,000 cfs) are 1-2 ft/s.

Table H-11. Garner Chute Existing Conditions Computed Discharge

Total Discharge (cfs)	Garner Chute Q (cfs)	Huron Chute Q (cfs)	Main Channel Q (cfs)
60,000	2,227	7,385	53,069
91,045	4,017	13,386	78,506
160,000	8,712	25,010	134,374
215,000	12,485	28,598	172,126

In the middle reach of Huron Chute, there are two islands that continue to experience erosion. The islands were identified as areas for potential project features and are therefore evaluated herein. The reach of Huron Chute where these islands are located is rather narrow and the Two Rivers Levee and Drainage District is located on the right descending bank of Huron Chute. Riprap has been placed along the levee near the islands to address existing erosion, therefore it will be critical to demonstrate that velocities are not increased as a result of any project features associated with the islands. Computed velocities under 160,000 cfs discharge conditions at cross-sections located upstream of the islands are shown below (figures H-21 & H-22).

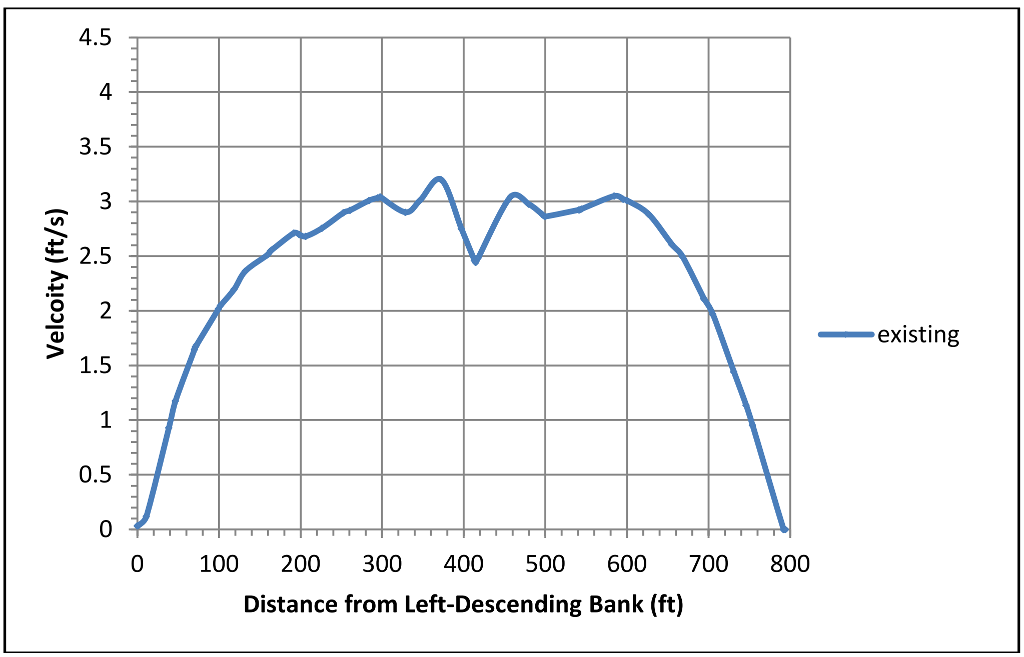

Figure H-21. Existing Computed Velocities During 160,000 cfs Discharge at the Location of thehe Proposed Upstream Chevron (I2)

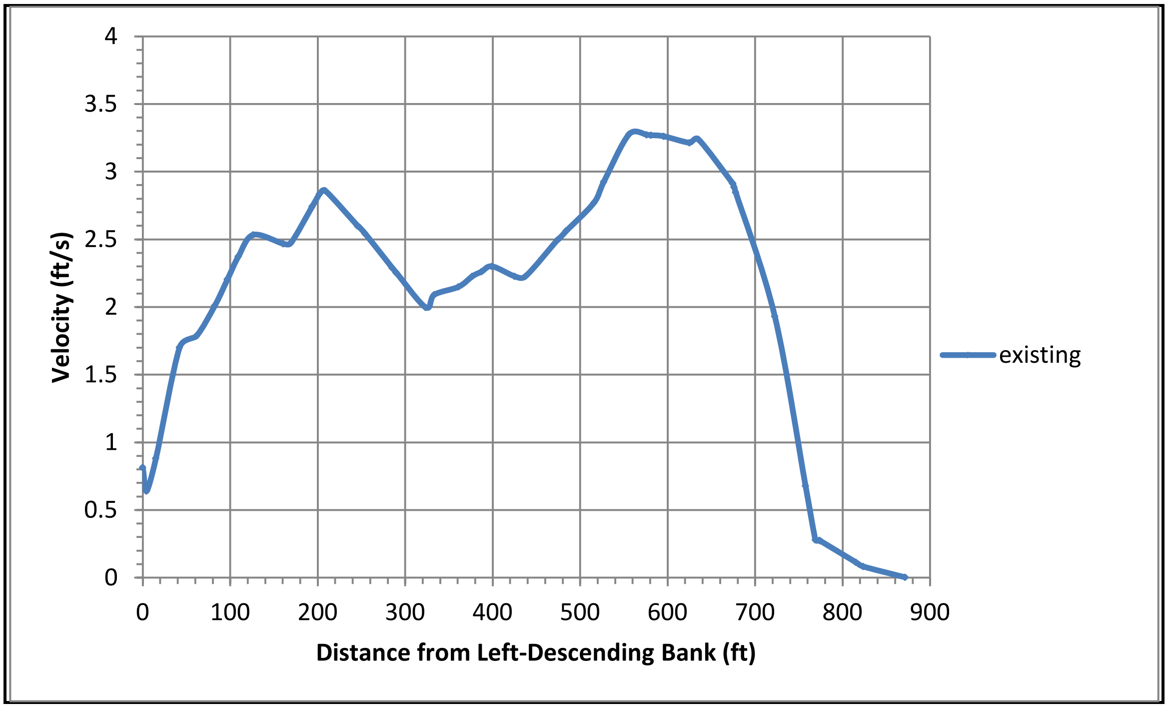

Figure H-22. Existing Computed Velocities During 160,000 cfs Discharge at the Location of theProposed Downstream Chevron (I2)

Goose Lake Pools 1 and 2 were identified as sites for potential project features; therefore, a discussion of the existing hydrodynamics in this area follows. Existing Huron Island overtopping flows illustrate the connection between Gun Slough, Huron Chute and Goose Lake Pools 1 & 2 under 160,000 cfs discharge conditions (figure H-23). Much of the flow into Pool 1 originates from the interior of the island and seems to travel a southerly flow path similar to that of Gun Slough. The velocity vectors indicate that much of the flow into Goose Lake Pool 2 exits Huron Chute at least 1,000 feet upstream of Pool 2 where it flows eastward onto the island and then travels overland in a downstream direction before it enters Pool 2.

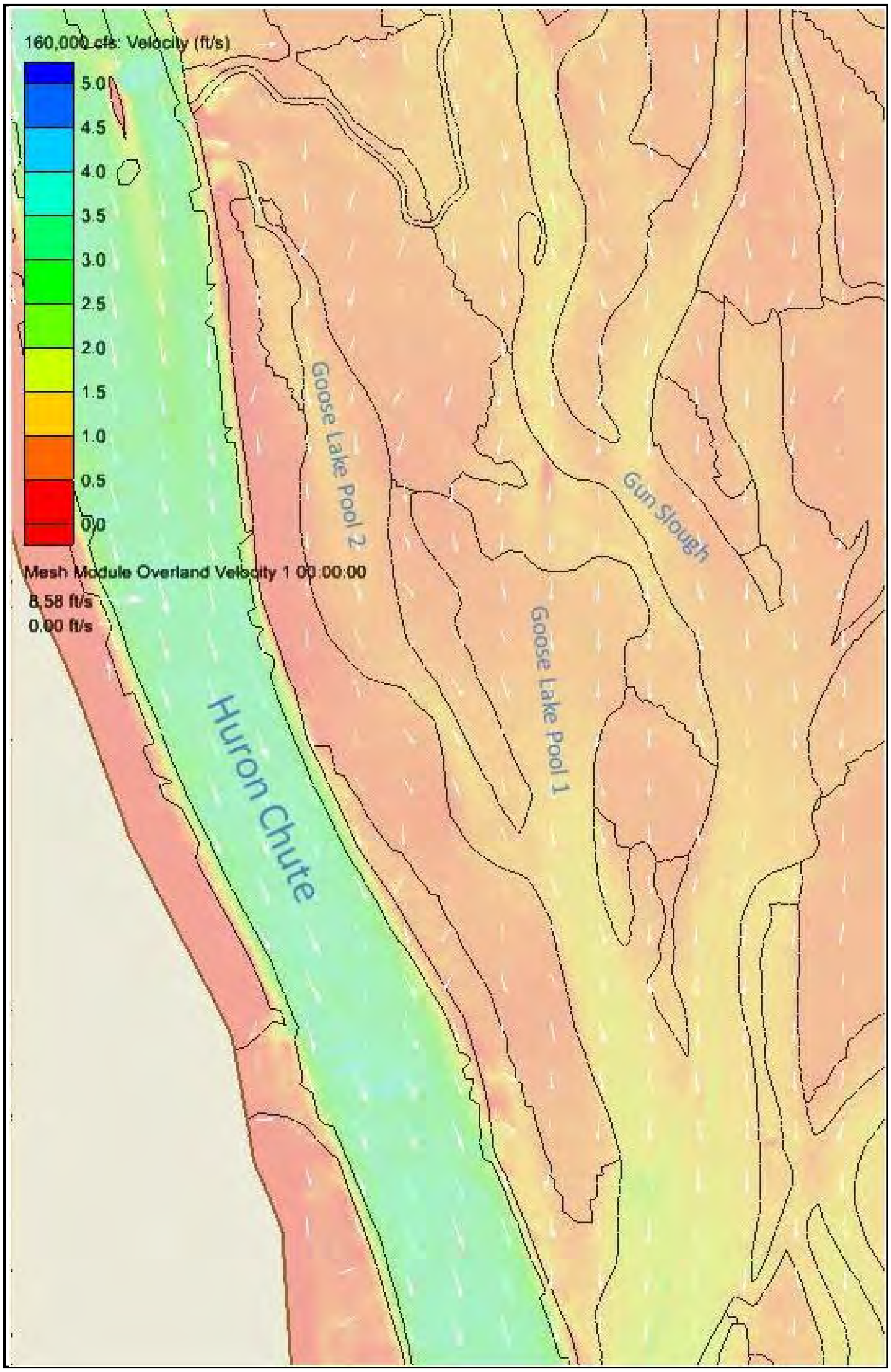

Figure H-23. Existing Condition Velocity Contours and Vectors Under a Discharge of 160,000 cfs

Under higher discharge conditions (215,000 cfs) there appears to be a more direct connection between Huron Chute and Goose Lake Pool 2, however much of the flow into Goose Lake Pool 1 still originates from the interior of the island under these higher discharge conditions (figure H-24).

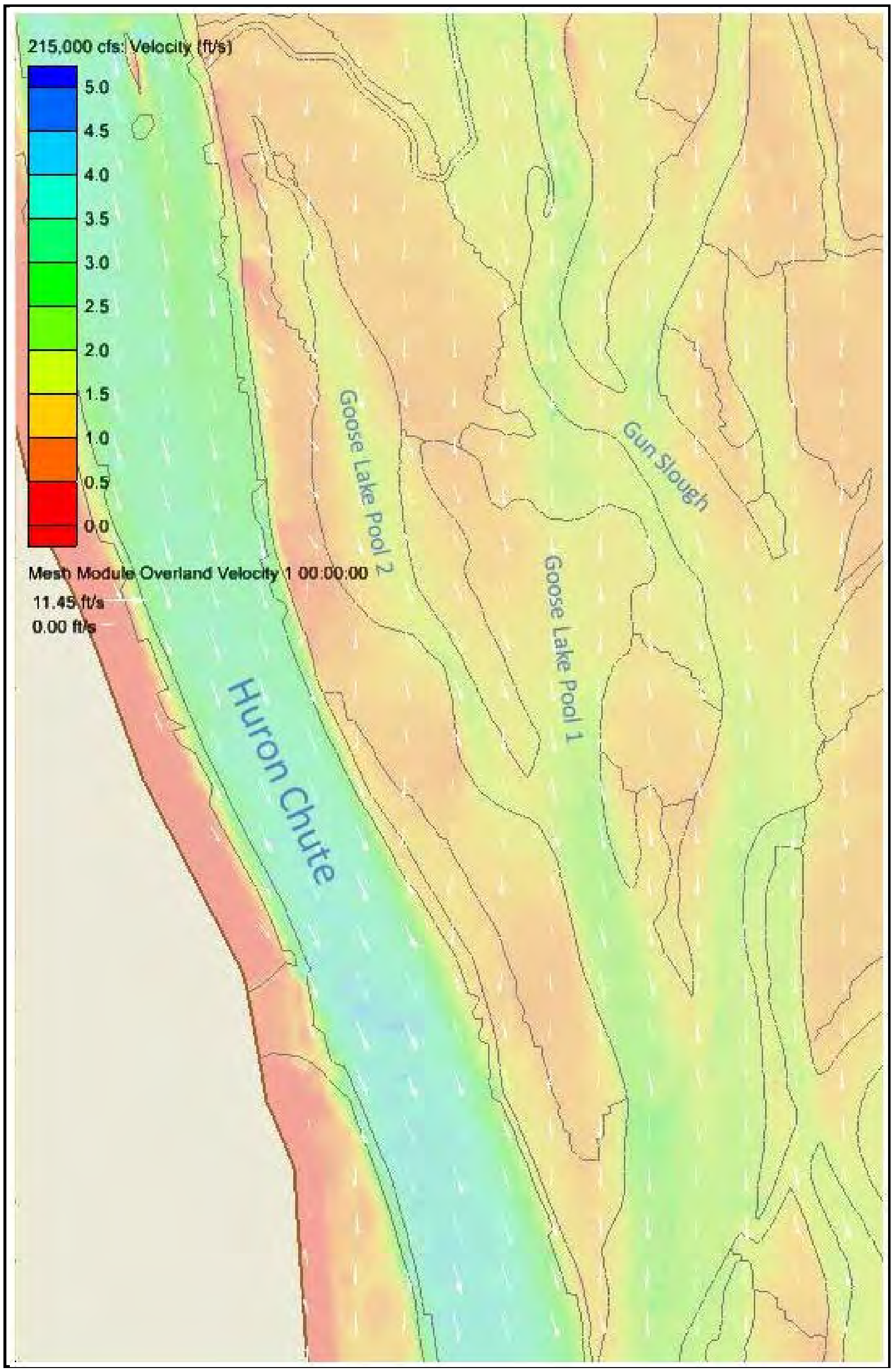

Figure H-24. Existing Condition Velocity Contours and Vectors Under a Discharge of 215,000 cfs

As previously discussed in Section 5.3.4.1, *Calibration Challenges*, narrow backwater channels and channel geometry data limitations presented significant challenges related to calibration in these interior areas. As a result, the computed discharges presented for interior areas such as Goose Lake are intended to illustrate overall trends between with and without project and are not intended to present accurate discharge values. Existing computed discharge into Pools 1 & 2 under different total flow conditions is shown in table H-12. In the lentic environment of Pool 2, simulated discharge was significantly higher than ADCP-measured discharge under total flow conditions of 160,000 cfs. Simulated discharge in more narrow backwater channels tended to be lower than ADCP measured discharge.

Computed discharges in Gun Slough (just downstream of Dead End) under existing conditions are also shown in table H-12. Again, these flows are presented to illustrate general trends between the existing condition and the TSP and not to provide definitive discharge values. A comparison table showing TSP discharge is shown in Section 5.3.5.3, *Evaluation of Tentatively Selected Plan*.

Table H-12. Goose Lake Pool 1, Pool 2 and Gun Slough Existing Conditions Computed Discharge

Total Discharge (cfs)	Goose Lake Pool 1 Q (cfs)	Goose Lake Pool 2 Q (cfs)	Gun Slough Q (cfs)	Huron Chute Q (cfs)	Main Channel Q (cfs)
60,000	0	0	23	7,385	53,069
91,045	3	2	158	13,386	78,506
160,000	2,112	973	978	25,010	134,374
215,000	6,919	3,106	3,260	28,598	172,126

5.3.5.2. Evaluation of CARS Regulating Structures. Initially two different wing dam alignments located just upstream of the Huron Chute inlet were identified for evaluation (figure H-25). The initial intent was to evaluate these structures independently and together to see which configuration would result in the greatest increase in main channel velocities in the vicinity of the shoaling problem. Table H-13 summarizes the change in discharge resulting from the different wing dam alternatives under discharge conditions of 160,000 cfs.

Table H-13. Comparison of Computed Discharge for Proposed Wing Dam Alternatives During a Total Discharge of 160,000 cfs

	Discharge (cfs)		
Transect ID	**Existing Condition**	**Downstream Wing Dam Alternative**	**Two Wing Dams Alternative**
1-US main channel	134,996	134,567	134,273
2-DS main channel	134,353	135,001	135,443
3-Mapes Chute	25,959	26,199	26,500
4-Huron Chute (Upstream of closing dam)	25,506	24,922	24,452

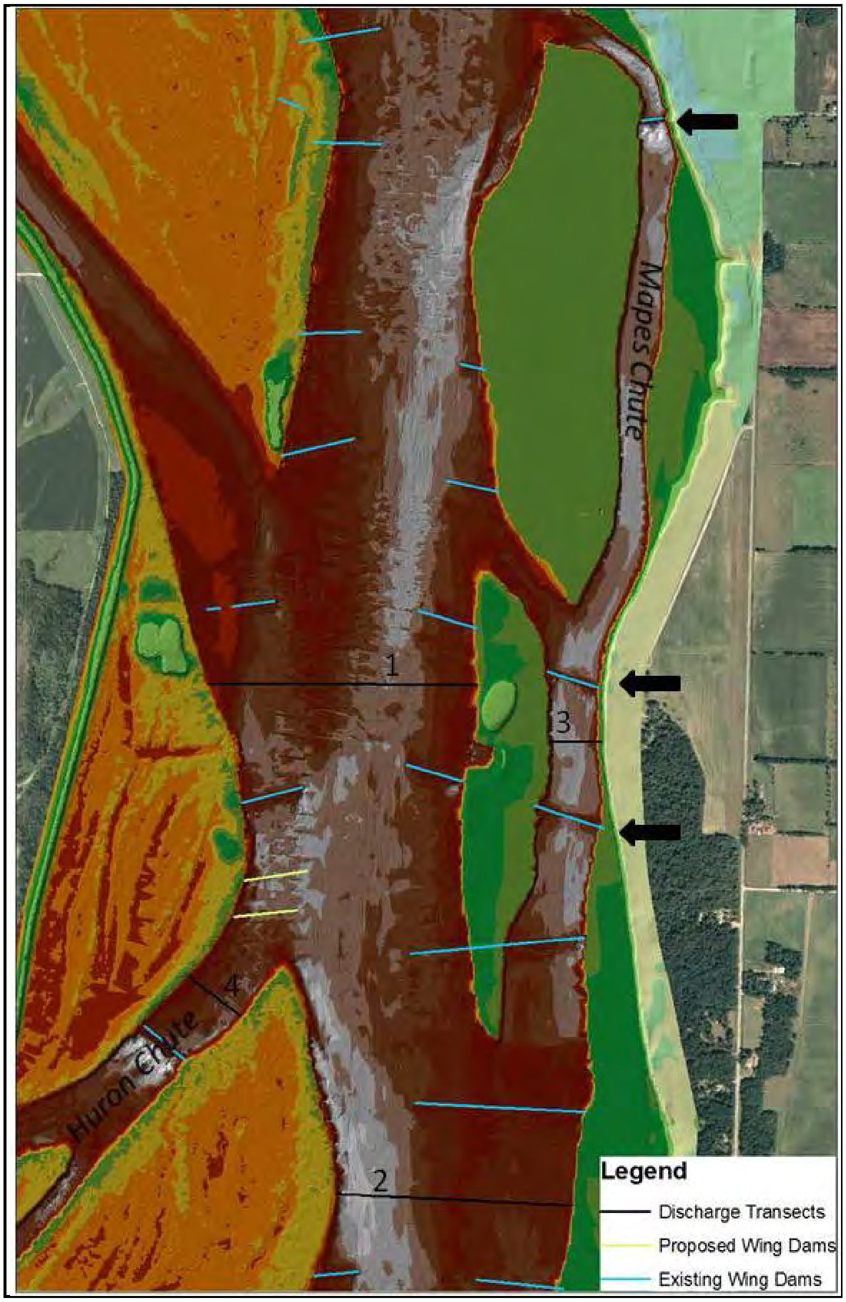

Figure H-25. Proposed Wing Dam Locations and Discharge Observation Transects

Based on the results in table H-13, the wing dam alternatives do not change the discharge distribution between Huron Chute and the main channel. However, if main channel velocities are increased sufficiently as a result of the wing dams the proposed structure may be effective in reducing shoaling in the reach of interest. The velocity evaluation is discussed in the following.

Transects were located very close to the proposed structures to compare computed velocities under the different wing dam alternatives with computed velocities under existing conditions (figure H-26). The results of these velocity comparisons at each transect are shown in figures H-27, H-28, H-29, and H-30.

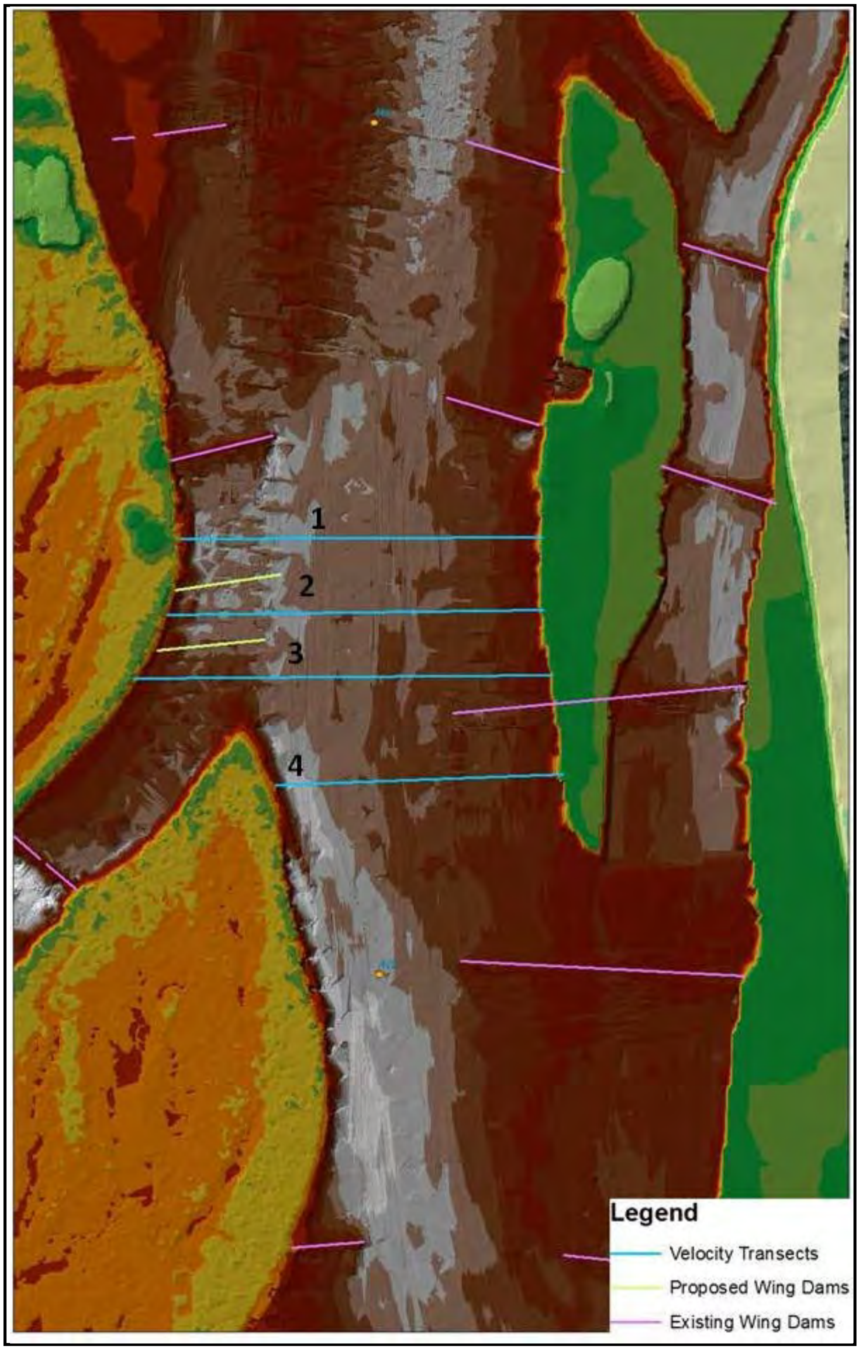

Figure H-26. Location of Velocity Transects with Respect to Proposed and Existing Wing Dams

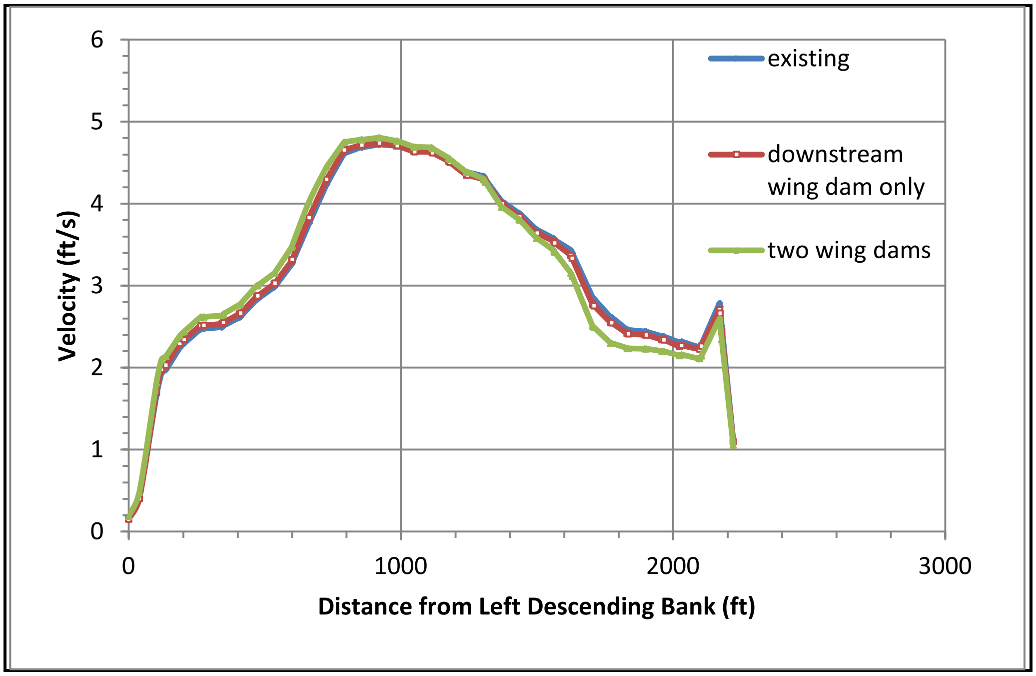

Figure H-27. Comparison of Computed Velocities During 160,000 cfs Discharge at Transect 1 (figure H-26)

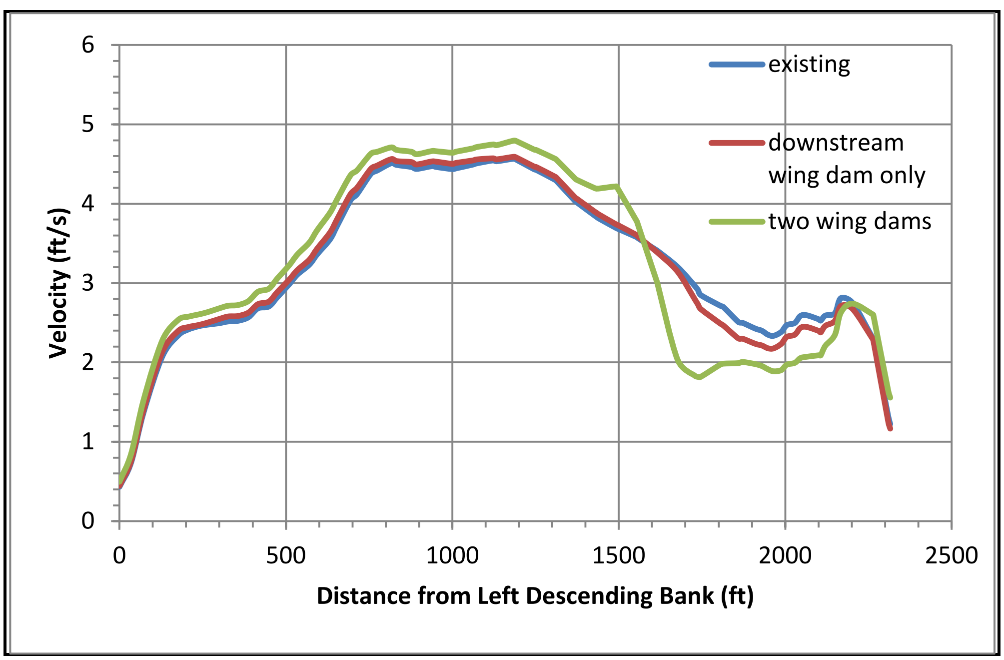

Figure H-28. Comparison of Computed Velocities During 160,000 cfs Discharge at Transect 2 (figure H-26)

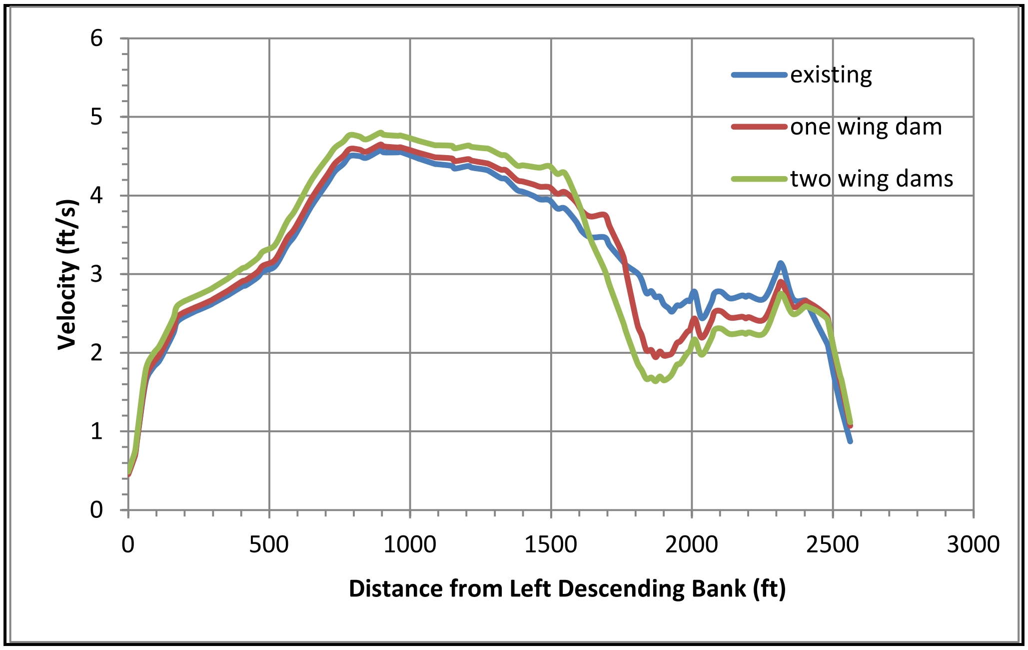

Figure H-29. Comparison of Computed Velocities During 160,000 cfs Discharge at Transect 3 (figure H-26)

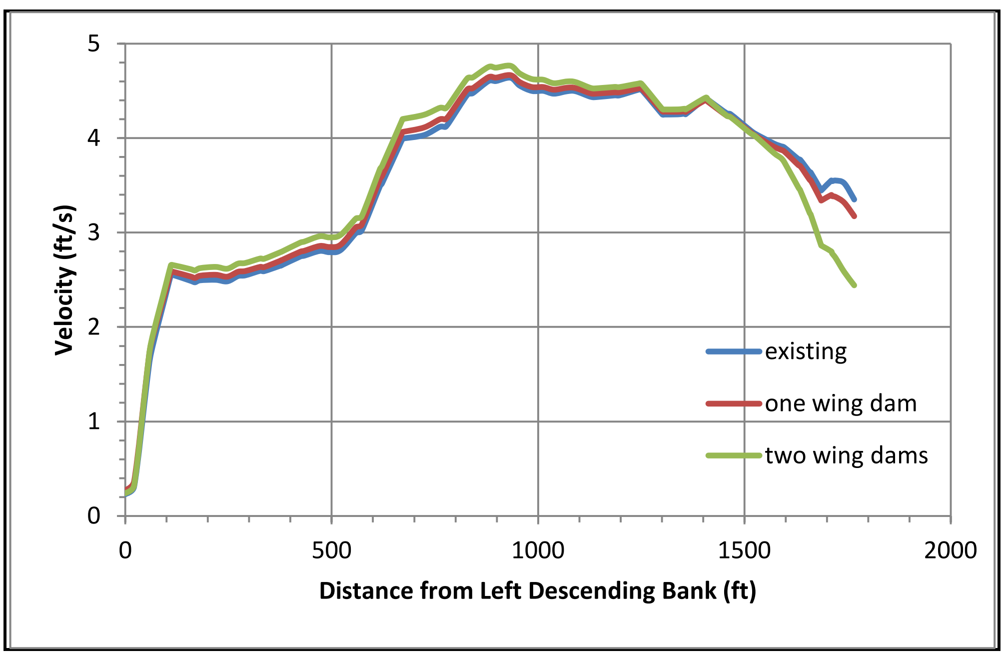

Figure H-30. Comparison of Computed Velocities During 160,000 cfs Discharge at Transect 4 (figure H-26)

The velocity transects illustrate the greatest increase in velocity results from the two wing dam alternative, however the magnitude of the increase is very small (≤ 0.5 ft/s). The computed velocity impacts were not significant enough to consider these structures adequate for addressing the shoaling problem.

The relative insensitivity of the discharge distribution and velocity field to the wing dam alternatives evaluated above suggests that a more systemic look at the shoaling problem should be taken. Although such an evaluation could not be completed prior to completion of the HREP feasibility study, the decision to evaluate a hypothetical large scale improvement to existing structures was made to determine if discharge to Huron Chute would remain insensitive.

Mapes Chute is located upstream of Huron Chute on the left descending bank and carries a similar amount of flow as Huron Chute. There are four closing dams located in Mapes Chute, and the elevations of the three upstream most structures are significantly below design grade. Restoring the elevation of these three structures to design grade was evaluated to determine if this would maintain a greater proportion of flow within the main channel throughout the shoaling reach. This alternative did not result in any significant change in discharge down Huron Chute. These results are shown in table H-14.

Table H-14. Comparison of Computed Discharges Under the Existing Condition and the Hypothetical Mapes Chute Improvement Alternative During a Total Discharge of 160,000 cfs

Transect ID	Existing Condition Q (cfs)	Mapes Chute Closing Structure Improvements Alternative Q (cfs)
1-US main channel	134,996	140,994
2-DS main channel	134,353	134,625
3-Mapes Chute	25,959	20,236
4-Huron Chute (Upstream of closing dam)	25,506	25,711

Although a final CARS design recommendation was not reached in time for the completion of the HREP Feasibility Report, evaluation of the proposed wing dam construction alternatives and the hypothetical Mapes Chute improvements demonstrates how insensitive discharge down Huron Chute is. The insensitivity of discharge down Huron Chute suggests that the HREP project is very unlikely to be impacted by a future regulating structure to address shoaling near the Huron Chute inlet.

5.3.5.3. Evaluation of the Tentatively Selected Plan. The TSP includes dredging of material from Pool 1(Goose Lake) (T1) and Pool 2 (T3) and adjacent placement to construct berms for forest diversity (F1 & F3). A forest diversity pad, constructed out of adjacent borrow, which ties into the berms is also included in the TSP (F5). The TSP also includes shoreline protection along Huron Chute (E1) and the construction of a closing structure at Garner Chute (T9). For a detailed illustration of the TSP please refer to Appendix N, Plate 12. Initially the TSP included the construction of chevrons for the two small islands (I2) located in Huron Chute, however as a result of impacts to the 1 percent exceedance probability flood profile, the chevrons were removed. Their impact to the flood profile is discussed in Section 6, *Impacts to Mississippi River Water Surface Levels,* of the report**.**

Huron Chute discharges (as measured in the upper reach, just downstream of the closing dam) with the TSP in place are shown in table H-15. Impacts to discharge in the upper reaches of Huron Chute are not expected because none of the Project features are located upstream of Huron Chute, and the modeling results support this.

Table H-15. Comparison of Existing Condition and Tentatively Selected Plan Computed Discharge [1] at Huron and Garner Chute

	Existing Conditions			Tentatively Selected Plan		
Total Discharge	**Garner Chute Q**	**Huron Chute Q**	**Main Channel Q**	**Garner Chute Q**	**Huron Chute Q**	**Main Channel Q**
60,000	2,227	7,385	53,069	208	7,176	53,282
91,045	4,017	13,386	78,506	767	12,824	79,065
160,000	8,712	25,010	134,374	5,885	24,183	135,390
215,000	12,485	28,598	172,126	9,523	27,890	172,615

[1]all discharge measured in cfs

Under the TSP, typical computed velocities in Huron Chute under flow conditions of 160,000 cfs (near the 50 percent exceedance probability) are 2.5-4.4 ft/s (figure H-31). Under flow conditions of 215,000 cfs (near the 20 percent exceedance probability) velocities within Huron Chute are slightly higher (2.5-4.6 ft/s) (figure H-32). During over-wintering conditions (60,000 cfs) typical velocities in Huron Chute are 1-3 ft/s (figure H-33). Under all three flow conditions, the increase in velocities under the TSP occurs downstream of the upstream junction of Huron Chute and Garner Chute where flow down Garner Chute is restricted by the closing dam measure (T9), thereby increasing the discharge and velocity down Huron Chute.

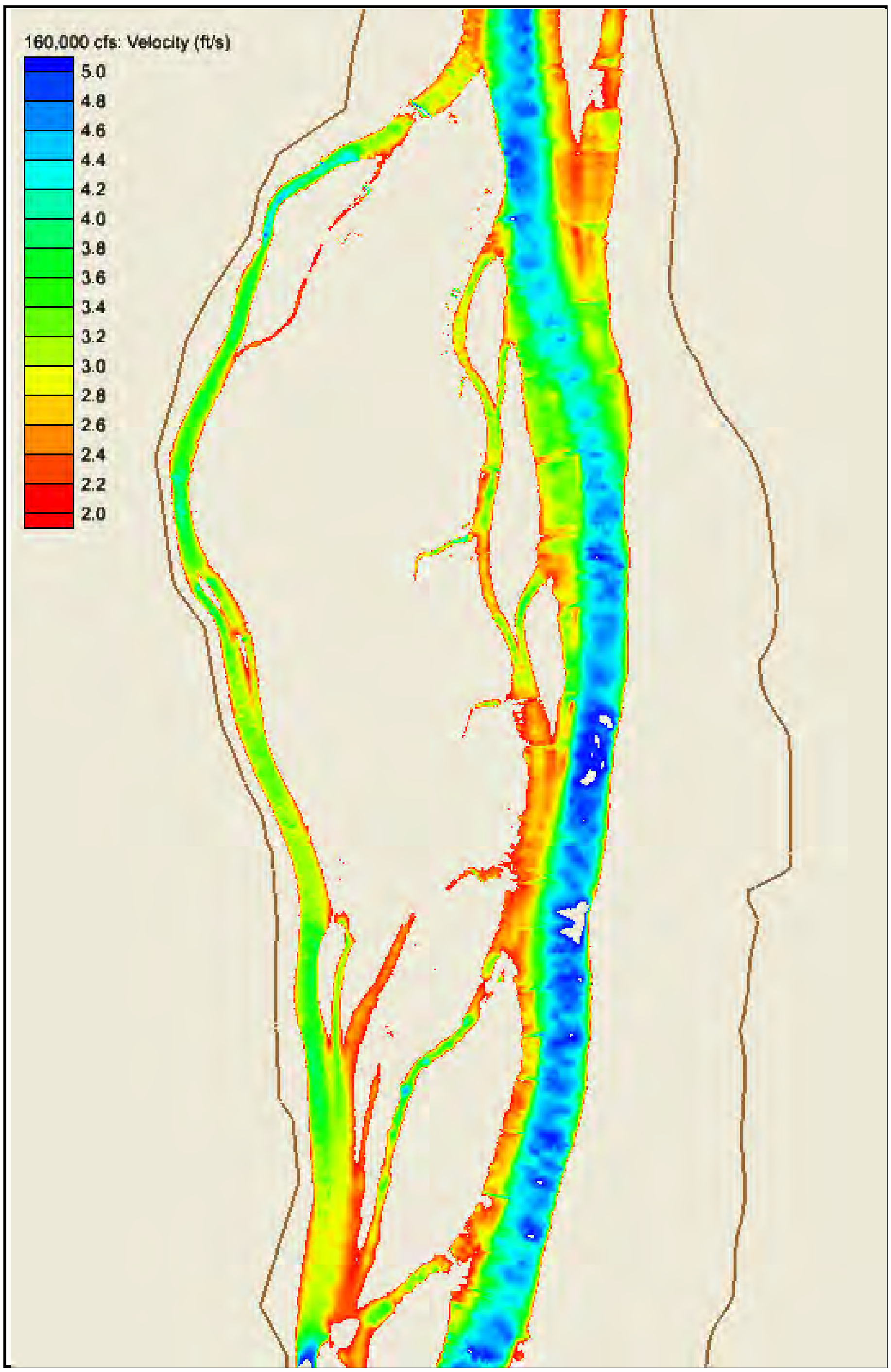

Figure H-31. Tentatively Selected Plan Velocity Results For Huron Chute, Garner Chute and the Main Channel Under Discharge Conditions of 160,000 cfs

Note that velocity results above 5 ft/s and below 2 ft/s are not explicitly mapped.

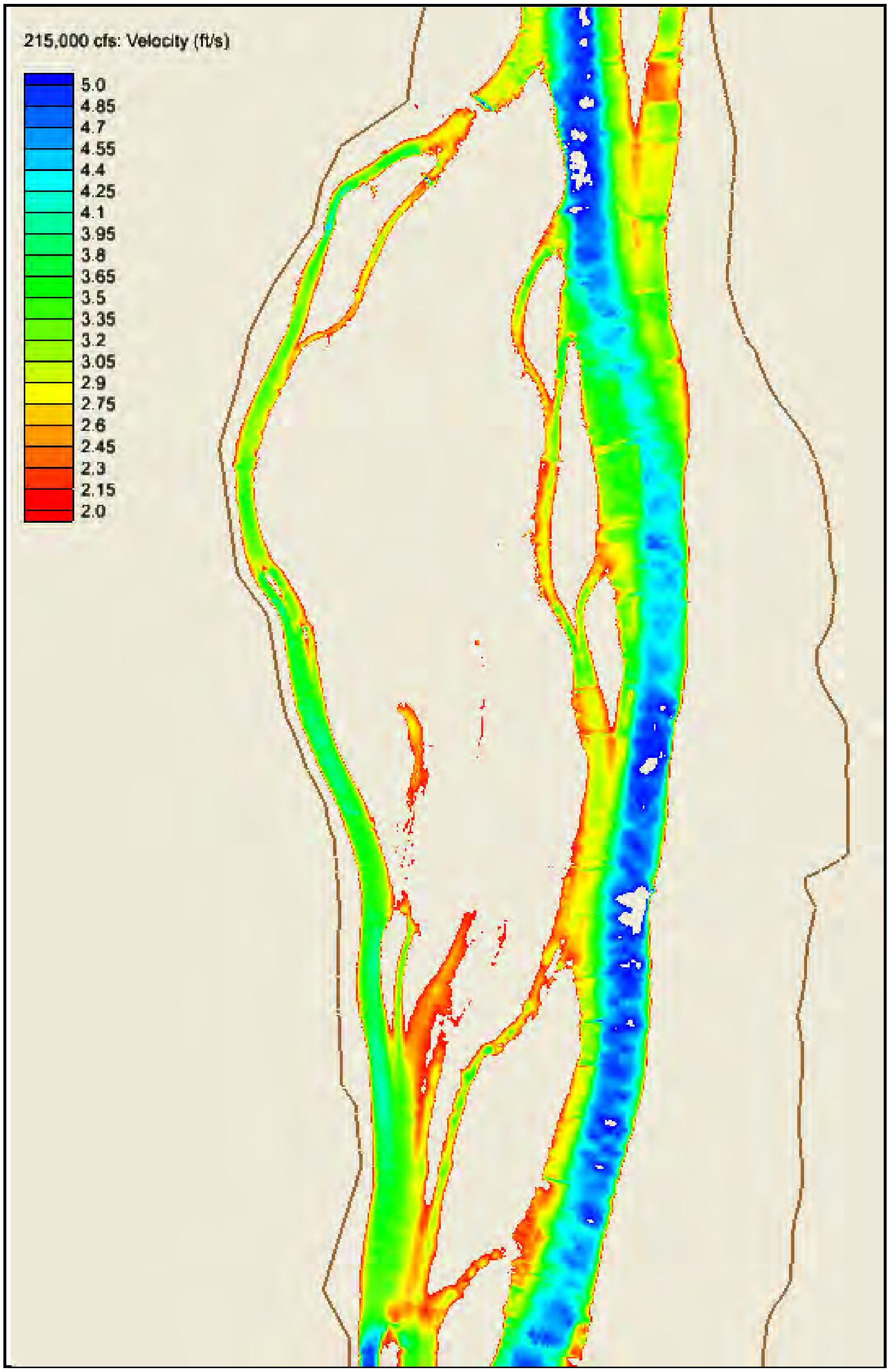

Figure H-32. Tentatively Selected Plan Velocity Results for Huron Chute, Garner Chute and the main Channel Under Discharge Conditions of 215,000 cfs

Note that velocity results above 5 ft/s and below 2 ft/s are not explicitly mapped.

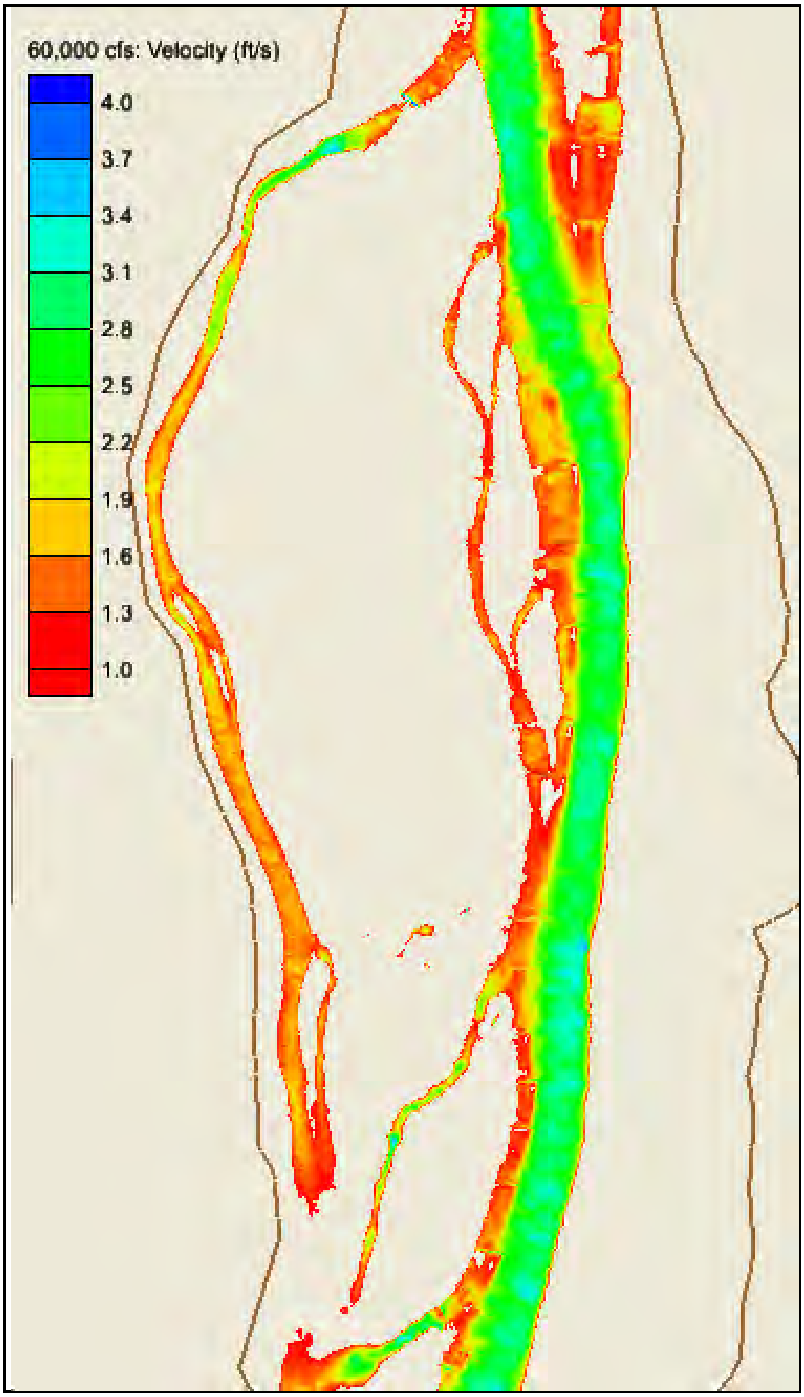

Figure H-33. Tentatively Selected Plan Velocity Results for Huron Chute, Garner Chute and the Main Channel Under Discharge Conditions of 60,000 cfs

Note that velocity results above 4 ft/s and below 1 ft/s are not explicitly mapped.

Garner Chute discharges are significantly reduced by the closing structure measure (T9) (table H-15). The objective of the Garner Chute closure is to reduce flows during the overwintering season to provide fish habitat and to decrease the amount of bed load transported into the Garner Chute reach. The crest elevation of the closing structure is 532 feet (4 feet above flat pool). Velocities in Garner Chute under the TSP also drop significantly. Throughout most all of Garner Chute velocities are less than 0.2 ft/s during overwintering conditions (60,000 cfs). The exception to this is in the vicinity of the closing dam where the velocities are much higher as flow crosses the structure.

As indicated previously, one of the TSP features (I2) included a chevron to be built upstream of each of the two small islands within Huron Chute to encourage deposition on the nose of the island, thereby increasing the size. Due to impacts to the 1 percent exceedance flood profile, this feature was removed from the TSP. For documentation purposes results from the velocity impact analysis of these two features remain in the document as follows.

Computed velocities under conditions of 160,000 cfs just downstream of the nose of the two proposed chevrons are shown in the figures below. Construction of the chevrons results in velocity increases by as much as 1.5 ft/s in some areas. Due to the proximity of the chevrons to a reach of the Two Rivers Levee and Drainage District that has a history of erosion, any increase in velocities associated with the chevron construction is concerning. These results were taken into consideration along with the floodplain impacts (see Section 6, *Impacts to Mississippi River Water Surface Levels*) when evaluating whether or not these features should remain as part of the TSP.

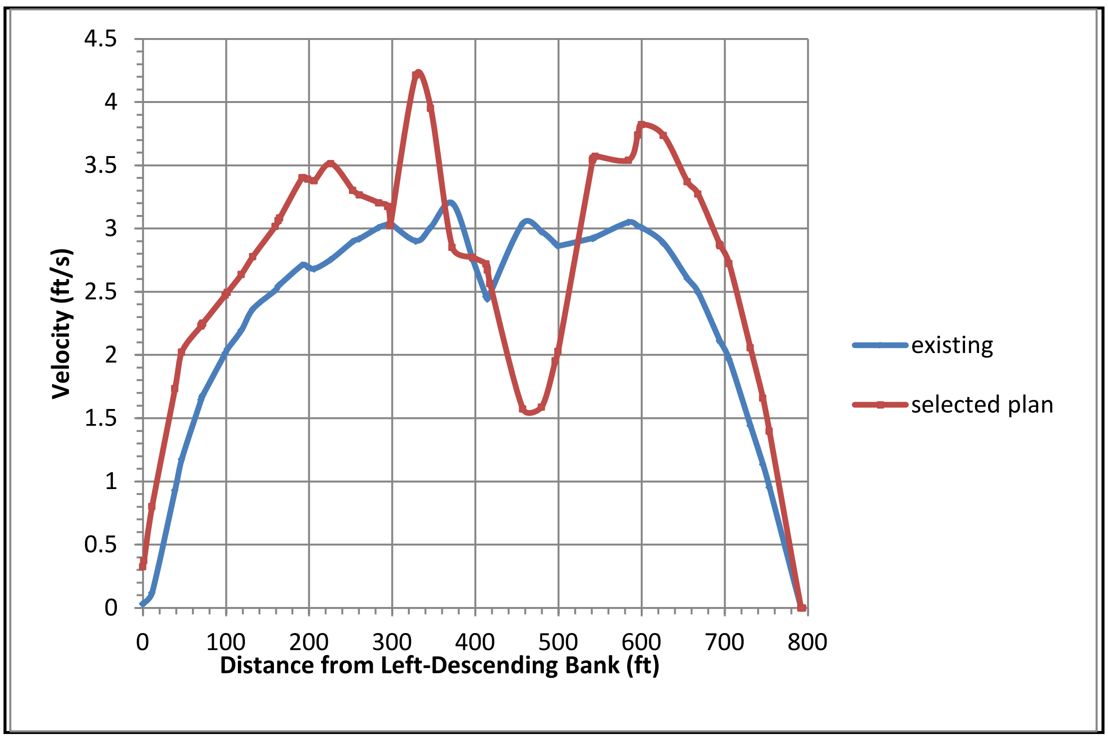

Figure H-34. Tentatively Selected Plan Computed Velocities During 160,000 cfs Discharge Just Downstream of the Proposed Upstream Chevron (I2)

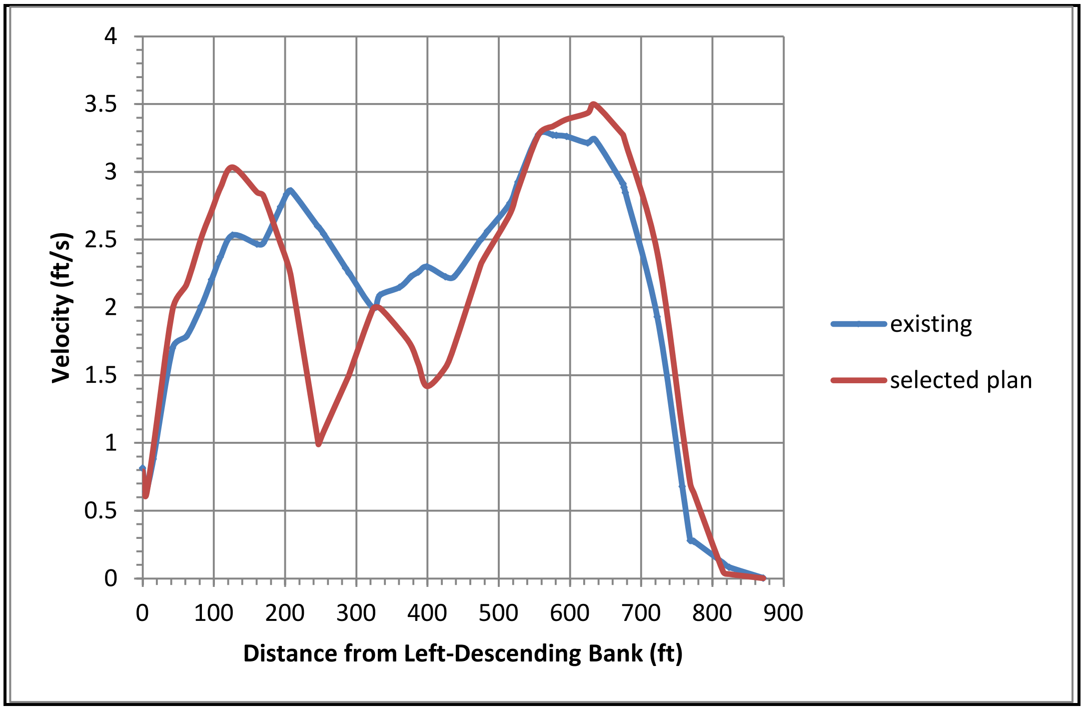

Figure H-35. Tentatively Selected Plan Computed Velocities During 160,000 cfs Discharge Just Downstream of the Proposed Downstream Chevron (I2)

In order to improve topographic and floodplain forest diversity, dredging of Goose Lake Pools 1 and 2 is planned. The dredge material will be side cast and shaped into berms with one tier at elevation 535 feet and one tier at elevation 537 feet, for tree and scrub-shrub planting (T1, T3, F1 & F3). Berm F1 is located along the east side of Goose Lake Pool 1 and F3 is located along the west side of Goose Lake Pool 2. The forested pad (F5) located to the northeast of both Goose Lake Pools 1 & 2 will be constructed by pushing up and shaping adjacent material to form three elevation tiers; one at 537 feet and two at 535 feet. The forested pad (F5) ties into features F1 and F3 to form a U-shaped feature that is open on the downstream end. The selected alignment of these features is intended to extend the life of the dredge cuts (T1&T2) for aquatic habitat. As discussed in the existing conditions, currently most of the flow into Goose Lake Pool 2 comes from the upstream direction, rather than directly from Huron Chute to the west. The alignment of these features (F1, F3 & F5) forms a continuous obstruction to overland flow that enters Goose Lake Pools 1 & 2 from the upstream side under existing conditions, thereby significantly decreasing flow into these backwater lakes (table H-16). As previously stated the discharge values in table H-16 are presented for relative comparison between with and without project conditions, not to present absolute discharge values. The velocity contours and vectors from the TSP simulation under discharge conditions of 160,000 cfs are shown in figure H-36 and under 215,000 cfs are shown in figure H-37. With the TSP in place, flow from the interior of the island that previously entered Pools 1 & 2 traveling along a southerly flow path is now deflected to the east where it rejoins Gun Slough. This results in increased velocities in Gun Slough.

Table H-16. Comparison of Existing Condition and Tentatively Selected Plan Computed Discharge [1] in Goose Lake Pools 1 & 2.

	Existing Conditions			Tentatively Selected Plan		
Total Discharge	**Pool 1 Q**	**Pool 2 Q**	**Huron Chute Q**	**Pool 1 Q**	**Pool 2 Q**	**Huron Chute Q**
60,000	0	0	7,385	0	0	7,176
91,045	3	2	13,386	0	0	12,824
160,000	2,112	973	25,010	0	0	24,183
215,000	6,919	3,106	28,598	277	222	27,890

[1]all discharge measured in cfs

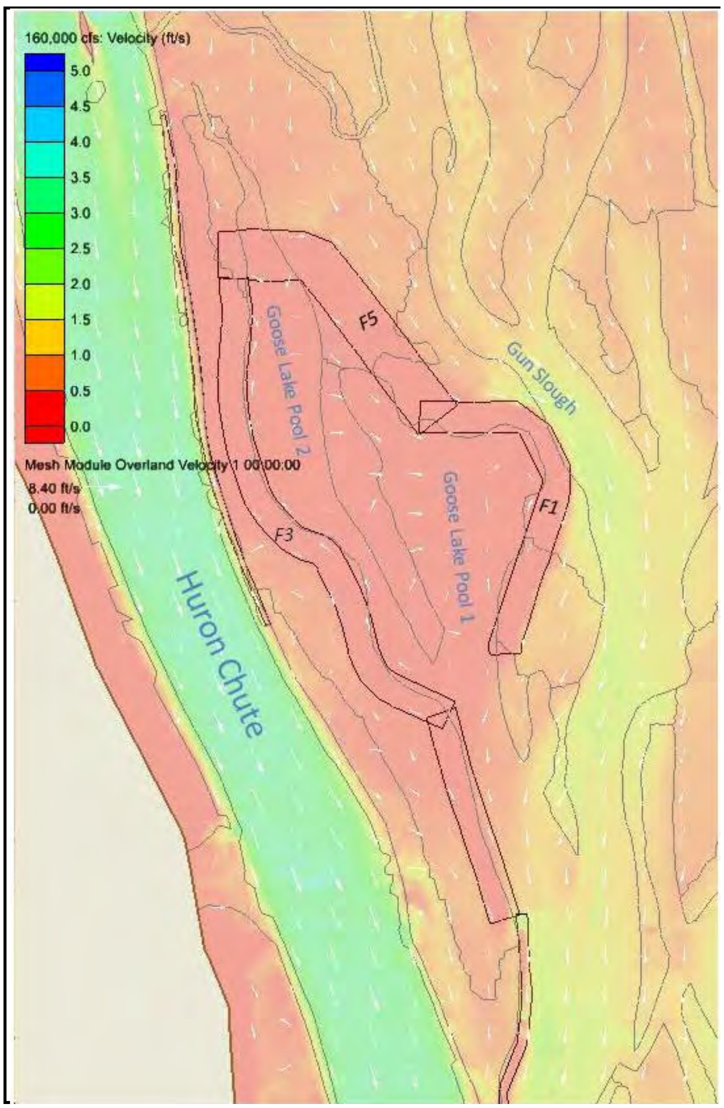

Figure H-36. Tentatively Selected Plan Velocity Contours and Vectors Under 160,000 cfs

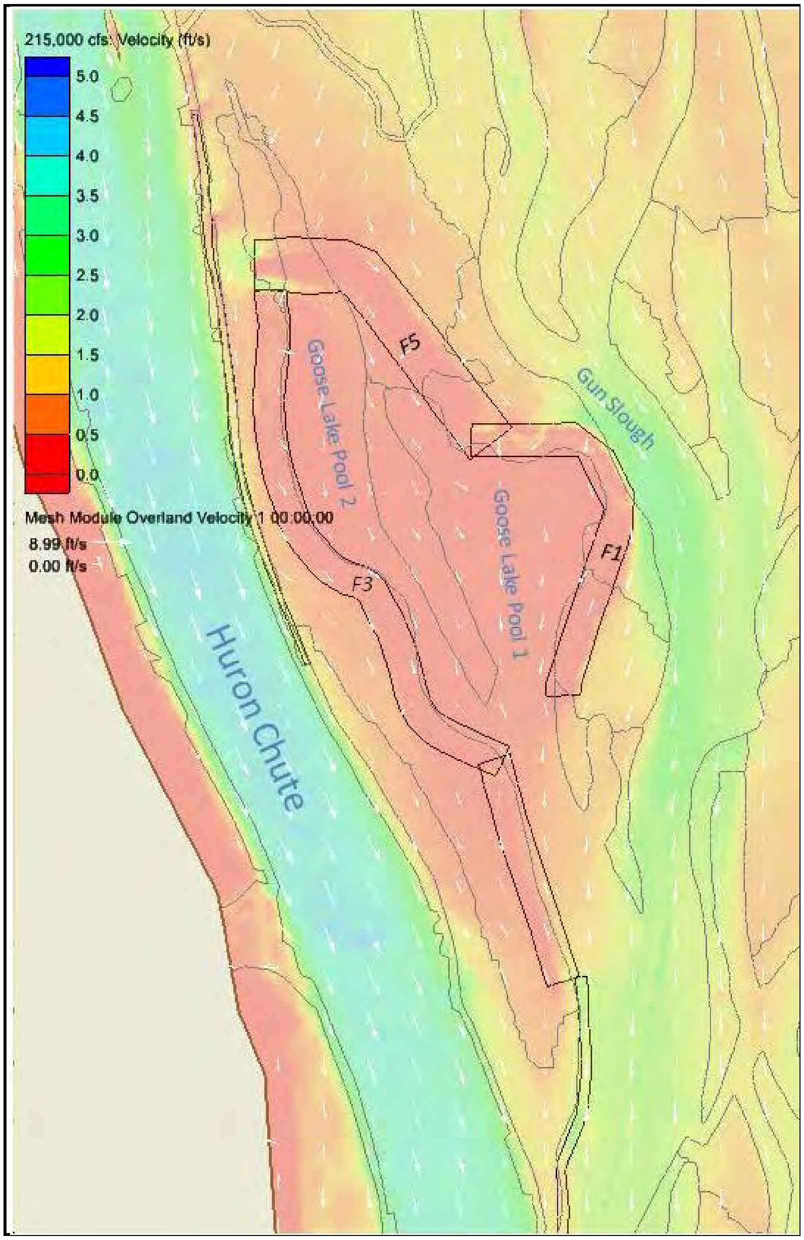

Figure H-37. Tentatively Selected Plan Velocity Contours and Vectors Under 215,000 cfs

Under higher discharges overland flow is deflected from entering Pools 1 & 2 from the north into Gun Slough with the TSP in place and discharges within Gun Slough therefore increase (table H-17). Again, the flows presented in table H-17 are intended to illustrate general trends between the existing condition and the TSP and not to provide absolute discharges.

Table H-17. Comparison of Existing Condition and Tentatively Selected Plan Computed Discharge[1] in Gun Slough

	Existing Conditions		Recommended Plan	
Total Discharge	**Pool 1 Q**	**Huron Chute Q**	**Pool 1 Q**	**Huron Chute Q**
60,000	23	7,385	23	7,176
91,045	158	13,386	153	12,824
160,000	978	25,010	2,477	24,183
215,000	3,260	28,598	6,202	27,890

[1]all discharge measured in cfs

In summary the model results illustrate that the TSP features are effective in deflecting overland flows away from Goose Lake Pools 1 and 2. Presumably by decreasing the frequency with which suspended sediment-rich flows enter Goose Lake Pools 1 & 2 the longevity of the dredge cut will be sustained. The results from the AdH sediment transport simulations are discussed in Section 5.3.6.4, *AdH Sediment Transport Results,* of this appendix.

5.3.6. Sediment Transport Modeling. In order to evaluate the potential life expectancy of the proposed dredging in Pools 1 and 2 (Goose Lake), a better understanding of sedimentation rates and general sedimentation trends within the Huron Island Complex through sediment transport modeling was deemed necessary by the PDT. To date, studies of backwater sedimentation rates within the Upper Mississippi River (UMR) have focused within Navigation Pools 4-10, and 13 (References 7-11). Sedimentation rates from these studies range from as little as 0.2 cm/yr (Navigation Pool 7) to as high as 4 cm/yr (Navigation Pools 4-10). A sedimentation rate of 0.8 cm/yr for Navigation Pool 13 was reported by Rogala & Boma (Reference 10). Measurements of sedimentation rates within the Huron Island Complex were taken by former IA DNR Biologist Bill Aspelmeier (Reference 12). His observations were made at 4 locations within the Huron Island Complex over two 5 year periods (1984-1989 and 1989-1994). Observations from the Little Cody Chute site indicate consistent aggradation over the 10 year study period. However, observations made in Buffalo Slough suggest that degradation was occurring at the measurement location. Sedimentation rates for Huron Island reported by the Aspelmeier study vary as much as (-1.16 cm/yr to +3.47 cm/yr).

The variability seen among these UMRS estimated backwater sedimentation rates is caused by a number of different factors including when each measurement was taken with respect to a recent high water event. Variability within estimates for Huron Island itself indicates that there are many dynamic processes at work and that sedimentation rates are also dynamic. Sedimentation rates within the UMRS backwaters and Huron Island are a function of the discharge magnitude and the rainfall distribution in the contributing watershed, and are sensitive to the spatial and temporal variability in vegetation and natural impoundments such as beaver dams.

The AdH model is capable of simulating both non-cohesive (sand) and cohesive (clay and silt) sediments. The sediment is transported separately as suspended load and bed load during a single simulation. Given the lack of site specific sediment data available for transport modeling, estimates of sedimentation rates must be considered as a general guideline, not a precise rate. The availability of sediment data for the Huron Island project area is discussed below.

5.3.6.1. Suspended Sediment Characterization. Simulation of sediment transport in AdH requires suspended sediment concentration and suspended sediment particle size distribution information to define the boundary condition (specifically defined by means of a time series control card and a Dirichlet Transport Boundary in the solution control card). The District began collecting suspended sediment data at the Burlington gage in October of 1967. The Burlington gage is located at RM 403.2, downstream of the Project site and Lock and Dam 18. Daily suspended sediment concentration data for the period of record beginning WY1968 through WY2010 was plotted to visualize the relationship between discharge and suspended sediment concentration for the Huron model reach (figure H-38). This dataset was used to determine a range of expected suspended sediment concentration values for each of the three discharge conditions that were simulated (table H-18). Given the significant scatter present in the dataset, a best fit line as shown in figure H-38 was not used to develop the discharge-concentration relationship. Instead the dataset was sorted according to discharge and all discharge values within 3 percent of the target value were used to develop statistics for the corresponding concentration data. Based on the statistical results, a reasonable suspended sediment concentration value was chosen for each of the target discharges.

Table H-18. Summary of Suspended Sediment Concentration Data

Discharge (cfs)	Mean Concentration (mg/L)	Median Concentration (mg/L)	Standard Deviation Concentration (mg/L)	Number of Observations
91,000	128.1	102	88.2	454
160,000	174.3	138.6	106.8	260
215,000	143.1	84.4	195.8	79

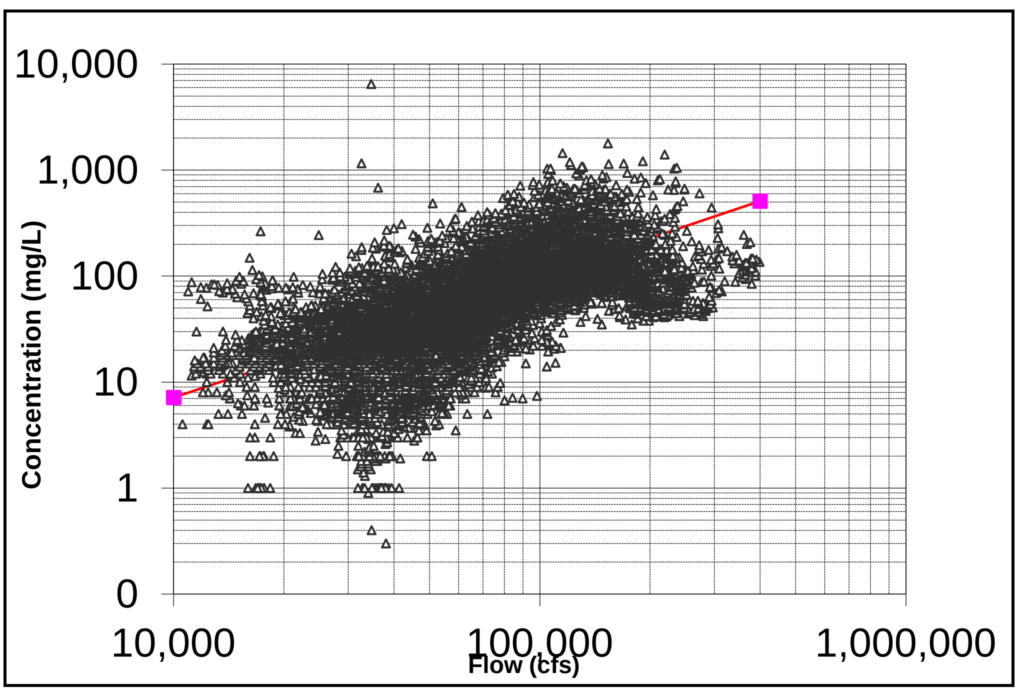

Figure H-38. Suspended Sediment Concentration at the Burlington, IA Gage for Water Years 1968-2010

The intent of this study is to model deposition of fine sediments in backwater lakes, therefore the particle size distribution data must capture the full range of suspended particle sizes (i.e. analysis of both the sieve size fraction as well as the fines in suspension is necessary). Applicable particle size distribution information for suspended sediment data at the Burlington Gage was unavailable. Depending on the analysis method, suspended sediment samples for particle size distribution analysis of fines can require a minimum sediment mass which often necessitates a very large volumetric sample, which is one reason why the availability of these samples is often limited. Data from nearby USGS sediment stations were then evaluated to determine if adequate particle size distribution information was available that could be applicable to the Huron model. The nearby USGS sediment stations identified included McGregor, IA; Lock & Dam 12; Clinton, IA; Keokuk, IA; Grafton, IL; below Grafton, IL; Alton, IL; below Alton, IL; and Winfield, MO; as well as the Iowa River at Wapello, IA. Unfortunately much of the data from these stations were not useful for this study because they only included particle size information for the sand size fraction (≥0.0625 mm).

The most abundant suspended particle size data available was from USGS Open File Report 94-474 that collected data three times over a one year period at three locations within a couple hundred miles of Huron Island (RM 423): Clinton, IA (RM 520); Keokuk, IA (RM 363); and Winfield, MO (RM 239) (figure H-39) (Reference 13). This data included the full range of particle sizes (clay, silt and sand). Discharge measurements and the suspended sediment samples were collected and analyzed in July 1991, October 1991, and April 1992. A plot of the average particle size distribution for each of the three stations, as well as the average of all three sites and an interpolation of these results at the Burlington gage is shown in figure H-39. The plot illustrates the least amount of variability among the three sites exists in the most coarsely grained sediments. Also the proportion of fine-grained material decreases moving downstream, which may be due to the greater carrying capacity for larger particle sizes as the discharge increases downstream.

It should be noted that the suspended sediment particle size distribution data can vary due to a number of factors, including the timing of the sample collection relative to the timing of the most recent storm event. Generally higher concentrations of suspended sediment occur early during a rainfall event as sediments suspended during overland flow are flushed into the stream, with decreasing concentrations as the rainfall declines. In agricultural watersheds, early spring rain that falls on fields without vegetative cover can result in significant sediment runoff.

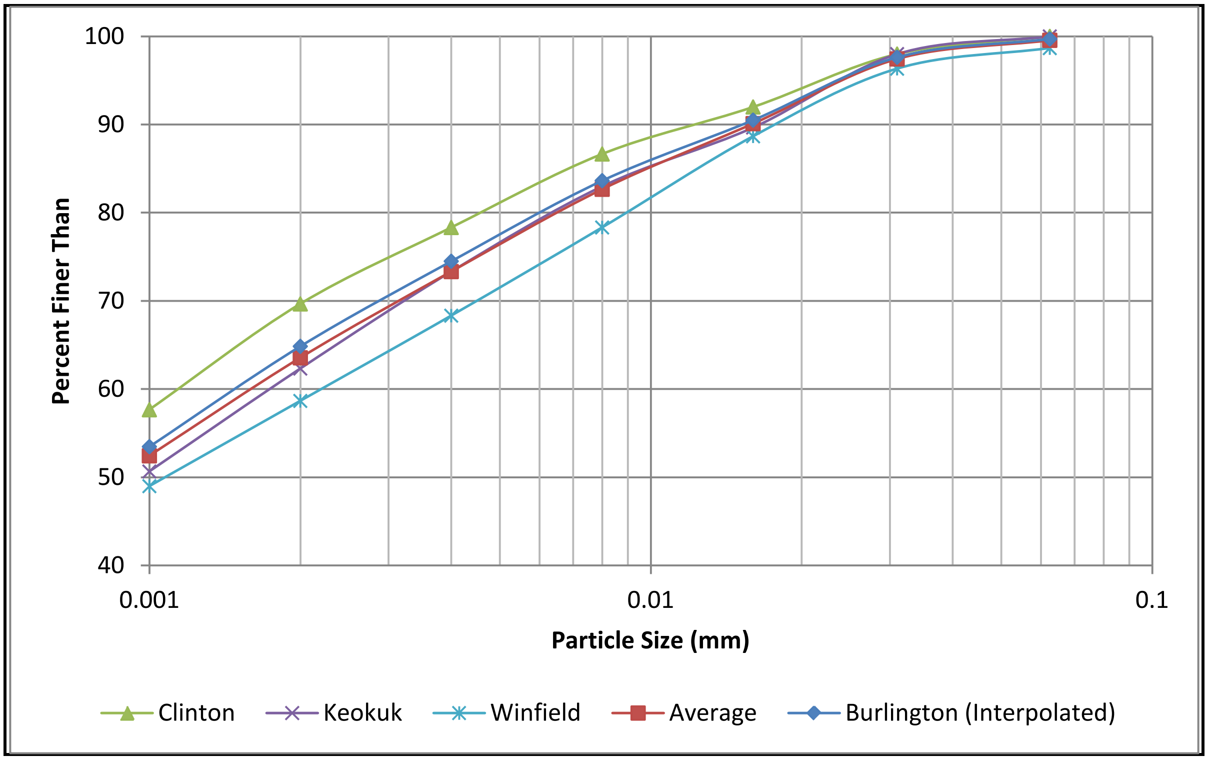

Figure H-39. Average Particle Size Distribution at Clinton, Keokuk and Winfield Sampling Sites

5.3.6.2. Fluvial and Terrestrial Sediment Characterization. A general understanding of the spatial distribution and type of different unconsolidated sediments (i.e., sands, silts, clays and combinations thereof) throughout Huron Island, both on the land and below the water, is important for determining the particle sizes that should be included in the model and for evaluating the performance of the sediment model. Available sediment data throughout the Project area is discussed in the following.

In the latter part of 2006, in support of the HREP study, the District's Water Quality and Sedimentation Section collected 13 bed sediment samples from various sites throughout the Huron Island backwater complex (figure H-40). A 4-foot long core sampler was used to sample the bed material at each site. The entire core sample was mixed and a single grab sample was then taken for particle size analysis of the coarse size fraction (≥ 0.074 mm (200 sieve size)). Particle size analyses for the coarse size fraction for 12 of these backwater samples were evaluated for characterization of backwater materials. Figure H-41 shows the resulting particle size distribution for the 12 samples for all particles larger than the 200 sieve size (0.074 mm). Five of these samples were classified as sands and seven of these samples were classified as clays. Four of the seven clay samples contain so much fine material that they are not clearly identifiable in figure H-34.

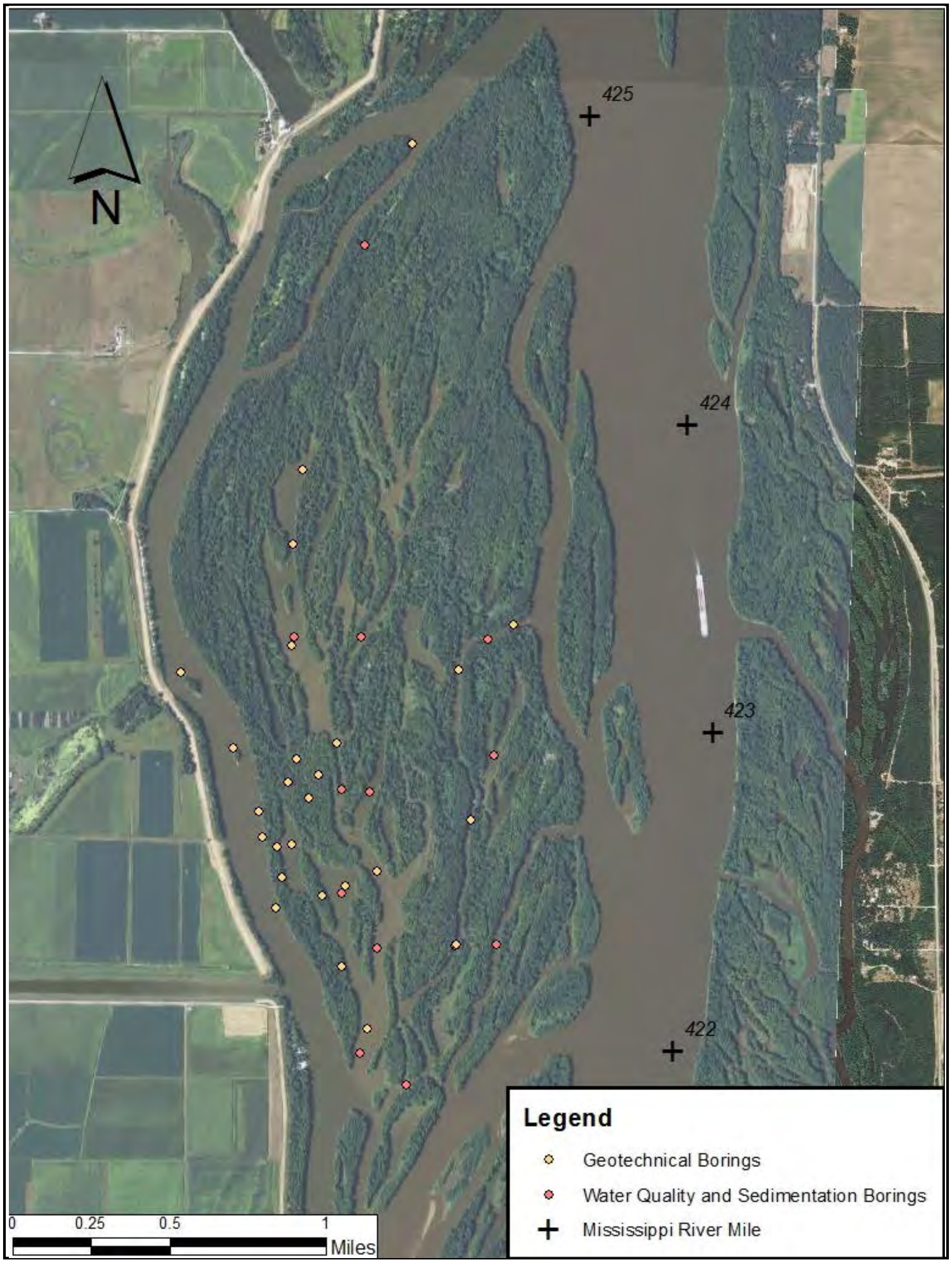

Figure H-40. Sediment Boring Locations Throughout Huron Island

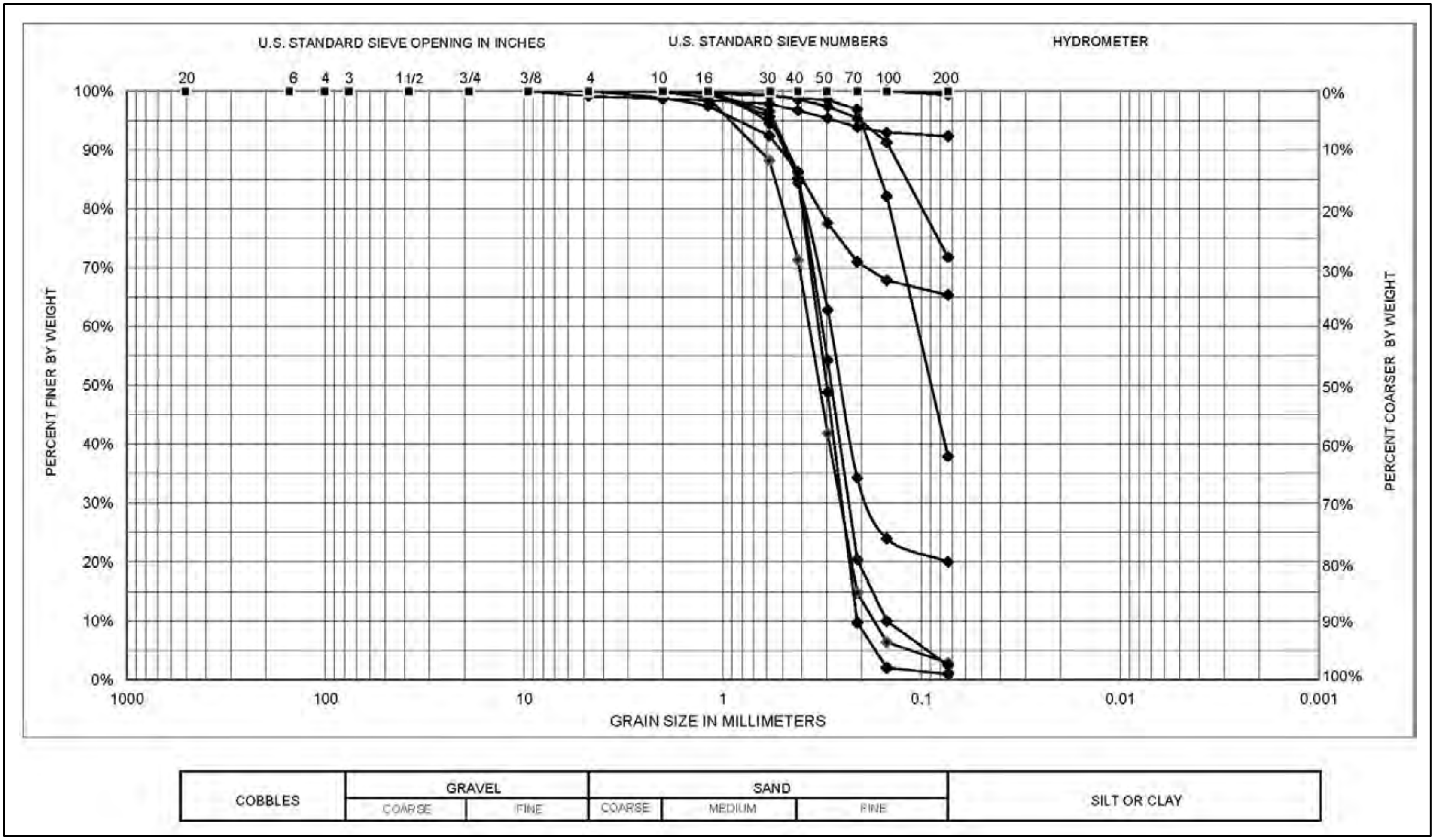

Figure H-41. Particle Size Distribution Results for Geotechnical Borings

As part of the Channel Maintenance Program, prior to channel maintenance dredging, the District's Water Quality and Sedimentation Section collected 4-foot core sediment samples at the dredge cut location at a spacing as close as $1/10^{th}$ of a mile. The sampling technique described above was used with intent of performing particle size distribution analysis for each of the samples. Particle size analysis results for the coarse size fraction (≥ 0.074 mm (200 sieve size)) for each of the dredge cut samples were evaluated for characterization of main channel materials. The overwhelming majority of these samples were entirely sand. The locations of past dredge cuts within the model reach (RM 416 to 431) are shown in figure H-5.

In February and August of 2011, the District's Geotechnical Branch collected 12 subsurface aquatic borings at locations where potential dredging was sited for project features identified as part of the feasibility study. In 2012, eight additional terrestrial borings were collected in the location of the forest diversity berm and pad features from the TSP (F1, F3 & F5). The location of these samples is shown on figure H-40. Samples within each of these borings were taken at intervals frequent enough to characterize the strata and engineering properties, such as moisture content and liquid limits, were measured to verify visual classifications. Plates 101, 301 and 302 in the main report label and identify the location of each of the borings and provide the boring log information. Within Goose Lake Pools 1 & 2 and other lentic backwater areas there is generally several feet (2 to 5 feet) of soft fat clay with high moisture content. This suggests that there is active deposition occurring in these areas.

During December of 2011, in support of the HREP study, the District's Water Quality and Sedimentation Section collected four additional samples located in the main channel and in a side channel, in specific locations where high shear stresses were expected. The intent of these sample locations was to capture samples of the most coarse materials found in the river, located where bed-armoring is occurring. If the coarse size fraction is underestimated in the model, excessive erosion can occur.

5.3.6.3. Sediment Transport Simulation. Particle size distribution data for suspended sediments and the soil borings were compiled and evaluated to identify the most abundant particle sizes. AdH sediment transport simulation requires input in metric units and particle sizes are based on the Wentworth soil classification scale (Reference 14). Based on the findings six different particle sizes were identified to track in the model: coarse sand (0.5-1 mm), medium sand (0.25-0.5 mm), fine sand (0.125-0.25mm), very fine sand (0.0625-0.125 mm), fine silt (0.008-0.016 mm) and clay (0.002-0.004 mm). ERDC assisted in the designation of sediment layers and emphasized the model's ability to resort sediments based upon the hydrodynamic solution. Therefore it was not necessary to accurately define the initial sediment layers as long as the model is allowed a warm up period where the hydrodynamics are able to redistribute the sediments. Another assumption inherent to the sediment model is that the primary source of sediment is that which is carried in the Mississippi River and not sediment that makes up Huron Island itself. Five different sediment layers were defined, each of which had a different thickness and particle size distribution depending on the location within the model domain. Defining five layers provides room to characterize existing sediments and to accommodate sorting and future sediment deposition. Table H-19 illustrates the different sediment bed layers defined for each of the model material types.

Table H-19. Bed Layer Assignment by Material Type

	Material Type	**Bed Layer 1 (bottom)**	**Bed Layer 2**	**Bed Layer 3**	**Bed Layer 4**	**Bed Layer 5 (top)**
Material Type	**Map ID (Figure H-14)**	**Thickness (m)/ Particle Size Distribution**	**Thickness (m)/ Particle Size Distribution**	**Thickness (m)/ Particle Size Distribution**	**Thickness (m)/ Particle Size Distribution**	**Thickness (m)/ Particle Size Distribution**
Main channel	1	10/ 25% of each of 4 sand classes	0.01/ 25% of each of 4 sand classes	zero thickness	zero thickness	zero thickness
Shallow side slopes/bank areas	4	10/ equal proportions of all 6 classes	0.01/ 25% of each of 4 sand classes	zero thickness	zero thickness	zero thickness
Overbank areas and islands	3, 5, 6, & 9	10/ equal proportions of all 6 classes	0.01/ 25% of each of 4 sand classes	zero thickness	zero thickness	zero thickness
Urban areas	7 & 25	10/ equal proportions of all 6 classes	0.01/ 25% of each of 4 sand classes	zero thickness	zero thickness	zero thickness
Wing dams	8, 10, & 11	zero thickness	0.01/ 25% of each of 4 sand classes	zero thickness	zero thickness	zero thickness
Huron Island channels	20	10/ equal proportions of all 6 classes	0.1/ 100% fine sand	zero thickness	zero thickness	zero thickness
High stem density, no understory	21	10/ equal proportions of all 6 classes	0.1/ 100% fine sand	zero thickness	zero thickness	zero thickness
Larger trees, understory	22	10/ equal proportions of all 6 classes	0.1/ 100% fine sand	zero thickness	zero thickness	zero thickness
Larger trees, sparse, no understory	23	10/ equal proportions of all 6 classes	0.1/ 100% fine sand	zero thickness	zero thickness	zero thickness
High stem density, understory	24	10/ equal proportions of all 6 classes	0.1/ 100% fine sand	zero thickness	zero thickness	zero thickness

In general the bottom-most layer (layer 1) was assigned a thickness of 10 meters and a distribution that accounted for all particle sizes present at that location. Throughout the main channel and side channels the next layer (layer 2) was assigned a thickness of 0.01 m and a distribution consisting of equal proportions of all four sand classes. Throughout Huron Island, layer 2 was assigned a thickness of 0.1 m and a distribution of 100 percent fine sand. The bottom-most layer (layer 1) defined for the material types which represent river regulating structures (closing dams and wing dams) was assigned a thickness of zero and the next layer on top (layer 2) was assigned a thickness of 0.01 m and a distribution of equal portions of all four sand classes, allowing only the upper layer to be eroded and re-deposited. The three upper-most layers were assigned a zero thickness throughout the model domain, allowing them to act as available storage for deposition.

As with the hydrodynamic simulation of AdH, version 4.01 of the sediment transport executable was compiled for use on the HPC. ERDC provided guidance in developing an appropriate modeling approach to meet the study's objectives and provided assistance completing model simulations on the HPC. Because the hydrodynamic model was developed for steady state simulations rather than unsteady simulations, evaluating sedimentation trends throughout Huron Island would require simulating sediment transport under various discharge conditions. Due to schedule and budget constraints, development of input files necessary for an unsteady simulation was not pursued.

The same three discharges (91,000 cfs, 160,000 cfs and 215,000 cfs) discussed in the hydrodynamic solution results were simulated to evaluate sediment transport. These three discharges represent conditions under which we would expect to see significantly different sedimentation rates, each of which can be attributed to a portion of the annual duration curve. Per ERDC's recommendation, the average annual sedimentation rate can be approximated by multiplying each of the three computed sedimentation rates by their respective duration and summing the results. A graphical illustration of how the annual duration curve was split into segments and the percentage of the year that each segment represents is shown in figure H-42. The net sedimentation that is attributed to each segment of the annual duration curve is represented by the sedimentation that occurs during one of the three representative flow values.

Simulating sediment transport in AdH requires a hydrodynamic solution to use as an initial condition to generate the hotstart file. The initial time step size used for the sediment simulations was 10 seconds and was increased to 200 seconds after 1,000 time steps. The sediment transport simulations were run for 56 days, however the initial 28 days are considered a warm up period. The 28 day results were subtracted from the 56 day results for a 28 day simulation solution. A 28 day solution was chosen because it is long enough to allow the model to deposit a measurable amount of sediment and that any day to day variation in sedimentation will be averaged out. The resulting equation used to compute average annual sedimentation is as follows:

Average annual sedimentation (cm) =

$$[(91{,}000 cfs\ sedimentation\ (cm)/28\ (day)) * (.88 * 365\ (day))] +$$
$$[(160{,}000 cfs\ sedimentation\ (cm)/28\ (day)) * (.08 * 365\ (day))] +$$
$$[(215{,}000 cfs\ sedimentation\ (cm)/28\ (day)) * (.04 * 365\ (day))]$$

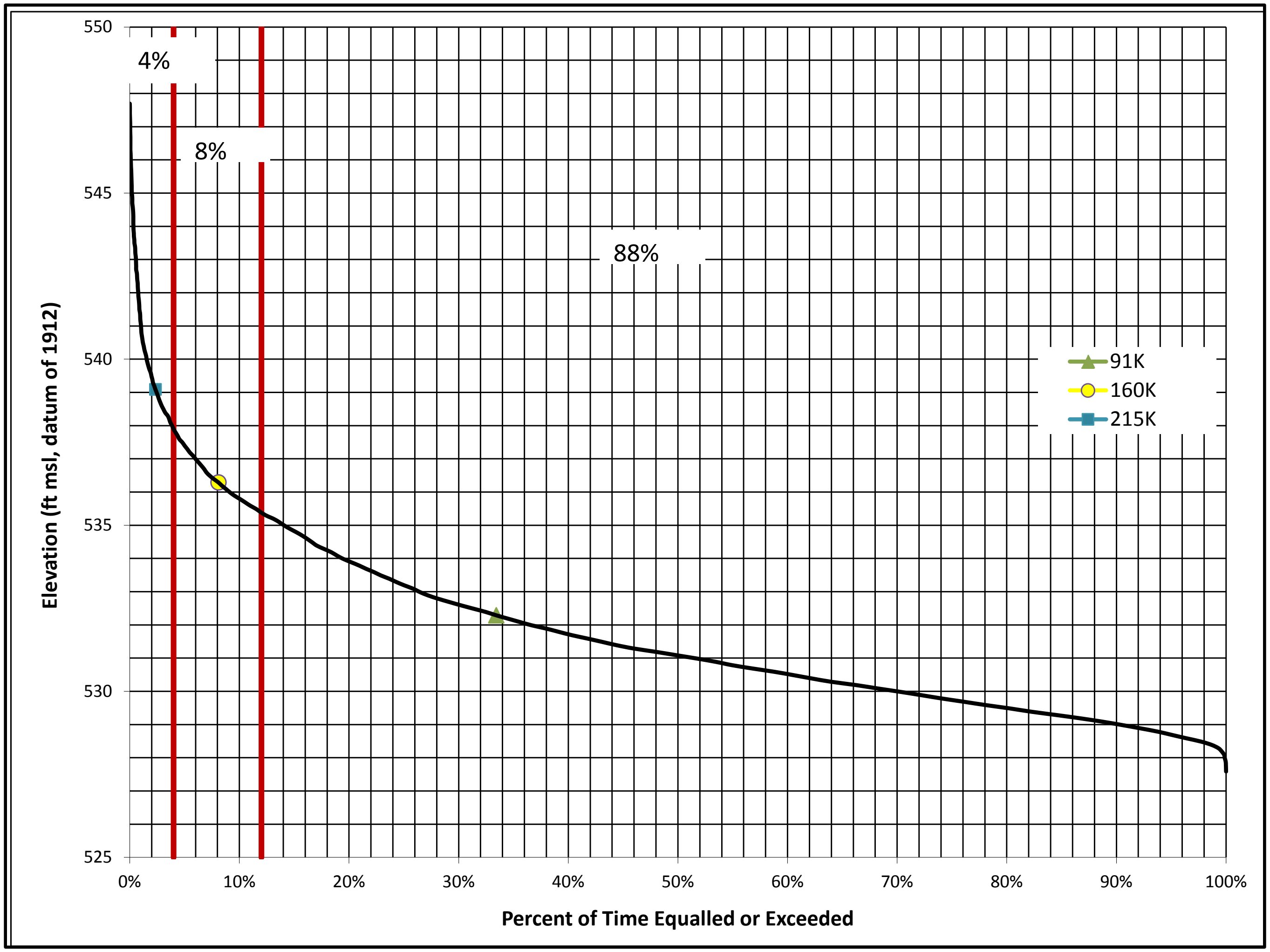

Figure H-42. Duration Curve Segmentation for Computing an Average Annual Sedimentation Rate

5.3.6.4. AdH Sediment Transport Results. The following sections, Section 5.3.6.4.1 through Section 5.3.6.4.2, present results from the AdH sediment transport modeling effort. Existing condition results are presented followed by the HREP TSP results. Sediment transport results under the three representative discharge conditions are presented, focusing on impacts to the project feature areas.

5.3.6.4.1. Existing Conditions. Under discharge conditions of 91,000 cfs deposition throughout Goose Lake Pools 1 & 2 is very limited (figure H-43). The average 28-day deposition in Goose Lake Pool 1 is 0.00019 cm and 0.0088 cm in Goose Lake Pool 2. Sedimentation within the entrance to Goose Lake Pools 1 & 2 is similar to that within the Pools itself. Sedimentation at the mouth of Gun Slough under these conditions is slightly higher (0.05-0.2 cm).

Under discharge conditions of 160,000 cfs results from the sediment transport model indicates that there is slightly greater deposition in Pool 1 than in Pool 2, during the 28 day simulation. The average 28-day deposition in Goose Lake Pool 1 is 0.617 cm and 0.185 cm in Goose Lake Pool 2. The flows that are depositing sediment within and along side of Pool 2 enter Huron Island over 500 feet upstream of Pool 2 where the flow path then turns southerly, flowing over forested areas along the way. The forest vegetation surrounding Pool 2 is causing sediment to drop out as shown in figure H-44. Flows that are depositing sediment in Pool 1 are traveling southerly from Gun Slough where the forested overland flow path may be shorter and not causing quite as much deposition. The model indicates erosional conditions within the entrance to Pools 1& 2. Within the lower reach of Gun Slough, the model illustrates primarily erosional conditions, however at the very mouth of Gun Slough there is some deposition taking place.

Under discharge conditions of 215,000 cfs the results from the sediment transport model continue to show greater deposition in Pool 2 than Pool 1 (figure H-45). Average deposition in Goose Lake Pool 1 is 1.07 cm and 0.739 cm in Goose Lake Pool 2 during the 28 day simulation. Overall however, there are more areas within Goose Lake Pools 1 & 2 that illustrate erosion is occurring. The entrance to the Goose Lake Pools continues to show some erosional areas and the depositional area observed at the mouth of Gun Slough under 160,000 cfs conditions is greatly reduced under conditions of 215,000 cfs.

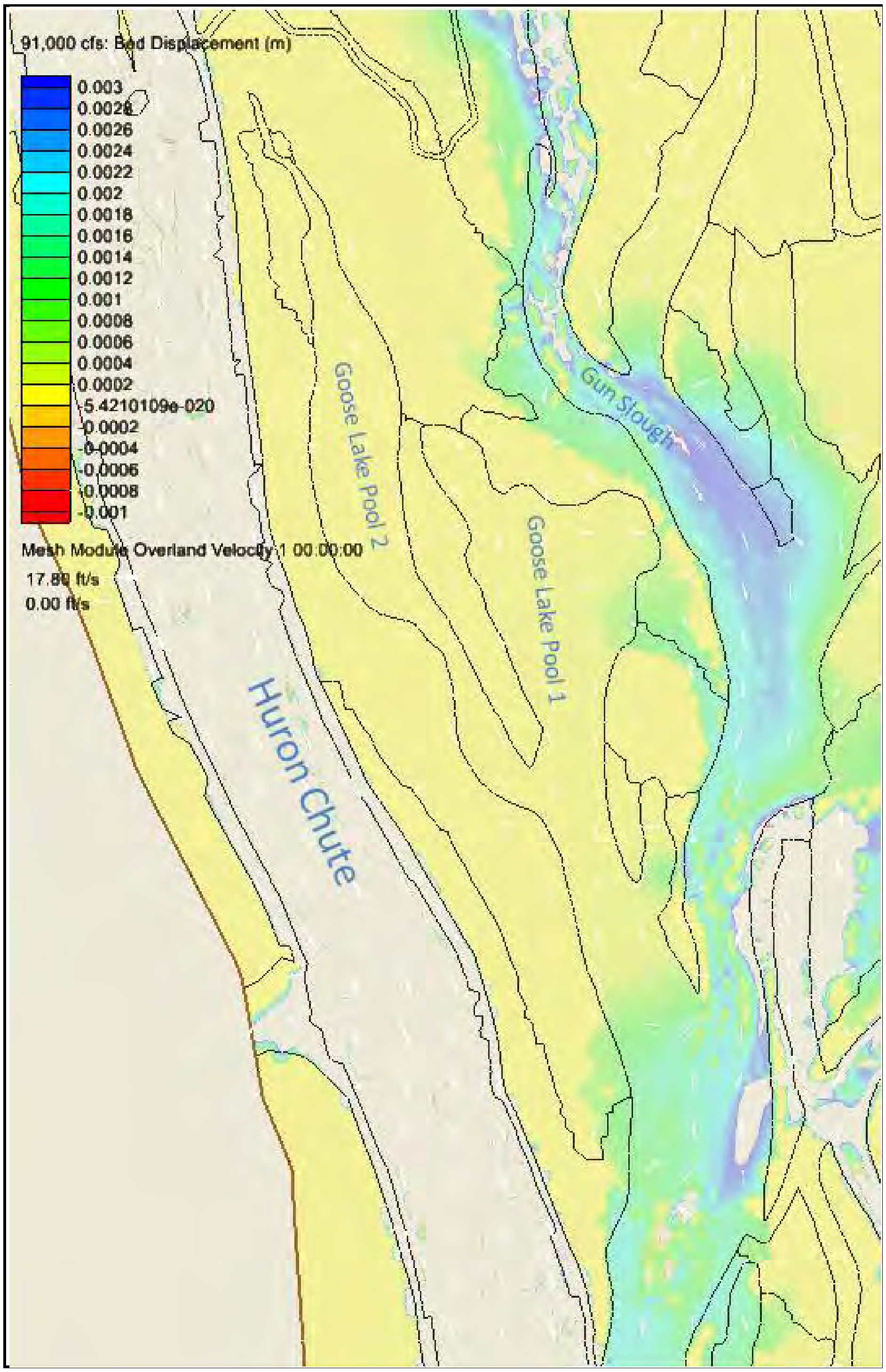

Figure H-43. Bed Displacement in Pools 1 & 2 Under Discharge Conditions of 91,000 cfs

Note that displacements greater than 0.003 m and less than -0.001 m are not mapped.

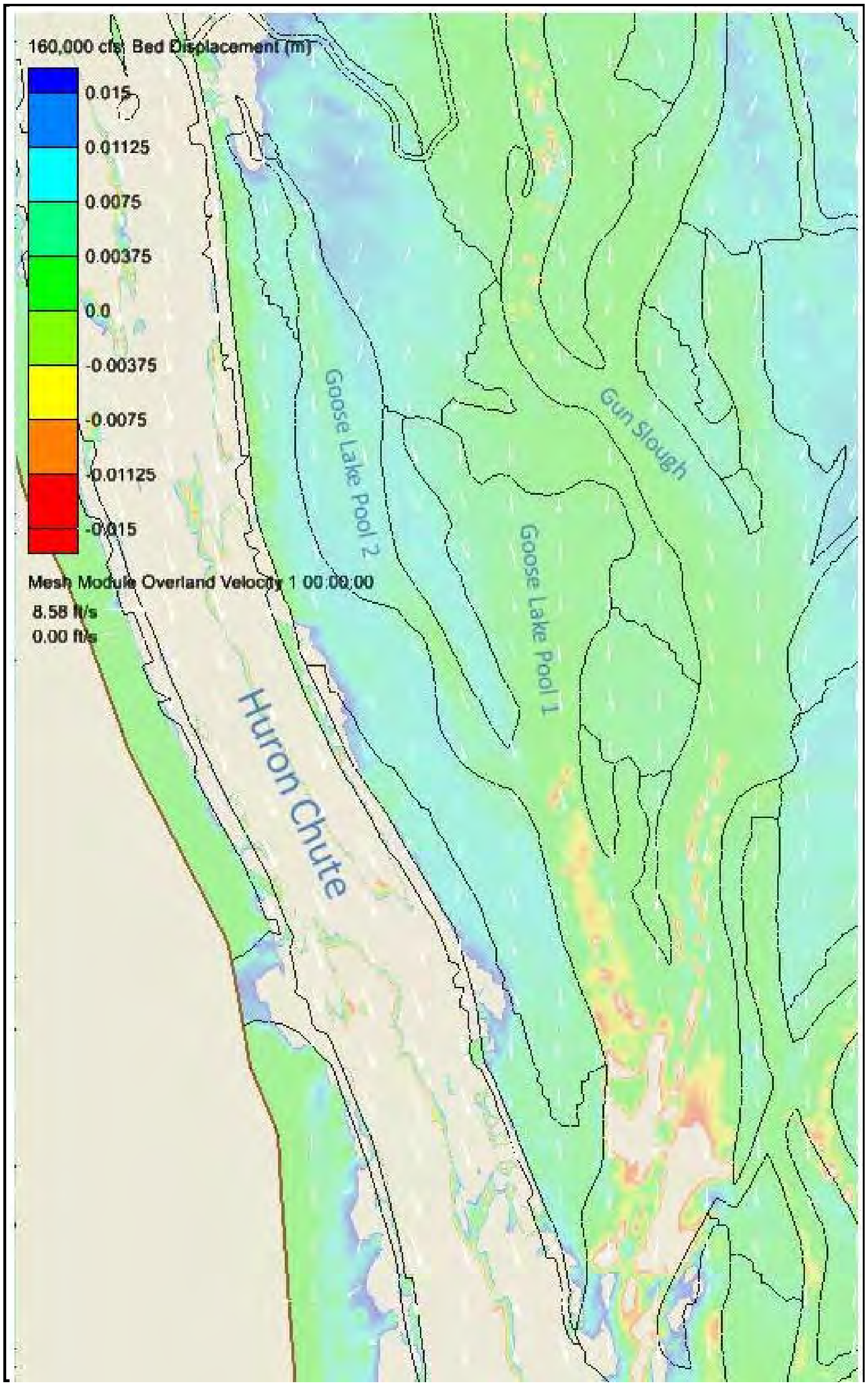

Figure H-44. Bed Displacement in Pools 1 & 2 Under Existing Conditions and Discharge Conditions of 160,000 cfs

Note that displacements greater than 0.015 m and less than -0.015 m are not mapped.

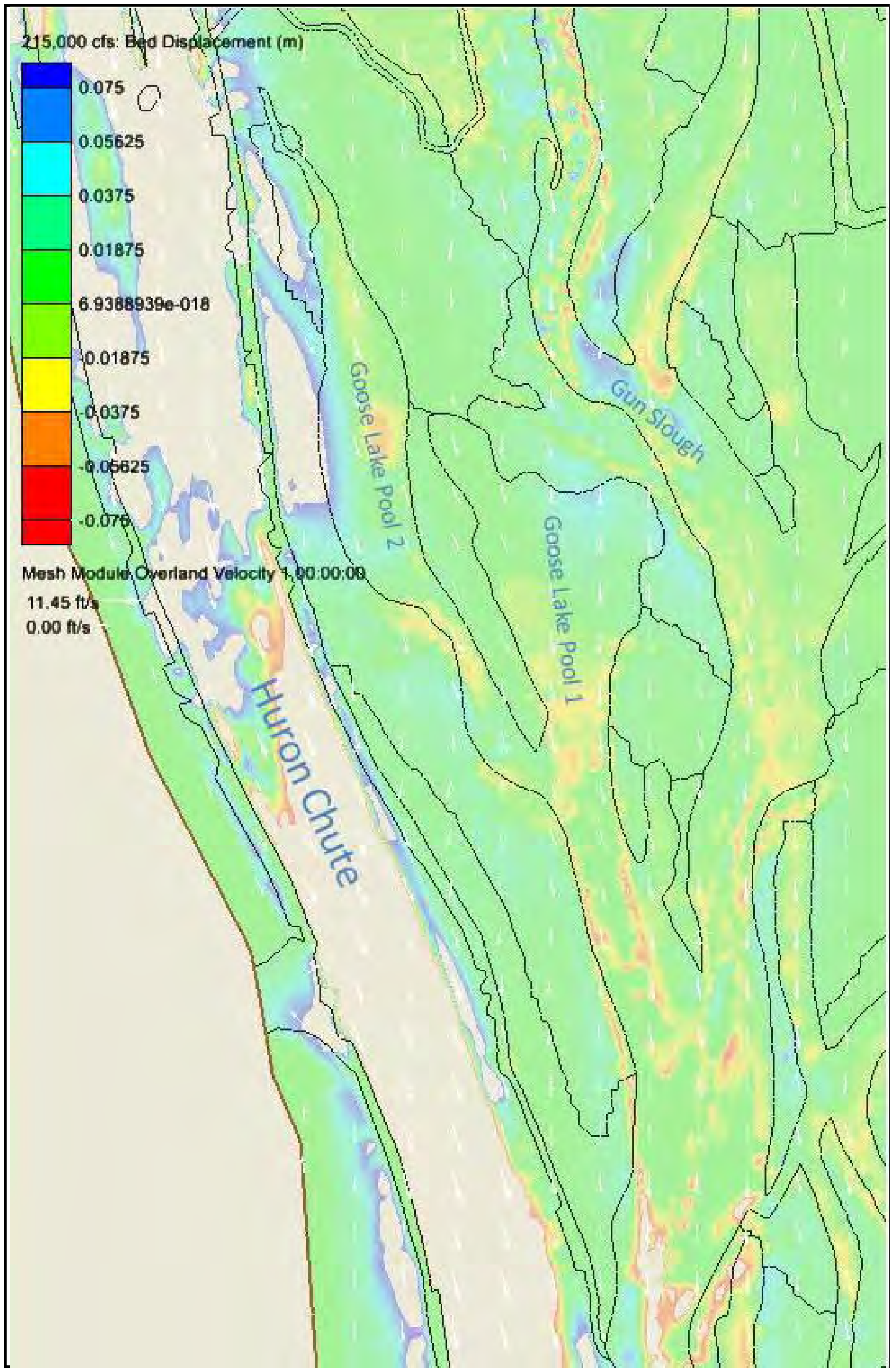

Figure H-45. Bed Displacement in Pools 1 & 2 Under Existing Conditions and Discharge Conditions of 215,000 cfs

Note that displacements greater than 0.075 m and less than -0.075 m are not mapped.

Based on these 28-day sedimentation results for the existing condition and applying the method discussed in Section 5.3.6.3, *Sediment Transport Simulation*, the average annual sedimentation rate for Pool 1 is 1.2 cm/yr and 0.68 cm/yr for Goose Lake Pool 2 (table H-20). These AdH estimates of sedimentation are similar to reported backwater sedimentation rates within the UMR (References 7-12). For example a sedimentation rate of 0.8 cm/yr for Navigation Pool 13 was reported by Rogala & Boma (Reference 10) and the average of the rates reported in the Aspelmeier study was 0.59 cm/yr (Reference 12). Sedimentation over the next 50 years without project, as based on the average annual AdH-computed rates, is expected to be 2.0 feet for Goose Lake Pool 1 and 1.1 foot for Goose Lake Pool 2.

Sedimentation within Garner Chute under existing conditions is examined to evaluate whether or not the proposed closure structure (T9) will result in significant changes to existing sedimentation. Under discharge conditions of 160,000 cfs sedimentation in Garner Chute is generally more erosional than depositional (figure H-46). Under discharge conditions of 215,000 cfs the upstream half of Garner Chute is erosional and the downstream half of Garner Chute is depositional (figure H-47).

Table H-20. Summary of 28-Day AdH Simulation Results for Average Deposition in Goose Lake Pools 1 and 2 Under Existing Conditions

	Discharge (cfs)				
	91,000	**160,000**	**215,000**	**Average Annual Sedimentation Rate**	**Sedimentation Over the 50-year Project Life**
Goose Lake Pool 1	0.00019	0.617	1.07	1.2 (cm/yr)	2.0 (ft)
Goose Lake Pool 2	0.0088	0.185	0.739	0.68 (cm/yr)	1.1 (ft)

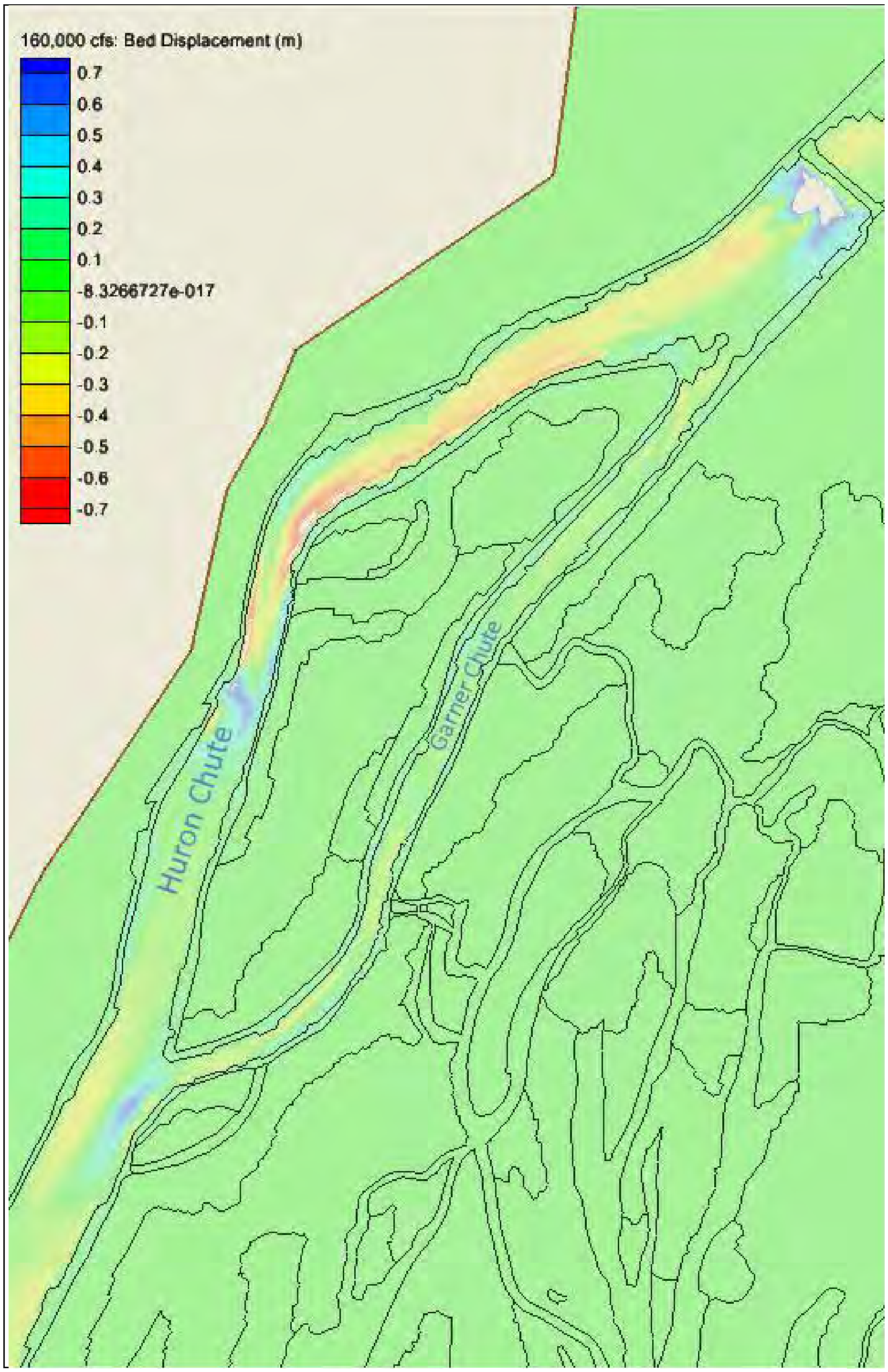

Figure H-46. Bed Displacement within Garner Chute Under Existing Conditions and Discharge Conditions of 160,000 cfs

Note that displacements greater than 0.7 m and less than -0.7 m are not mapped.

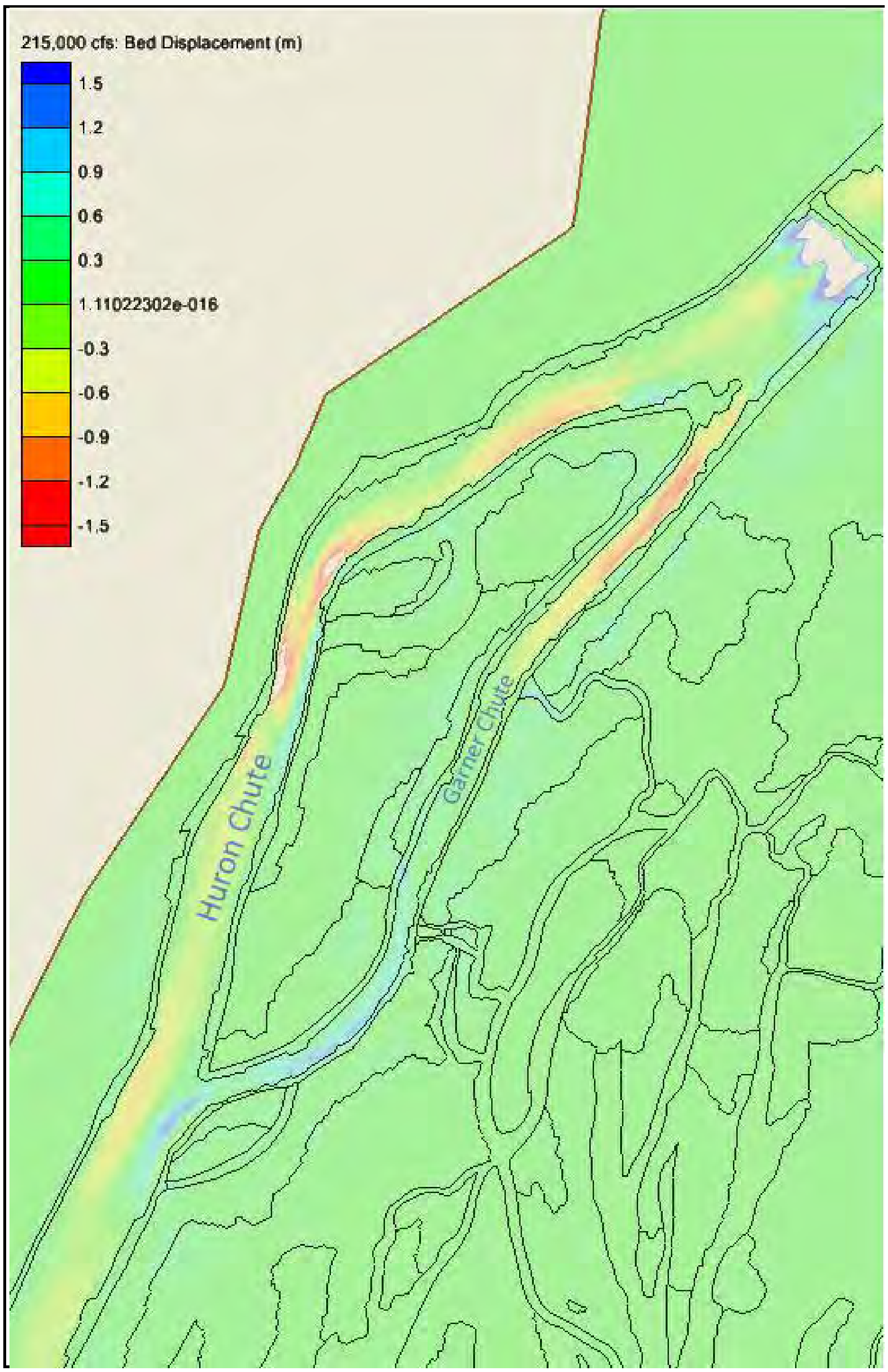

Figure H-47. Bed Displacement within Garner Chute Under Existing Conditions and Discharge Conditions of 215,000 cfs

Note that displacements greater than 1.5 m and less than -1.5 m are not mapped.

5.3.6.4.2. Evaluation of the Tentatively Selected Plan. With the TSP in place under discharge conditions of 91,000 cfs, the sedimentation that occurs during the 28-day simulation period is 0.0011 cm in Pool 1 and 0.0019 in Pool 2 (figure H-48). Average sedimentation at the confluence of Goose Lake Pools 1 & 2 under the TSP is higher than that under existing conditions and higher than sedimentation within the Pools themselves (0.025 cm). Sedimentation at the mouth of Gun Slough under these conditions is slightly higher (0.15-0.3 cm).

Average sedimentation during the 28-day simulation period under 160,000 cfs with the TSP in place is 0.22 cm in Pool 1 and 0.14 cm in Pool 2. As shown in figure H-49, just off the end of the topographic diversity feature F1 deposition of sediment is occurring as overland flow from Gun Slough wraps around berm F1 and then interfaces with the quiescent water within Pools 1 & 2. This is resulting in an alluvial fan depositional feature near the confluence of Pools 1 & 2. Average sedimentation at the confluence of Goose Lake Pools 1 & 2 with the TSP in place is 0.69 cm. Although this depositional pattern is not ideal, over the 50 year project life this area is still only expected to see an average deposition of 2.2 feet. Based on these results a dredge depth of eight feet will still be adequate to sustain fish overwintering throughout the Project life. Depositional conditions at the mouth of Gun Slough under these discharge conditions are erosional.

Under discharge conditions of 215,000 cfs with the TSP in place the average sedimentation that occurs during the 28-day simulation period is 0.59 cm in Pool 1 and 0.28 cm in Pool 2. The average deposition that occurs at the confluence of Pools 1 & 2 under 215,000 cfs is 0.63 cm and is slightly less than that under 160,000 cfs (0.69 cm) (figure H-50). Depositional conditions at the mouth of Gun Slough under 215,000 cfs discharge conditions remain erosional.

During the plans and specifications phase of this Project there may be some additional fine-tuning made to the berm alignments (F1 and F3) in order to encourage deposition of sediment within the forested area to the east of Pool 1 and F1 instead of depositing at the confluence of the two pools.

Table H-21. Comparison of 28-day AdH Simulation Results for Average Deposition in Goose Lake Pools 1 and 2 Under Existing Conditions and the Tentatively Selected Plan

	Discharge (cfs)				
	91,000	**160,000**	**215,000**	**Average Annual Sedimentation Rate**	**Sedimentation Over the 50-year Project Life**
Existing Condition					
Pool 1 (cm)	0.00019	0.617	1.07	1.2	2.0
Pool 2 (cm)	0.0088	0.185	0.739	0.68	1.1
TSP Plan					
Pool 1 (cm)	0.0011	0.22	0.59	0.55	0.90
Pool 2 (cm)	0.0019	0.14	0.28	0.32	0.53
Pool Confluence	0.025	0.69	0.63	1.3	2.2

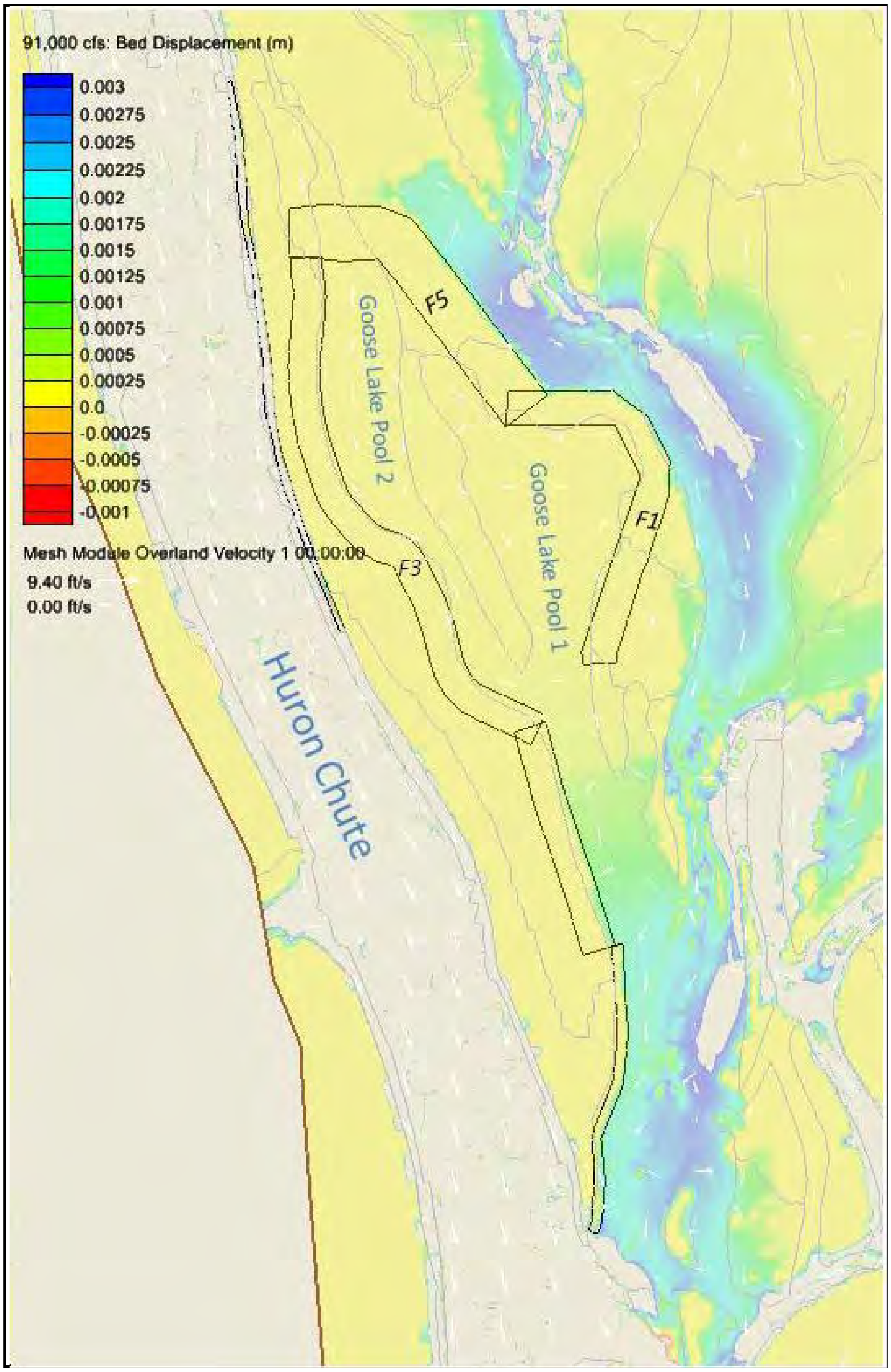

Figure H-48. Bed Displacement in Pools 1 & 2 Under Discharge Conditions of 91,000 cfs with the Tentatively Selected Plan in Place

Note that displacements greater than 0.003 m and less than -0.001 m are not mapped.

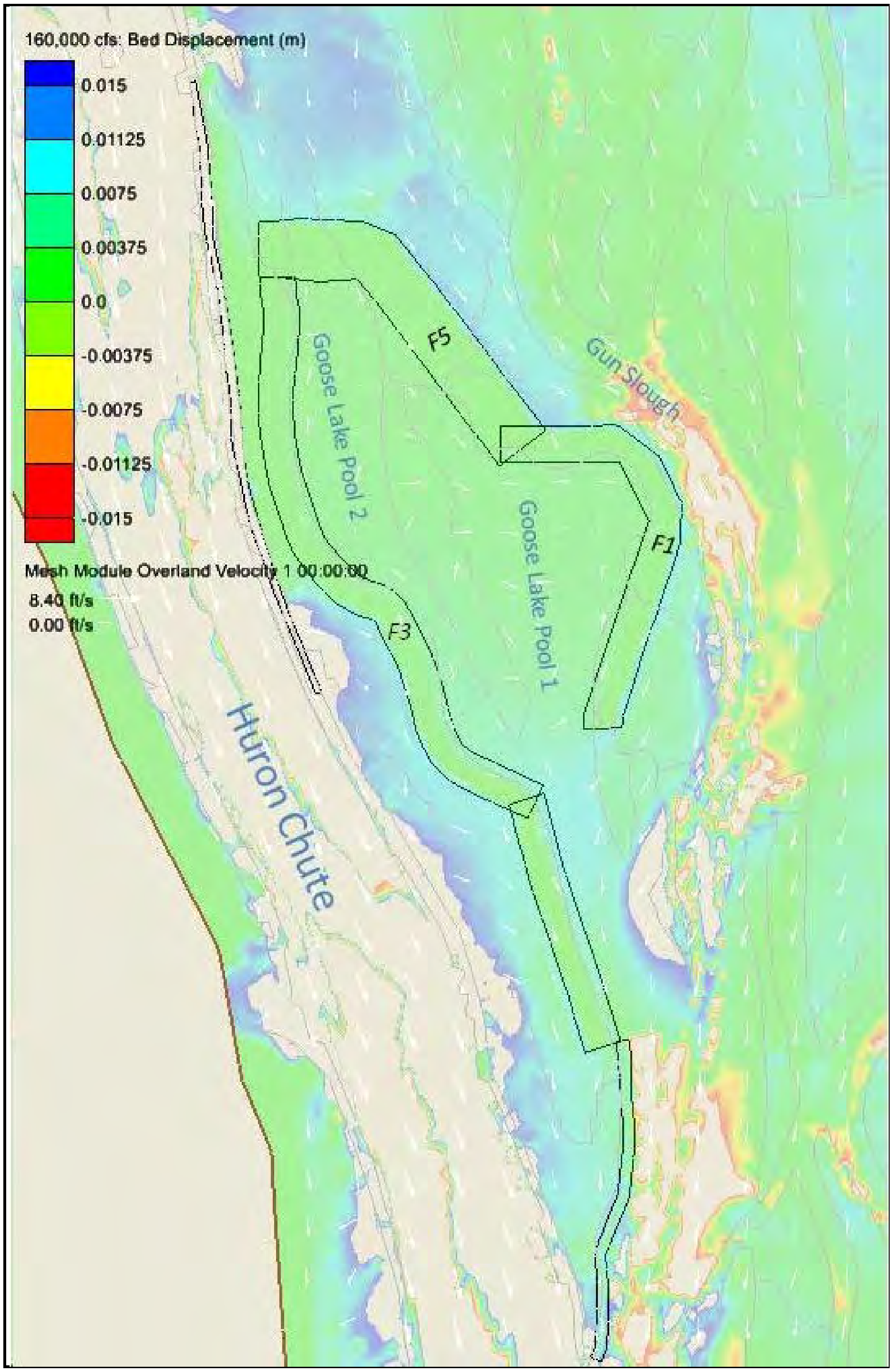

Figure H-49. Bed Displacement in Pools 1 & 2 Under Discharge Conditions of 160,000 cfs with the Tentatively Selected Plan in Place

Note that displacements greater than 0.015 m and less than -0.015 m are not mapped.

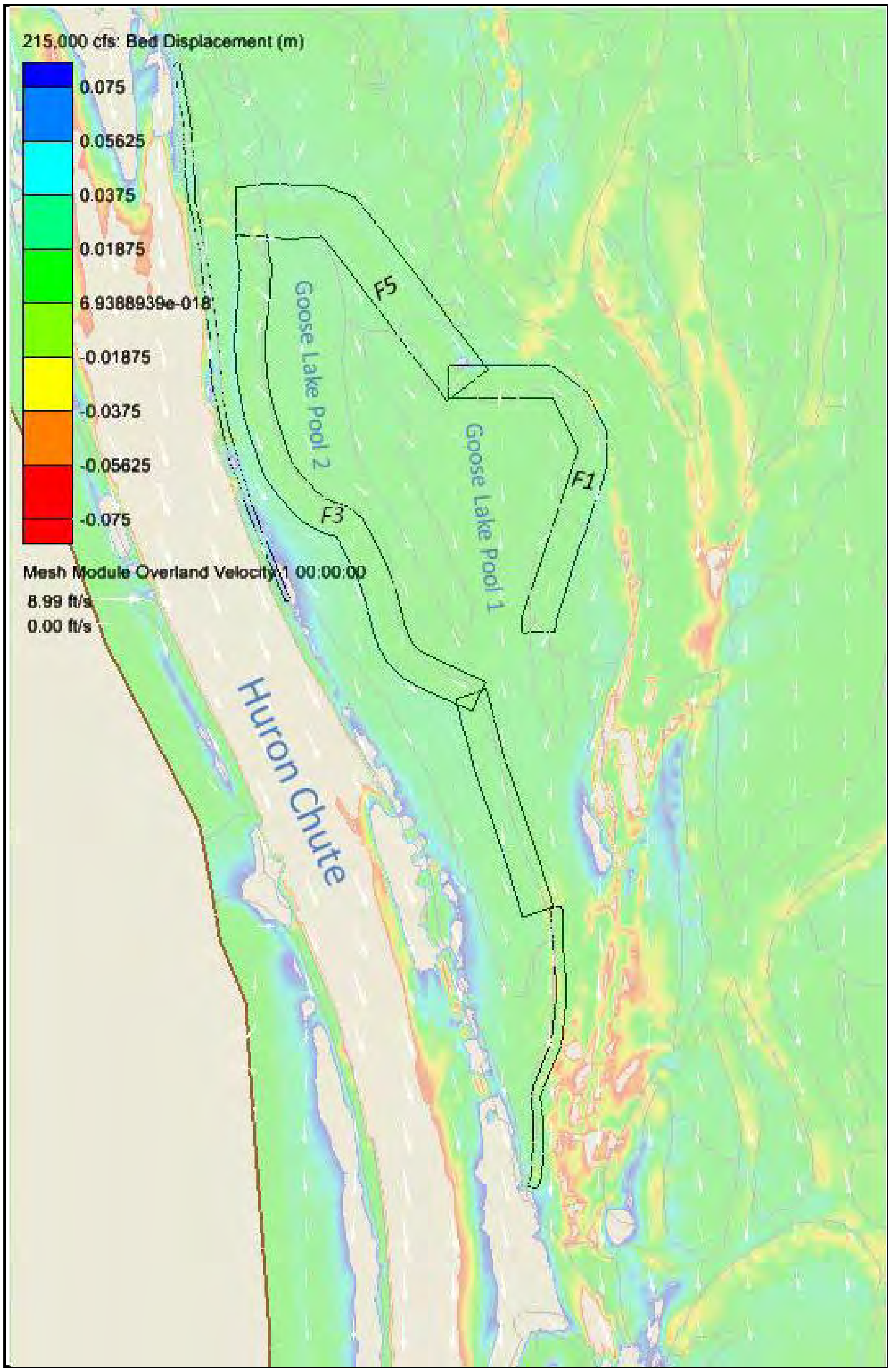

Figure H-50. Bed Displacement in Pools 1 & 2 Under Discharge Conditions of 215,000 cfs with the Tentatively Selected Plan in Place

Note that displacements greater than 0.075 m and less than -0.075 m are not mapped.

These 28-day simulation sedimentation results under the TSP were applied to the same average annual sedimentation calculation method resulting in an average annual sedimentation rate for Pool 1 of 0.55 cm/yr and 0.32 cm/yr for Pool 2. Over the 50-year project life, there will be 0.90 foot of sedimentation in Pool 1 and 0.53 foot of sedimentation in Pool 2. At the confluence of Pools 1 & 2 the average annual sedimentation rate is 1.35 cm/yr, which results in the deposition of 2.21 feet over the Project life. According to the method used to compute average annual sedimentation, the with project rates indicate that the TSP is effectively reducing sedimentation within Goose Lake Pools 1 & 2 relative to existing conditions.

Sedimentation patterns within Garner Chute do change with closing structure (T9) in place. Under discharge conditions of 160,000 cfs relatively minor deposition occurs throughout Garner Chute (figure H-51). This is in contrast to the slightly erosional conditions in Garner Chute under existing conditions under 160,000 cfs. Under discharge conditions of 215,000 cfs with the closure structure in place, there are some local depositional features near the closing structure and below the structure erosional conditions occur in the upper reach and depositional conditions occur in the lower reach of Garner Cute (figure H-52). T9 acts to restrict water from entering Garner Chute, thereby forcing more water to Huron Chute. As a result, with the closure structure in place the magnitude and extent of erosional conditions within Huron Chute increases under 160,000 cfs and 215,000 cfs conditions.

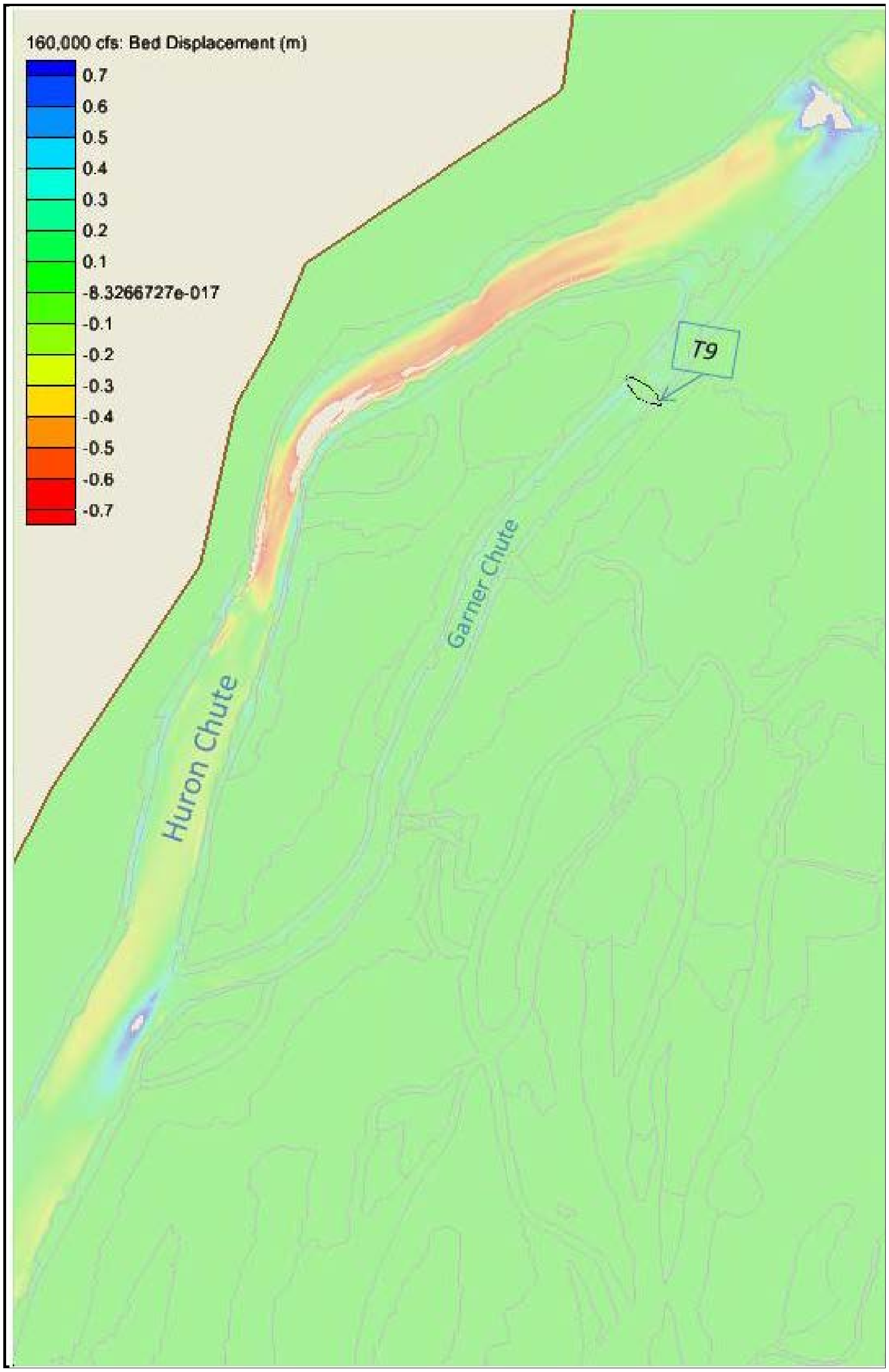

Figure H-51. Bed Displacement Within Garner Chute Under the Tentatively Selected Plan and Discharge Conditions of 160,000 cfs

Note that displacements greater than 0.7 m and less than -0.7 m are not mapped.

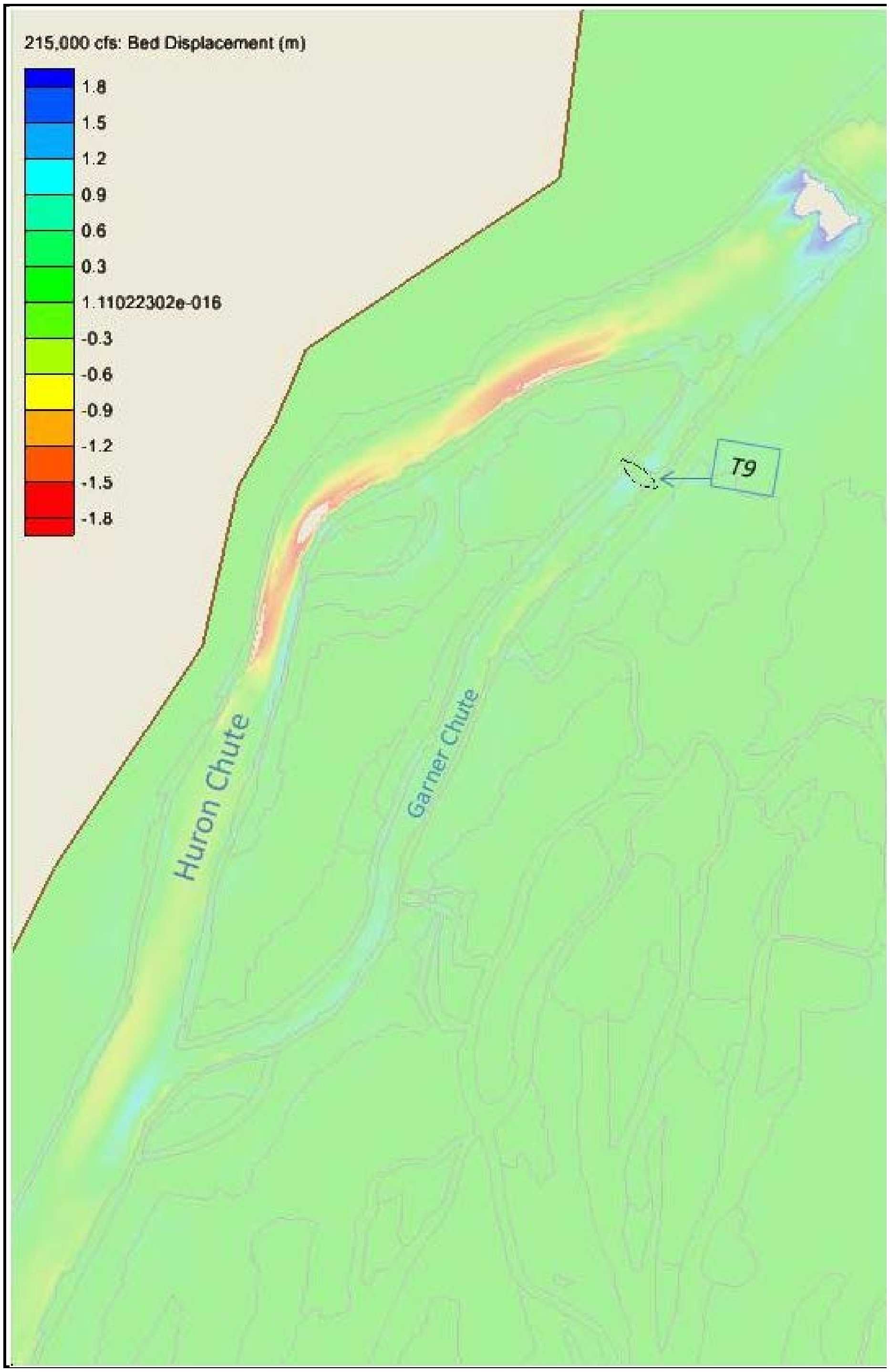

Figure H-52. Bed Displacement Within Garner Chute Under the Tentatively Selected Plan and Discharge Conditions of 215,000 cfs

Note that displacements greater than 1.8 m and less than -1.8 m are not mapped.

5.3.7. Island Scour Analysis. In response to public comments, an additional 2D hydraulic analysis was performed to assess potential velocity changes along the right descending bank of Huron Chute near RM 423. Three geometry variations were run and compared to existing conditions: 1) Selected Plan; 2) Selected Plan with Riprap along the right descending bank; and 3) without the two islands pictured (figure H-53). Each geometry was run under the following flow rates: 91,094 cfs, 160,000 cfs, and 215,000 cfs. No significant changes in velocity magnitude or direction were observed along the right descending bank (figures H-54 through H-59).

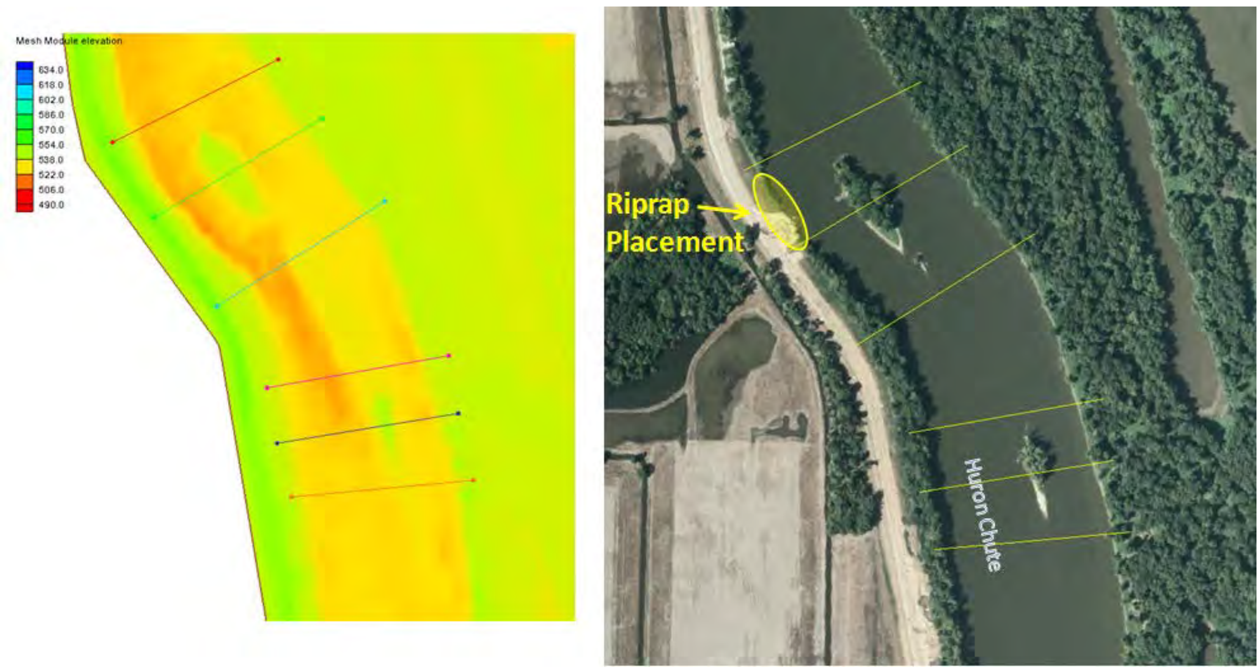

Figure H-53. Location of Island Scour Analysis

Mesh Elevations and Aerial With XS Cut Locations, Also Illustrating Location o Riprap Placement Alternative

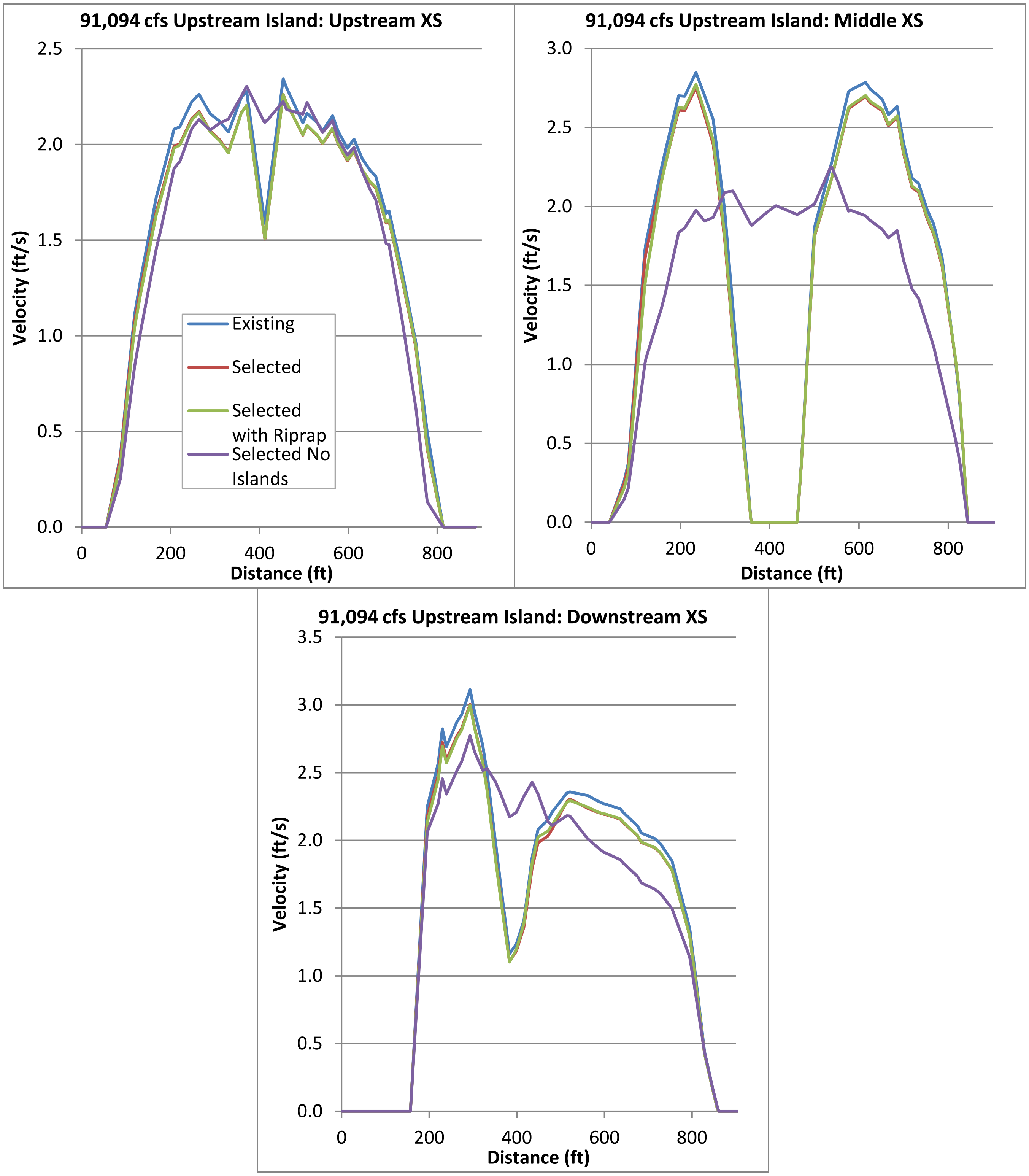

Figure H-54. Results for 91,094 cfs Upstream Island Velocity Sections

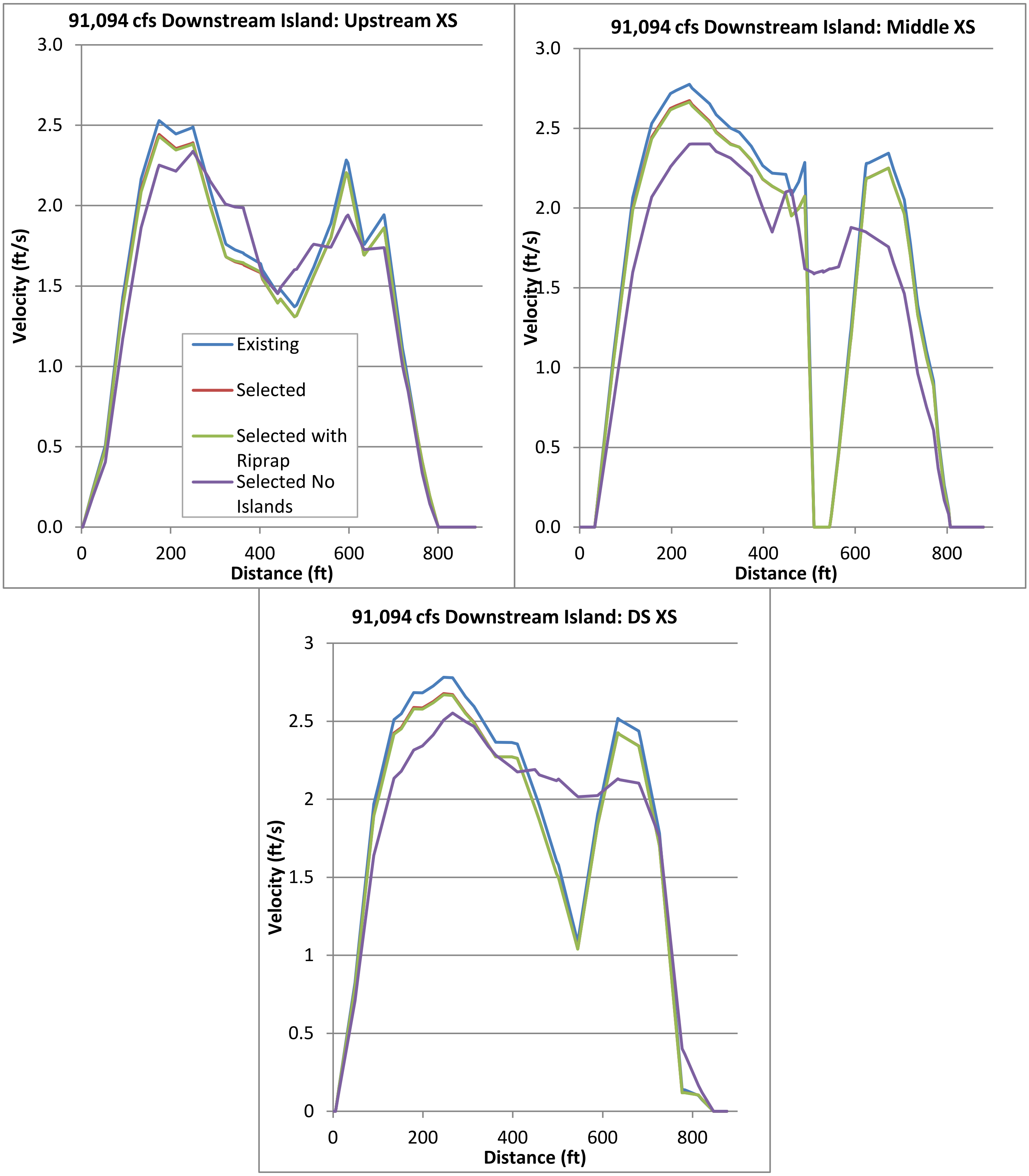

Figure H-55. Results for 91,094 cfs Downstream Island Velocity Sections

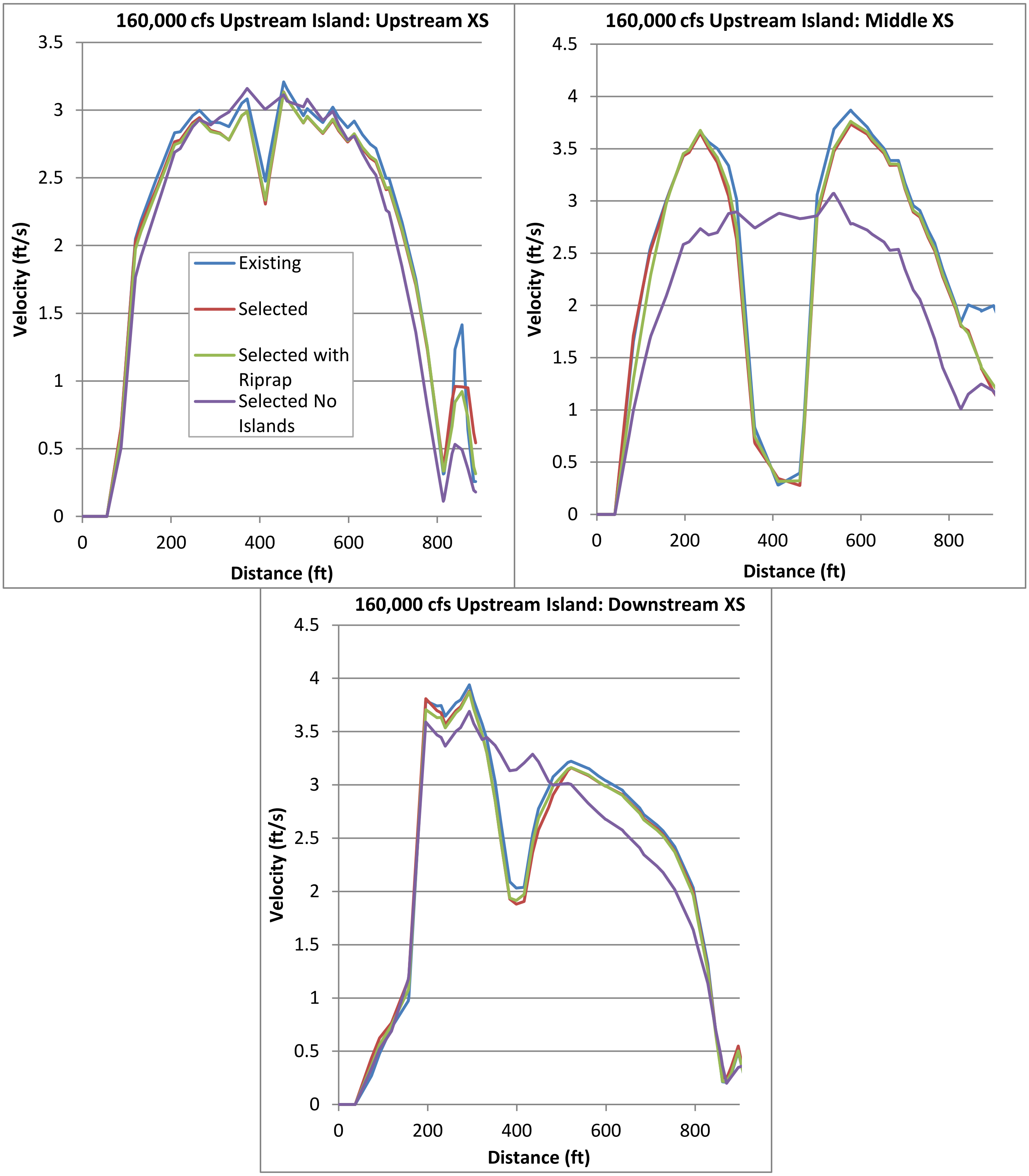

Figure H-56. Results for 160,000 cfs Upstream Island Velocity Sections

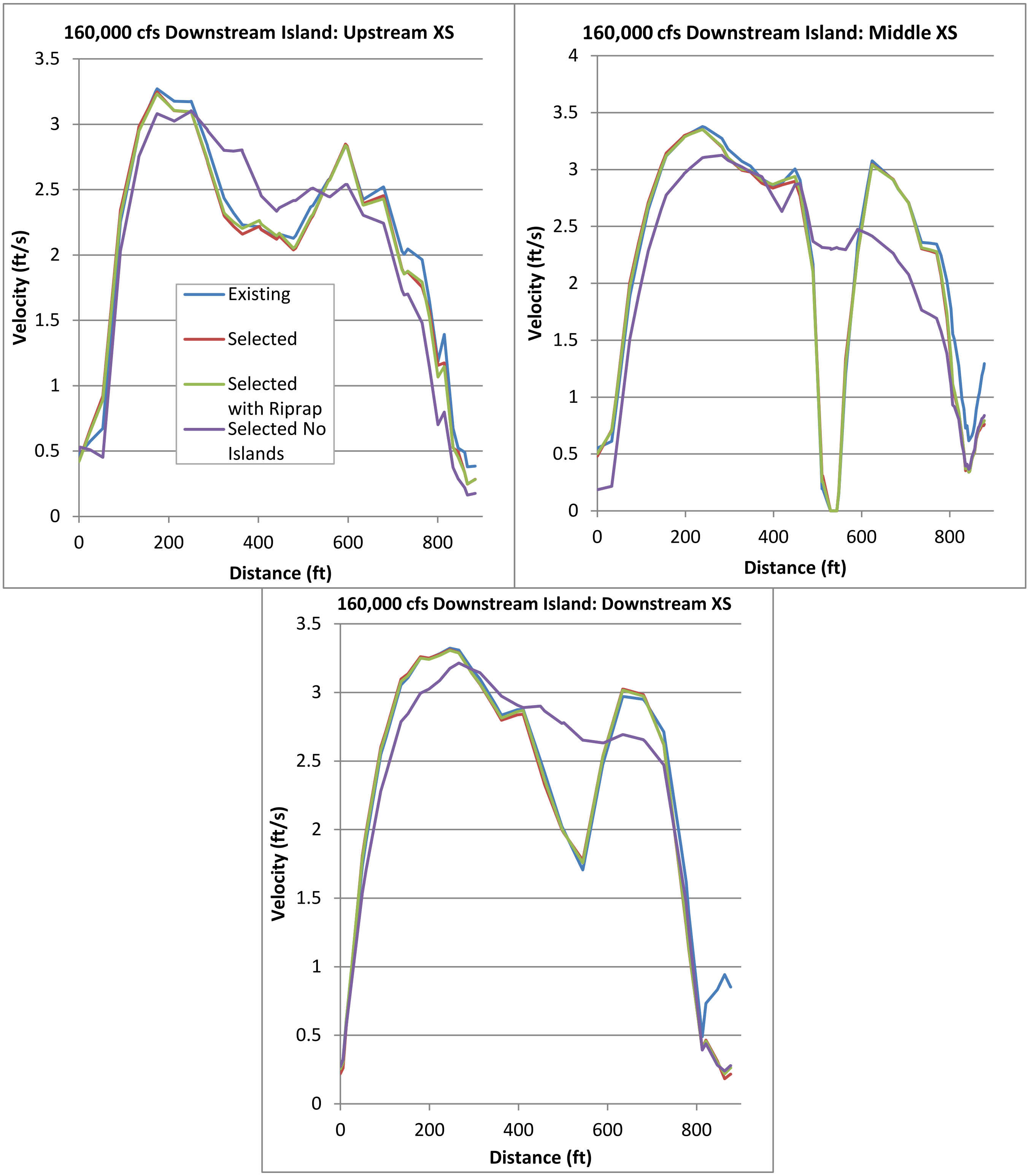

Figure H-57. Results for 160,000 cfs Downstream Island Velocity Sections

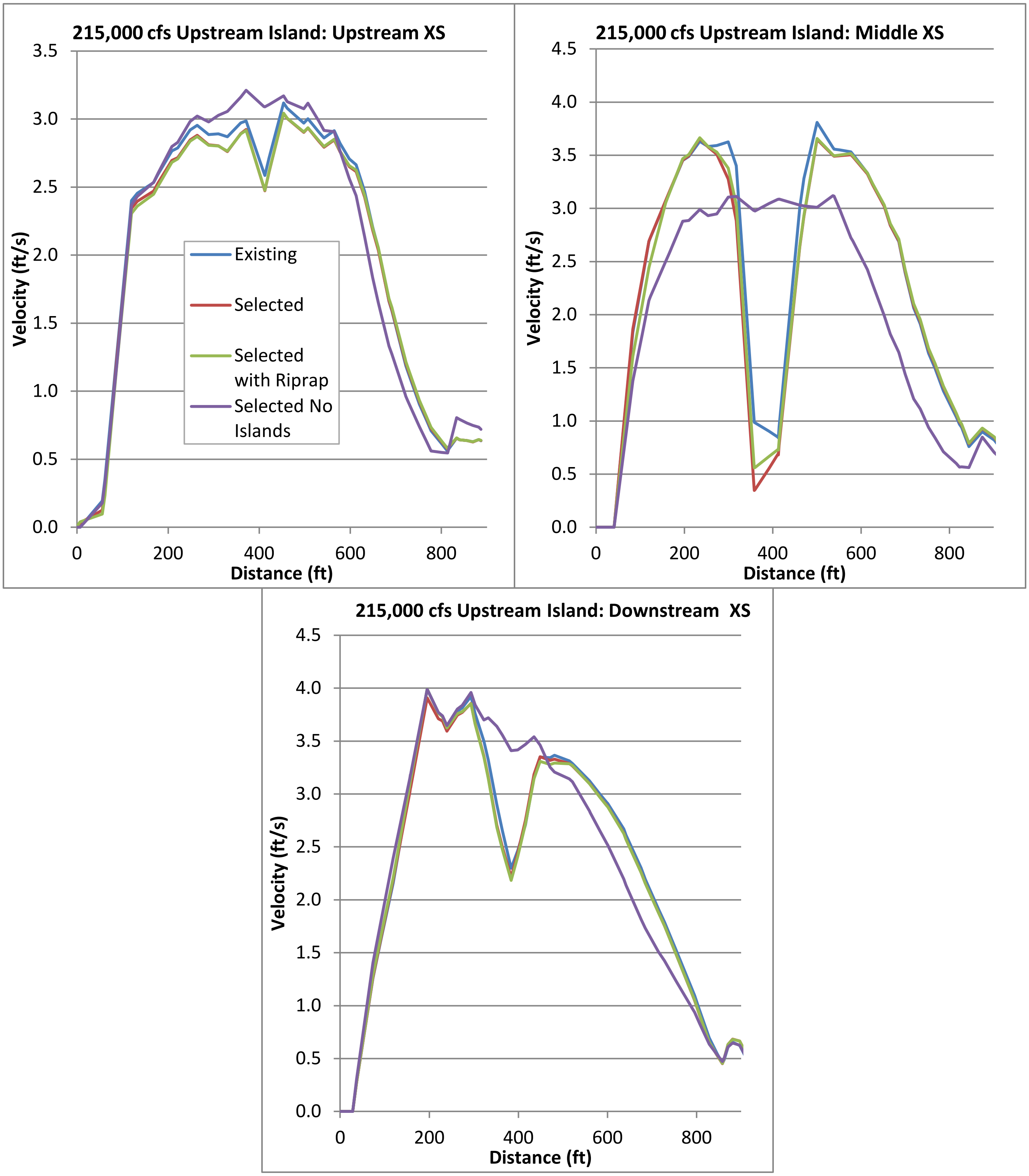

Figure H-58. Results for 215,000 cfs Upstream Island Velocity Sections

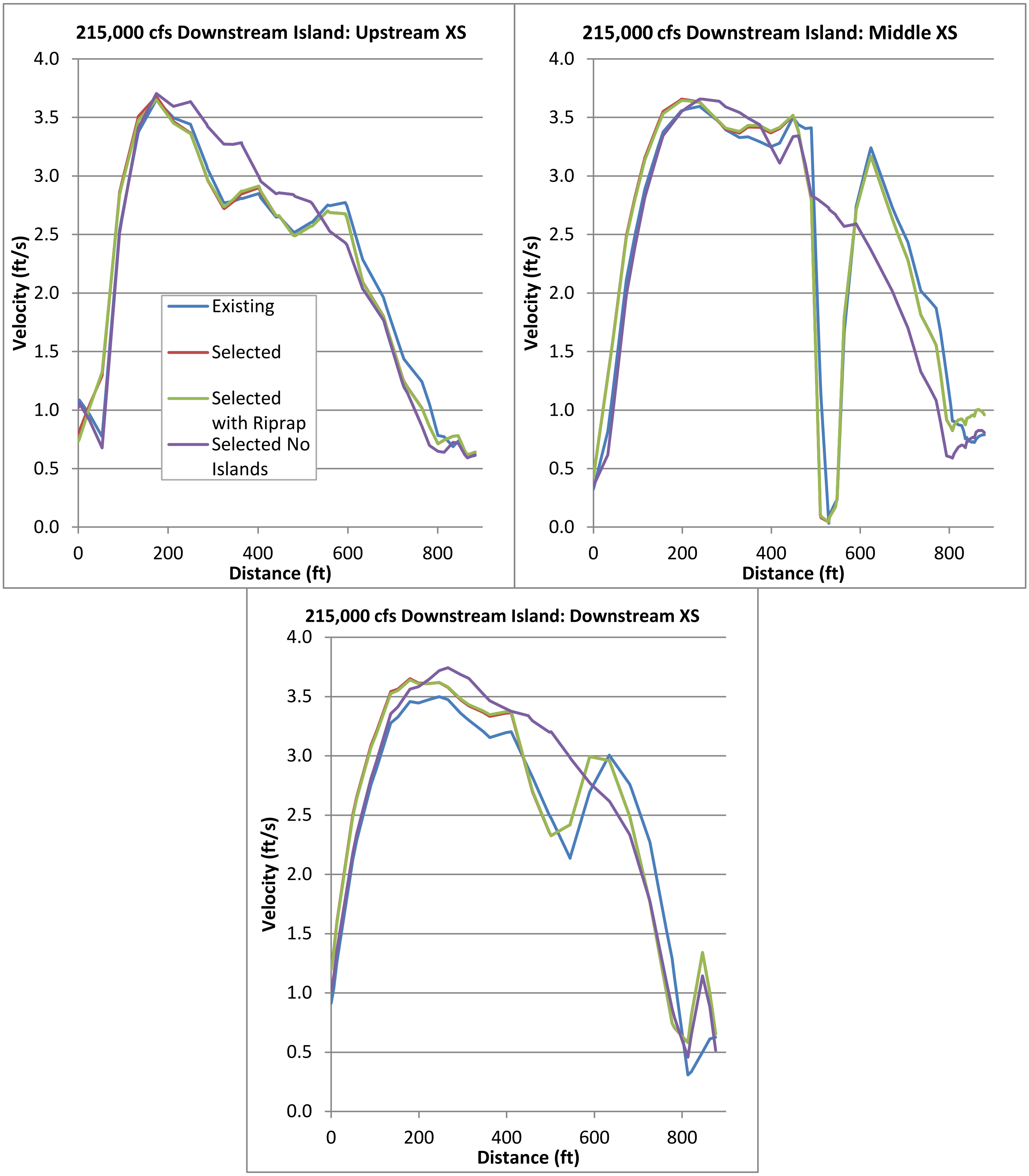

Figure H-59. Results for 215,000 cfs Downstream Island Velocity Sections

6. IMPACTS TO MISSISSIPPI RIVER WATER SURFACE LEVELS

The location of the Huron Island Project area imposes two sets of criteria with regard to impacts to the floodplain. Firstly, the Iowa River-Flint Creek Levee District No. 16 is located on the right descending bank of Huron Chute (Reference 15). Located adjacent to an existing federal project, the Huron Island Project is restricted to "no rise" to the 1 percent exceedance probability water surface profile. The District has interpreted "no rise" to mean less than 0.1 foot of rise. The Huron Island Project is located within the floodway within which the Federal Emergency Management Agency requires "no rise" to the 1 percent exceedance probability water surface profile. The state of Iowa interprets this as restricting impacts to the 1 percent exceedance probability water surface profile to 0.01 foot of rise per Iowa Administrative Code 567 (Reference 16).

In order to model the impacts of the Project, HEC-RAS was used to characterize the impacts of the Project using a more traditional one-dimensional analysis. Existing HEC-RAS floodway model cross sections were updated to include the current bathymetric and topographic surface (used for the feasibility study) in order to more accurately characterize existing conditions for the Project feasibility study and design (figure H-60). The results from this simulation were considered as the reference existing condition or the base condition.

A surface with the TSP features was used to generate new cross-sections that included all of the proposed features with the exception of the Garner Chute Closure (T9). The results from the TSP simulation illustrate that the chevrons (I2) produce an increase in water surface elevation at the upstream sections (0.017 foot) that exceeds the no rise criterion. The results were discussed among the PDT and the decision was made to reduce the scope of the chevrons. In lieu of island creation features such as the chevrons (I2), the PDT decided on an island protection feature with a minimal footprint, such as riprap to be placed along the nose of the islands. The floodway model was then run removing the chevrons (I2) but keeping all of the other TSP features. With the removal of the chevron features (I2) the Project complies with the floodplain regulations. During plans and specifications cross-sections to include the Garner Chute closing structure (T9) will be added to ensure this structure does not result in impacts to the flood profile.

The recommended alternative is not expected to be significantly affected by potential changes in the hydrograph as a result of global climate change. For example an increase in the magnitude of the annual flood peak would not result in increased tree mortality. However, if annual flood peaks were significantly increased and these peak stages were sustained, an increase in tree mortality would likely occur. For example based on the last thirty years of record the minimum berm design elevation of 535 feet at RM 422.4 (equivalent to an elevation of approx. 537 at the Keithsburg gage (RM 427.4)) is exceeded 6.3 percent of the time, or 23 days in a given year. Recognizing that these 23 days are not consecutive days and knowing that even the least tolerant tree species can withstand a minimum of 25 consecutive days of inundation, illustrates that it would take an extreme change in hydrology to create the conditions necessary to cause increased mortality. It is also very unlikely that the Project would be impacted as a result of decreased water levels because of the 9-foot Channel Project that requires the navigation pool be maintained. Overall the Project demonstrates resilience to potential changes in water level resulting from climate change.

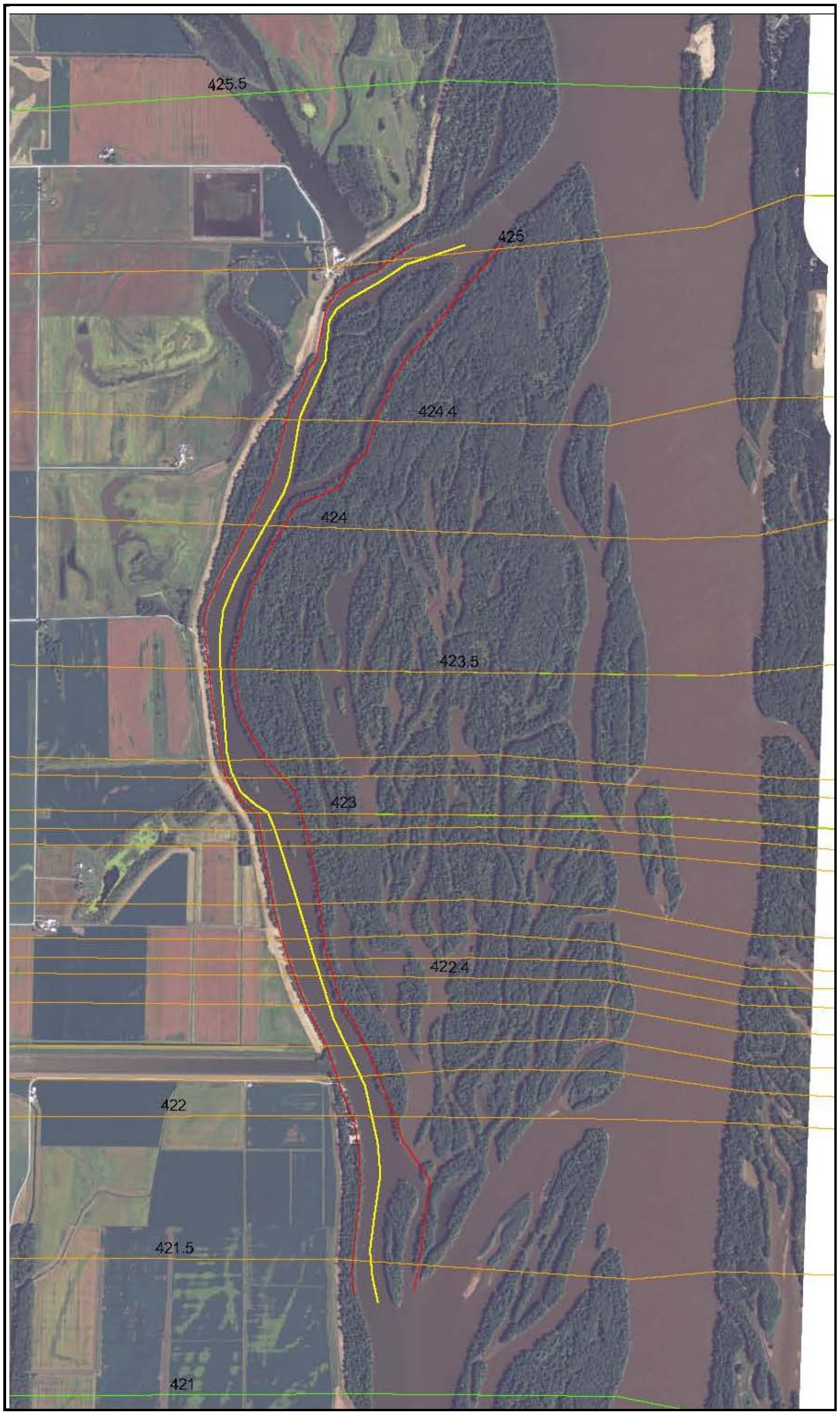

Figure H-60. Updated HEC-RAS Floodway Model Cross-Sections

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COST ESTIMATE

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COST ESTIMATE

1. INTRODUCTION

This appendix contains a detailed Project cost estimate prepared for the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project). The Project area is in Pool 18 between river miles 421.2 and 425.4, approximately 20 miles upstream of Burlington, Iowa. The Iowa River enters the Mississippi River roughly 12 miles upstream of the island complex. Areas considered as part of this complex, and described as the "Project area" include Buffalo Slough, Gun Slough, Cody Chute, Beaver Chute, Huron Chute, and areas associated with Garner Island. Currently there are 164 acres of backwater areas and 500 acres of secondary channels in the Huron Island Complex. There are additionally many acres of interwoven island habitat that together with the backwater areas and secondary channels creates a 2,000 acre complex. Figure 1 and 2 provide vicinity and specific location maps for the Huron Island Complex.

The Project lands, which are federally owned by the U.S. Army Corps of Engineers (Corps), are out granted to the U.S. Fish and Wildlife Service (USFWS). Responsibility for the operation, maintenance, and repair of the lands has, in turn, been out-granted to the Iowa Department of Natural Resources (IADNR) by the USFWS through a cooperative agreement.

2. PROJECT DESCRIPTION

The goals of the proposed Project are to restore and protect aquatic habitat and restore floodplain forest habitat.

2.1. Dredging. The Project consists of the clearing of the dredging placement sites by removal of trees and brush and piling them into piles onsite. The backwater areas will be dredged using a clamshell bucket and crane on a floating plant. The material will be side-casted onto those cleared areas to build up the existing island topography to the desired design elevations. Once the material is dried, it will be shaped onsite to the appropriate slopes. Tree planting will then take place, at the placement site, in a two-year placement schedule.

2.2. Bank Stabilization. At certain locations the Project will require placement of bedding stone and riprap on the bank lines to prevent erosion. It is assumed that this will be done by the floating crane with the clamshell or a skip box.

3. COST METHODOLOGY

3.1. General. This Fully Funded Estimate (FFE) has been prepared to June 2012 price levels. The costs are considered to be fair and reasonable to a well-equipped and capable contractor and include overhead and profit. The preparation of this estimate was created in accordance with Engineering Regulation *1110-1-1300 – Cost Engineering Policy and General Requirements*, (26 March 1993) and Engineering Regulation *1110-2-1302 – Civil Works Cost Engineering*, (15 September 2008). The Fully Funded Estimate (FFE) was completed in accordance with “Engineering Manual 1110-2-1304 – *Civil Works Construction Cost Index System*, (revised 31 March 2012).

The estimate was developed using Micro Computer Aided Cost Estimate System (MCACES) MII v4.1, Build 4, cost estimating software. Applicable crews and equipment were applied in the estimate to correspond with the work being performed. Material prices were developed using the MII Cost Book, R.S. Means references, and quotes obtained from suppliers. The midpoint of construction for the overall Project is anticipated to be the 2nd quarter of 2016, and was used to determine the FFE.

This Project is assumed to be an open bid, although the possibility of this being an 8A contract was discussed and properly evaluated in the determination of what contingency value to apply to the Project.

3.2. Direct Cost. Direct costs are based on the anticipated material, equipment, and labor needed to construct the Project based on the current scope of work. Material quotes were obtained for the major cost items. Direct costs were calculated independent of the contractor assigned to perform the work. Contractor assignments were determined after the formulation of the direct costs. The majority of the work is assumed to be done by the dredging subcontractor, with the remaining work being performed by the tree planting subcontractor. It is assumed the prime contractor, an 8A contractor, will perform the Project coordination and oversight with little or no construction work.

3.2.1. Labor-Rate Determination. Labor Rates are based on 2012 Davis-Bacon Wage Rates general decision IA120003, 08/31/2012.

3.2.2. Equipment Rates. All equipment costs are from MII Equipment Region 5 2011 and MII English Cost Book 2010.

3.2.3. Fuel Rates. Rates have been updated as of Monday December 17, 2012. Current fuel prices are based on Midwest averages from http://www.eia.doe.gov/. This includes gasoline, on-road diesel, and off-road diesel.

3.2.4. Overtime Consideration. Overtime was considered and it was determined that overtime was required on the mechanical dredging work items to fit the required work into the number of months that could be worked before the weather turned too cold. The overtime which was calculated inside the MII system, was set for 12 hours per day for a 6-day work week.

3.2.5. Sales Tax. The Rock Island District does not use sales tax in the creation of estimates as contractors are issued tax exemption numbers to use when purchasing materials.

3.2.6. Productivity. Production rates were created based on historical rates used in the Cost Engineering Section in Rock Island and also based on what was determined reasonable by the cost estimator. In addition, user crews were created using the estimator's judgment.

3.3. Indirect Costs

3.3.1. Prime Contractor

Job Office Overhead (JOOH). Overhead rate for JOOH was applied as a running percentage. In this case a value of 15 percent was applied for the prime contractor. This is higher than the recommended rate of 11 percent for a job this size, but the costs associated with a field office environment that is moving as a floating plant requires somewhat higher percentage.

Home Office Overhead (HOOH). Overhead rate for HOOH was applied as a direct percentage. In this case, the value of 6 percent was applied for the prime contractor, which is one percent higher than the recommended rate for a job this size. HOOH includes such items as office rental/ownership costs, utilities, office equipment ownership/maintenance, office staff (managers, accountants, clerical, etc.), insurance, and miscellaneous costs. In reality, the range of home office overhead can be quite broad and depends largely on the contractor's annual volume of work and the type of work that is generally performed by the contractor.

Profit. Profit has been included and was applied as a direct percentage. For the prime contractor a value of 8.00 percent was assumed due to the medium level difficulty for the type of work involved on this Project.

Bond. Bond was included and applied as a direct percentage. In this case, a value of 1 percent was used assuming the contractor is an experienced contractor doing standard dredging and landscaping work.

3.3.2. Subcontractors

JOOH. Overhead rates for JOOH were applied as a running percentage. In this case, a value of 10 percent was applied to the dredging subcontractor and 10 percent for the tree planting subcontractor.

HOOH. Overhead rates for HOOH were applied as a direct percentage. In this case, a value of 6 percent was applied to both the dredging subcontractor and the tree planting subcontractor.

Profit. Profit has been included and was applied as a direct percentage. In this case, a value of 9 percent was assumed for the dredging subcontractor and the tree planting subcontractor since they will be doing the bulk of the work on this Project.

3.4. Escalation. The Project costs have been escalated to the midpoint of construction, assumed to be the 2nd quarter of 2016 for the overall Project.

3.5. Contingency. After review of Project documents and discussion with members of the Project development team involved in the design of the Project, an informal risk analysis was conducted resulting in the development of a contingency. The average contingency for all Project construction features is 20.92 percent. This contingency was developed reflecting the uncertainty and risk associated with the work features. This includes the development of the contingencies applied to PED and Construction Management feature accounts.

3.6. Other Assumptions

3.6.1. Mobilization. Equipment needs were identified from work items in the MII estimate. Equipment was assumed to be mobilized within 50 miles for land based equipment. Marine equipment was assumed to be mobilized within a distance upriver or downriver that included at least three biddable contractors for this type of work. Different periods for mobilization were created based on the construction schedule.

3.6.2. Government Furnished Materials. The estimate is based on no government furnished materials.

3.6.3. Site Access. It is assumed that the site can be accessed from May 15 through November 15 of each year, except in the event of a flood. There is to be no clearing of trees from April 1 through September 30 due to the Indiana bats migration/nesting activity in the Project site.

3.6.4. Waste Disposal. Trees and brush will be piled on-site and some of the debris/logs will be used for habitat. It is assumed that there will be no disposal removal from the site.

4. PROJECT FEATURE ACCOUNTS

4.1. (01) Lands and Damages. This account contains no values as no real estate will need to be acquired for this Project.

4.2. (06) Fish and Wildlife Facilities. The mechanical dredging and placement site shaping are included under this account as well as other miscellaneous tasks such as tree and brush removal, pre and post dredging surveys and tree planting.

4.3. (16) Bank Stabilization. The work involved with bank stabilization will include some clearing, shaping of the bankline, and placement of bedding stone and riprap.

4.4. (30) Planning, Engineering, and Design. The work covered under this account includes the project management, engineering, and design costs spent to date as well as the remaining estimated costs that will be associated with the engineering and design for this Project. The percentages for PED were determined by the Project Engineer and the Project Manager.

4.5. (31) Construction Management. The work covered under this account includes the expected costs for contract supervision, contract and construction administration, technical management activities, district office supervision, and administration costs. The percentages for Construction Management were determined by the Project Engineer and the Project Manager.

5. PROJECT SCHEDULE

The estimated duration of the Project is 645 days, which is based on the construction starting in FY 14 and ending in FY 16. The clearing construction dates take into account the restrictions to construction activity because of the Indiana bat migration/nesting schedule. In addition to the dredging, placing and shaping of embankment, the Project duration also includes the execution of the aquatic planting and the tree planting over a 3-year period.

6. TOTAL PROJECT COST SUMMARY

The total Project cost prior to being fully funded is $12,818,000.00 (First Costs). The total fully funded Project cost is $15,039,000.00 at 2013 fiscal year pricing. Based on the construction schedule, work will commence in September 2013. There is no cost sharing on this Project and is expected to be fully funded by the U.S. Army Corps of Engineers.

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REAL ESTATE PLAN
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1. PURPOSE

This Real Estate Plan (REP) is developed in support of the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project). The Project is authorized under the Water Resources Development Act (WRDA) of 1986, (P.L. 99-662), Section 1103 as amended. The Upper Mississippi River System - Environmental Management Program (UMRS-EMP) is currently a Federal-State partnership to plan, construct, and evaluate measures for fish and wildlife habitat improvement through habitat rehabilitation and enhancement projects. The cooperative partnership exists between the Corps of Engineers (Corps), the U.S. Fish and Wildlife Service (Service), and the Iowa Department of Natural Resources (State). For this Project the Service is acting as the Federal Sponsor. This is the only REP developed for this Project.

The Corps proposes to rehabilitate and enhance the Huron Island Complex (Complex) 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 the Complex.

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

1. The existing aquatic habitat is generally shallow, turbid, and lacks aquatic vegetation important for year-round habitat functioning.
2. The existing topography lacks diversity and is completely inundated during minor flood events. Consequently, hard mast tree regeneration, growth, and survival are reduced.
3. Without action the existing aquatic habitat will cease to function as fish habitat. Floodplain habitat will decrease in quality through succession to reed canary grass, which is an invasive species.

2. DESCRIPTION OF THE LANDS, EASEMENTS, AND RIGHTS-OF-WAY (LER) REQUIRED FOR CONSTRUCTION, OPERATION, AND MAINTENANCE OF THE PROJECT

The Complex is located along the right descending bank of the Mississippi River in the northern portion of Des Moines County, Iowa. The Project area is in Mississippi River Pool 18 between river miles 421.2 and 425.4, approximately twenty miles northeast of Burlington, Iowa. The Iowa River enters the Mississippi River approximately 12 miles upstream of the Complex. Areas considered as part of the Complex and described as the “Project Area” include Buffalo Slough, Gun Slough, Goose Lake, Huron Chute, and areas associated with Garner Chute. The Complex contains more than 2,600 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. Coordinates are Sections 3, 9, 10, 14, 15, 16, 21, 22, 23, 27, Township 72 North, Range 1 West (Des Moines County, Iowa). The Project area is shown on figures J-1 and J-2.

Access to the Project area will be achieved from the Hawkeye Dolbee River Access point which is managed by the Des Moines County Conservation Board (DMCCB). The DMCCB entered into a 25-year management/lease agreement with the Corps for the Hawkeye Dolbee Access ending October 31, 2030. Located in Huron Township, this 10.1-acre area was developed to include a double lane concrete boat ramp with boat dock and gravel parking lot. The DMCCB provides a dock during the summer and fall boating seasons as river stages allow. The area is inaccessible when the river stage at Keithsburg exceeds 12.8 feet. Anticipated use of the Hawkeye Dolbee River Access will need to be coordinated with the DMCCB prior to the commencement of any construction efforts. The lease area and river access is shown as figure J-3.

The recommended plan for habitat rehabilitation and enhancement of the Complex includes increasing bathymetric diversity in Pools 1 and 2 of the Goose Lake backwater area (measures T1 and T3), improving forest topographic diversity adjacent to Pools 1 and 2 by increasing the elevation to 537 (F1 and F3) and planting 15 mast tree species, construction of a closure structure in Garner Chute (T9), island bankline protection (I1), and increasing forest diversity in non-diverse forested areas by increasing the elevation to 537 (F5). The details of this plan are described below.

2.1. Bathymetric Diversity of Goose Lake Backwater Area Pool 1 to Elevation 537 (T1). This measure involves mechanically dredging material in Goose Lake Pool 1 and side casting the material on the existing floodplain. The dredge cut is 2,402 feet long by 75 feet wide. The placement site consists of an upper site extending 1,002 feet and a lower site extending 1,163 feet.

The proposed placement sites are adjacent to the dredge cut. The placement sites were selected due to the lack of topographic diversity (maximum elevation is roughly 2 feet below the 2-year flood elevation) and even-aged mature silver maple dominated forest community. The area will be cleared of trees (approximately 8 acres) and stockpiled adjacent to the cut to increase cover and foraging habitat for fish. The maximum elevation of the placement site does not exceed an elevation of 537. The base (EL. 530-535) of the placement site would include aquatic vegetation and wetland scrub/shrub plantings. Higher elevations, including the shelves and the top of the site would include planting an array of 15 species of native mast tree species (refer to Measure F1 for placement site shaping and plantings).

2.2. Bathymetric Diversity of Goose Lake Backwater Area Pool 2 at Elevation 537 (T3). This measure involves mechanically dredging material in Goose Lake Pool 2 and sidecasting the material on the existing floodplain. The dredge cut extends 2,642 feet long by 50 feet wide. The placement site extends 2,642 feet.

Bank protection in the form of riprap is included along the bankline of Huron Island near Goose Lake Pool 2. This measure is included to reduce active erosion and protect the investment made for the dredging, placement sites, and aquatic vegetation. Steep banks and a building foundation, which 75 years ago was over 100 feet from the bankline, is now hanging over the water indicating significant erosion. Riprap would be placed along 2,415 feet of bankline at a 2H:1V slope at a 24 inch thickness on 12 inches of bedding stone, with a 6 foot weighted toe.

2.3. Forest Diversity Adjacent To Pools 1 to Elevation 537 (F1). The 2,165 feet long dredged material placement site contained in Measure T1 would be shaped as follows: The placement site will slope up at a 8H:1V slope to elevation 535 feet MSL at which point a 30 foot wide tier will be constructed. The placement site will continue to slope upward at a 3H:1V slope to elevation 537 ft MSL. The top of the placement site will be 30 feet wide before sloping back down at a 3H:1V slope. Native temporarily inundated forested wetland trees and scrub/shrub species will be planted on each of the tiers.

2.4. Forest Diversity Adjacent To Pools 2 to Elevation 537(F3). The 1,453 feet long dredged material placement site contained in Measure T3 would be shaped as follows: The placement site will slope up at a 8H:1V slope to elevation 535 feet MSL at which point a 30 foot wide tier will be constructed. The placement site will continue to slope upward at a 3H:1V slope to elevation 537 ft MSL. The top of the placement site will be 30 feet wide before sloping back down at a 3H:1V slope.

Similar to measure F1, native floodplain vegetation including trees, scrub/shrub wetland plants, and an understory seed mix will be incorporated in the berm design. Planting design will be identical to the design described in F1 except only 2 plots will be constructed.

2.5. Garner Chute Closure Structure (T9). This measure includes the construction of a rock closure structure near the upstream end of Garner Chute between Garner Island and Huron Island. The structure would be constructed of riprap and built to elevation 532 ft MSL. The top width (upstream to downstream) would be 14 feet. Construction of the closure structure will reduce water velocities and provide optimal overwintering habitat. Additionally, placement of the closure structure upstream of the inlet channel feeding Upper Buffalo Slough should reduce the inflow of sediment to the Complex. The downstream confluence of Garner Chute and Huron Chute will remain open to allow for adequate dissolved oxygen circulation and ingress and egress of fish throughout the year.

2.6. Huron Chute Diversity Island Bank Stabilization (I1). Two small islands are located in Huron Chute, and provide the only breakwater between Garner Island and the end of Huron Island (approximately between river mile 424 and 422. Protecting the islands will provide additional forested wetland habitat, and diversity of aquatic habitat in Huron Chute. Aquatic habitat will be provided in the form of depositional areas at the downstream portion of the island, which provides critical spawning, rearing, foraging, and resting habitat for a variety of riverine fishes.

Bank protection in the form of riprap is included along the head end of both the upstream and downstream islands. This measure is included to reduce active erosion and potentially allow the islands to expand on the downstream end over time. Riprap would be placed along 300 feet of bankline at both the upper and lower islands.

2.7. Forest Diversity in Non-Diverse Forested Area to Elevation 537 (F5). A ridge and swale habitat would be constructed using adjacent borrow. This location is upstream of Pool 1 and Pool 2. The topographic diversity will extend just over 1,000 feet (upstream to downstream) and will be constructed with borrow from adjacent land and pools. The site will be constructed with three tiers at 2 elevations, with the highest tier being in the middle at elevation 537 (with a width of 80 feet), and the lower two tiers on either end at elevation 535 feet (each one with a width of 50 feet).

Preparation of the borrow areas and placement site would include approximately 7 acres of clearing and 7 acres of clearing, grubbing and stripping. Similar to measures F1 & F3, native floodplain vegetation including trees, scrub/shrub wetland plants, and an understory seed mix will be incorporated in the berm design.

The number of owners, acres and type of estates required are as follows:

Number of Tracts	No. & Type of Owner	Acres	Type of Estate
27	1 - Federal Gov.	Approx. 2,600	Fee
1	1 - State of Iowa	Approx. 7.3	No acquisition required due to the application of Navigation Servitude

3. SPONSOR-OWNED LANDS

All of the lands required for the Project that exist above the ordinary high water mark are owned by the Federal Government. Those lands required for the Project that fall below the ordinary high water mark are owned by the State of Iowa. However, in this situation Navigation Servitude is available and will be exercised for Project purposes.

4. NON-STANDARD ESTATES

The Project does not require the use of any non-standard estate.

5. EXISTING FEDERAL PROJECT WITHIN THE LER REQUIRED FOR THE PROJECT

The United States, through the Department of the Army, acquired lands, to include the Huron Island Complex, in the State of Iowa under the authority of the Acts of 3 July 1930, as amended, and 30 August 1935, for the improvement of the Mississippi River between the Missouri River and Minneapolis, Minnesota and is referred to as the Navigation Channel Project. Those lands being in and adjacent to the pools formed by Mississippi River Locks and Dams Nos. 9, 10, 11, 12, 13, 14, 16, 17, and 18.

6. EXISTING FEDERALLY-OWNED LAND

On November 1st, 1938 a United States District Judge awarded the absolute unqualified fee simple title for Tracts No. IaIs-22 to IaIs-47 and Tract No. IaIs-26A to the United States of America. Those tracts make up the entire Complex. The Environmental Management Program is specifically developed for lands that are already under the ownership of the Federal Government.

7. NAVIGATION SERVITUDE

A legal opinion was developed by Office of Council on October 29, 2012 to determine whether Navigation Servitude could be used for the Project. Office of Counsel found that the conditions the Project addresses were ultimately caused by navigation, therefore Navigation Servitude would apply to those lands required for the Project that fall below the ordinary high water mark. This includes submerged rock placement and dredging activities. All placement materials will be from dredged material below the ordinary high water mark and from existing topsoil on Huron Island.

8. MAP DEPICTING THE AREA

The real estate Vicinity Map, Project Area Map and Hawkeye Dolbee River Access Point are attached as figures J-1, J-2, and J-3.

9. INDUCED FLOODING

There will be no flooding induced by the construction or the operation and maintenance of the Project.

10. BASELINE COST ESTIMATE

A Baseline Cost Estimate for Real Estate was not developed because there are no anticipated lands to be acquired for the Project and it is not cost-shared with a non-Federal sponsor.

11. PUBLIC LAW (PL) 91-646 RESIDENCE/BUSINESS RELOCATION ASSISTANCE BENEFITS

The Project does not require any relocation of persons, farms, or businesses; therefore, there are no anticipated Public Law 91-646 Relocation Assistance Benefit payments.

12. MINERAL ACTIVITY IN THE PROJECT AREA

There is no known mineral activity occurring or anticipated in the vicinity of the proposed Project that may affect construction, operation, or maintenance of the Project. As mentioned in the amended Cooperative Agreement between the Service and the State dated 22 March 2012, the Corps retains responsibility for management of forest resources on these General Plan lands to include the Huron Island Complex. The development of Corps forest management plans are coordinated with the State and Service for input and review to ensure compatibility, as defined by the Forest Cover Act, with wildlife management use of the Project. Revenue from sale of any timber in conjunction with the Forest Cover Act Program shall be credited to the Corps. The last recorded timber sale on the Complex was completed in September 1991 and was not within the limits of the proposed Project area.

13. NON-FEDERAL SPONSOR’S LEGAL AND PROFESSIONAL ACQUISITION CAPABILITY TO ACQUIRE LER

For this Project the U.S. Fish and Wildlife Service is acting as the Federal Sponsor; therefore, the non-Federal Sponsor Acquisition Capability Checklist is not applicable and is not included.

14. ZONING ORDINANCES

No known zoning ordinances are proposed.

15. SCHEDULE OF LAND ACQUISITION

There are no anticipated lands to be acquired for the Project. As mentioned in Section 7, *Navigation Servitude*, of this report, navigation servitude will be exercised.

16. FACILITY/UTILITY RELOCATIONS

There are no facility or utility relocations associated with this Project.

17. IMPACTS OF SUSPECTED OR KNOWN CONTAMINANTS

An Environmental site Assessment (ESA) Transaction Screening Process was completed on 15 June 2011 for the proposed work and staging areas for the Huron Island Complex Habitat Rehabilitation and Enhancement Project (Project Area) in general conformance with ASTM Practices E 1528-06, ER 1165-2-132, and MVD DIVR 1165-2-9. The inquiry consisted of an inspection of aerial photographs (1930, 1950, 1960, 1990, 2004 and 2010), an 1837 Land Survey Map, a USGS Topographical Map, records research and an interview. These inquiry activities revealed no evidence of hazardous substances, HTRW, or other regulated contaminants in connection within the Project Area.

18. LANDOWNERS SUPPORT OR OPPOSITION TO THE PROJECT

At this time, the support or opposition of adjoining or nearby landowners is unknown. Adjoining and nearby landowner concerns are not anticipated.

19. RISKS OF ACQUIRING LANDS BEFORE EXECUTION OF THE PPA

Notice to the sponsor regarding risks of acquisition prior to the signing of the agreement is not necessary since no acquisitions are expected. For this Project a Memorandum of Agreement (MOA) between the United States Fish and Wildlife Service and the Department of the Army will need to be executed. An MOA is used to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service and the Department of the Army will operate in constructing, operating, maintaining, repairing, and rehabilitating the Huron Island Complex Habitat Rehabilitation and Enhancement Project.

20. OTHER REAL ESTATE ISSUES RELEVANT TO THE PROJECT

There are no other known real estate issues at this time.

Appendix J
Real Estate Plan

Date: 8-October-2013

Prepared by:

Jason C. Appel
Realty Specialist
Planning & Acquisition Branch
Regional Real Estate Division North
Rock Island District

Date: 8 Oct 2013

Reviewed by:

Ronald E. Silver
Lead Realty Specialist
Planning & Acquisition Branch
Regional Real Estate Division North
Rock Island District

Date: 8 October 2013

Approved by:

Stuart P. Jackson
Chief, Regional Real Estate Division North
U.S. Army Corps of Engineers
Rock Island District

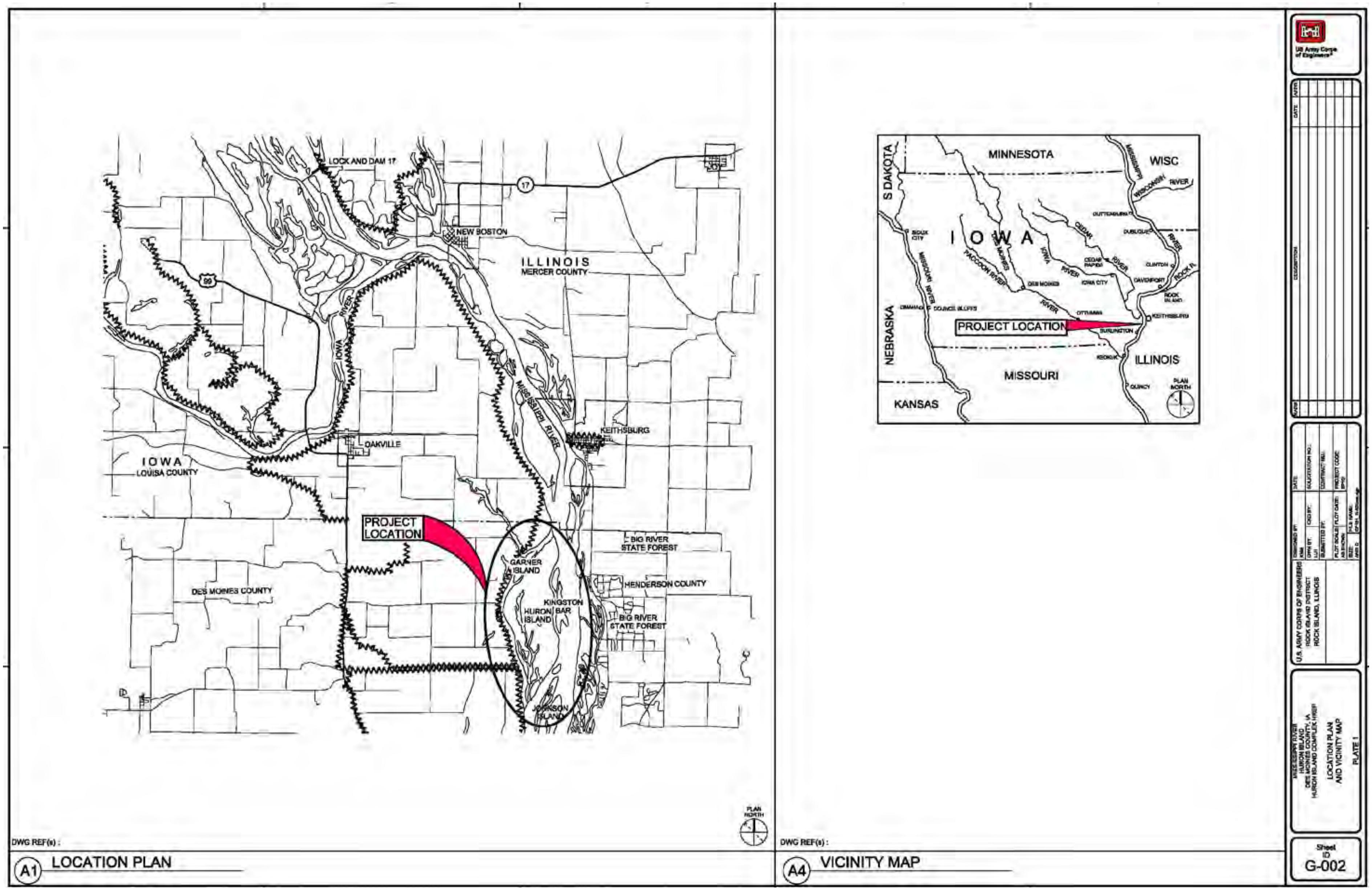

Figure J-1. Vicinity Map

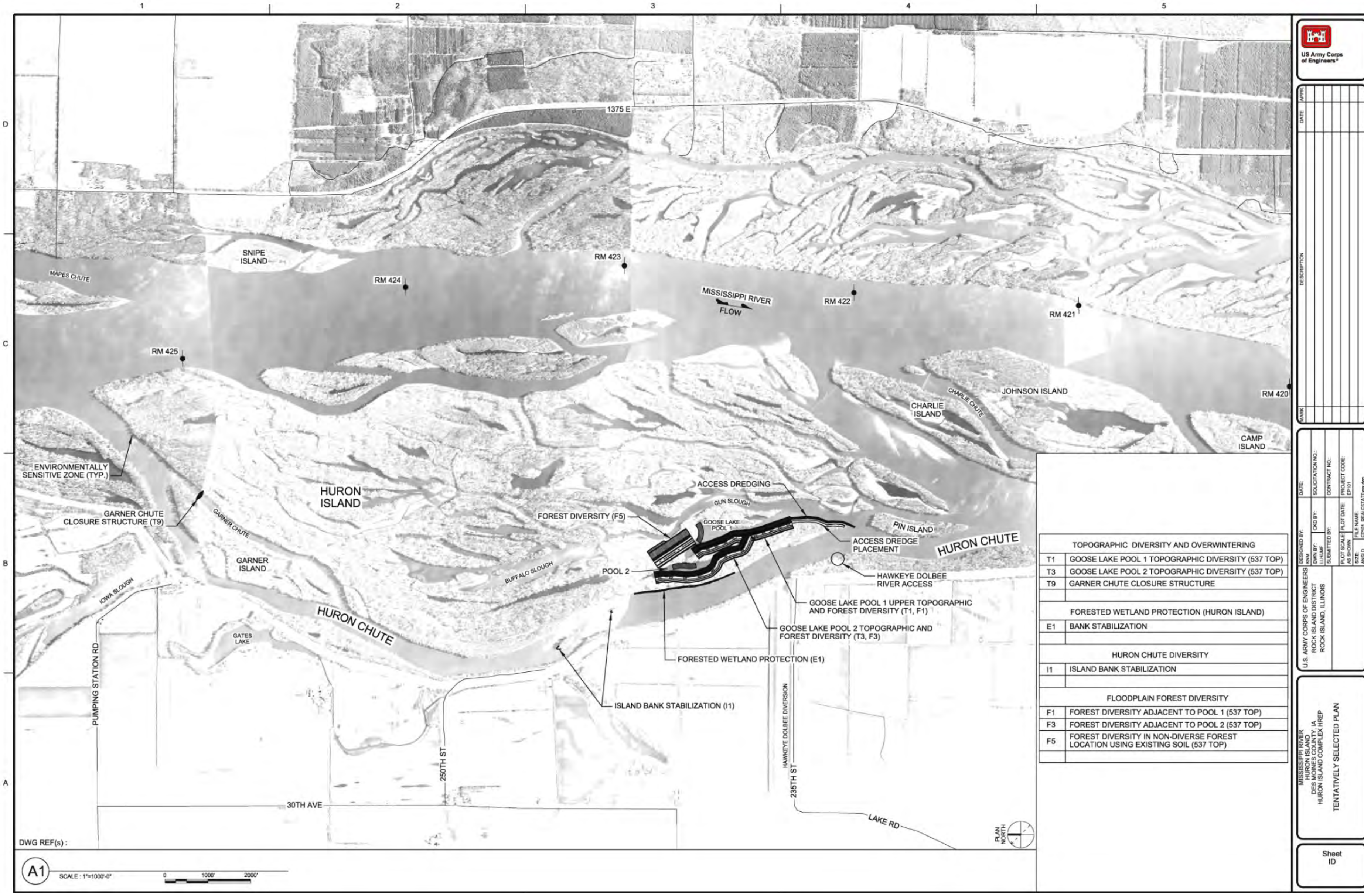

Figure J-2. Project Area Map

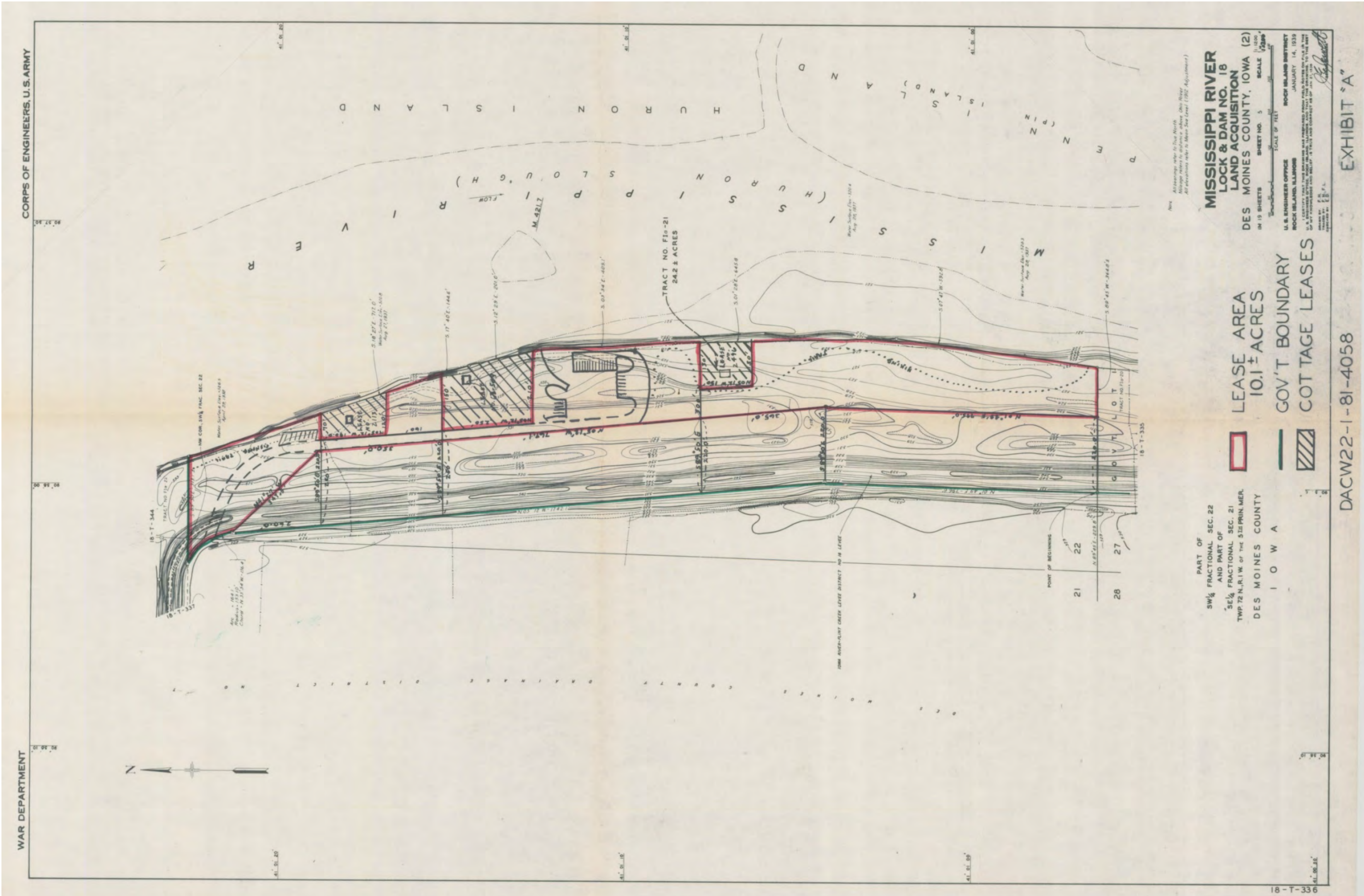

Figure J-3. Hawkeye Dolbee River Access Point

Quality Control Plan Checklist

Real Estate Plans

And other similar Feasibility-Level Real Estate Planning Documents

ER 405-1-12, Section 12-16, Real Estate Handbook, 1 May 1998

A Real Estate Plan (REP) is prepared in support of a decision document for full-Federal or cost shared specifically authorized or continuing authority projects. It identifies and describes lands, easements and rights-of-way (LER) required for the construction, operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of a proposed project including requirements for mitigation, relocations, borrow material, and dredged or excavated material disposal. It also identifies and describes facility/utility relocations, LER value, and the acquisition process. The REP does not just cover LER to be acquired by the non-Federal sponsor (NFS) or Government. The report covers all LER needed for the project, including LER already owned by the NFS, Federal Government, other public entities, or subject to the navigation servitude.

The REP must contain a detailed discussion of the following 20 topics, as set out in Section 12-16 of the ER, including sufficient description of the rationale supporting each conclusion presented. If a topic is not applicable to the project, this should be stated in the REP. The pages of a REP should be numbered.

PROJECT - Upper Mississippi River System, Environmental Management Program, Huron Island Complex, Habitat Rehabilitation and Enhancement Project

REPORT TITLE – Upper Mississippi River, Environmental Management Program, Definite Project Report with Integrated Environmental Assessment for the Huron Island Complex Habitat Rehabilitation and Enhancement Project

Date of Report – August 2012 **Date of REP** – August 2012

1. **Purpose of the REP**. _X_
   a. Describe the purpose of the REP in relation to the project document that it supports.
   b. Describe the project for the Real Estate reviewer.
   c. Describe any previous REPs for the project.

2. **Describe LER**. _X__
   a. Account for all lands, easements, and rights-of-way underlying and required for the construction, OMRR&R of the project, including mitigation, relocations, borrow material and dredged or excavated material disposal, whether or not it will need to be acquired or will be credited to the NFS.
   b. Provide description of total LER required for each project purpose and feature.
   c. Include LER already owned by the Government, the NFS and within the navigation servitude.

d. Show acreage, estates, number of tracts and ownerships, and estimated value.

e. Break down total acreage into fee and the various types and durations of easements.

f. Break down acreage by Government, NFS, other public entity, and private ownership, and lands within the navigation servitude.

3. **NFS-Owned LER.** _X__

a. Describe NFS-owned acreage and interest and whether or not it is sufficient and available for project requirements.

b. Discuss any crediting issues and describe NFS views on such issues.

4. Include any proposed **Non-Standard Estates**. _X__

a. Use Standard Estates where possible.

b. Non-standard estates must be approved by HQ to assure they meet DOJ standards for use in condemnations.

c. Provide justification for use of the proposed non-standard estates.

d. Request approval of the non-standard estates as part of document approval.

e. If the document is to be approved at MSC level, the District must seek approval of the non-standard estate by separate request to HQ. This should be stated in the REP.

f. Exception to HQ approval is District Chiefs of RE approval of non-standard estate if it serves intended project purposed, substantially conforms with and does not materially deviate from the standard estates found in the RE Handbook, and does not increase cost or potential liability to the Government. A copy of this approval should be included in the REP. (See Section 12-10c. of RE 405-1-12)

g. Although estates are discussed generally in topic 2, it is a good idea to also state in this section which standard estates are to be acquired and attach a copy as an appendix. The duration of any temporary estates should be stated.

5. **Existing Federal Projects**. _X__

a. Discuss whether there is any existing Federal project that lies fully of partially within LER required for the project.

b. Describe the existing project, all previously-provided interests that are to be included in the current project, and identify the sponsor.

c. Interest in land provided as an item of local cooperation for a previous Federal project is not eligible for credit.

d. Additional interest in the same land is eligible for credit.

6. **Federally-Owned Lands** _X__

a. Discuss whether there is any Federally owned land included within the LER required for the project.

b. Describe the acreage and interest owned by the Government.

c. Provide description of the views of the local agency representatives toward use of the land for the project and issues raised by the requirement for this land.

7. **Navigation Servitude.** _X__

a. Identify LER required for the project that lies below the Ordinary High Water Mark, or Mean High Water Mark, as the case may be, of a navigable watercourse.

b. Discuss whether navigation servitude is available

c. Will it be exercised for project purposes? Discuss why or why not.

d. Lands over which the navigation servitude is exercised are not to be acquired nor eligible for credit for a Federal navigation or flood control project or other project to which a navigation nexus can be shown.

e. See paragraph 12-7 of ER 405-1-12.

8. **Map** _X__

a. An aid to understanding

b. Clearly depicting project area and tracts required, including existing LER, LER to be acquired, and lands within the navigation servitude.

c. Depicts significant utilities and facilities to be relocated, any known or potential HTRW lands.

9. **Induced Flooding** can create a requirement for real estate acquisition. __X__

a. Discuss whether there will be flooding induced by the construction and OMRR&R of the project.

b. If reasonably anticipated, describe nature, extent and whether additional acquisition of LER must or should occur.

c. Physical Takings Analysis (separate from the REP) must be done if significant induced flooding anticipated considering depth, frequency, duration, and extent of induced flooding.

. d. Summarize findings of Takings Analysis in REP. Does it rise to the level of a taking for which just compensation is owed?

10. **Baseline Cost Estimate** as described in paragraph 12-18. _X__

a. Provides information for the project cost estimates.

b. Gross Appraisal includes the fair market value of all lands required for project construction and OMRR&R.

c. PL 91-646 costs

d. Incidental acquisition costs

e. Incremental real estate costs discussed/supported.

f. Is Gross Appraisal current? Does Gross Appraisal need to be updated due to changes in project LER requirements or time since report was prepared?

11. **Relocation Assistance Benefits** Anticipated. _X__

a. Number of persons, farms, and businesses to be displaced and estimated cost of moving and reestablishment.

b. Availability of replacement housing for owners/tenants

c. Need for Last Resort Housing benefits

d. Real Estate closing costs

e. See current 49 CFR Part 24

12. **Mineral Activity**. _X__

a. Description of present or anticipated mineral activity in vicinity that may affect construction, OMRR&R of project.

b. Recommendation, including rationale, regarding acquisition of mineral rights or interest, including oil or gas.

c. Discuss other surface or subsurface interests/timber harvesting activity

d. Discuss effect of outstanding 3rd party mineral interests.

e. Does estate properly address mineral rights in relation to the project?

13. **NFS Assessment** _X__

a. Assessment of legal and professional capability and experience to acquire and provide LER for construction, OMRR&R of the Project.

b. Condemnation authority

c. Quick-take capability

d. NFS advised of URA requirements

e. NFS advised of requirements for documenting expenses for credit.

f. If proposed that Government will acquire project LER on behalf of NFS, fully explain the reasons for the Government performing work.

g. A copy of the signed and dated Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability (Appendix 12-E) is attached to the REP.

14. **Zoning** in Lieu of Acquisition _X__

a. Discuss type and intended purpose

b. Determine whether the proposed zoning proposal would amount to a taking for which compensation will be due.

15. **Schedule** _X__

a. Reasonable and detailed Schedule of land acquisition milestones, including LER certification.

b. Dates mutually agreed upon by Real Estate, PM, and NFS.

16. **Facility or Utility Relocations** _X__

a. Describe the relocations, identity of owners, purpose of facilities/utilities, whether owners have compensable real property interest.

b. A synopsis of the findings of the Preliminary Attorney's Investigation and Report of Compensable Interest is included in the REP as well as statements required by Sections 12-17c.(5) and (6).

c. Erroneous determinations can affect the accuracy of the project cost estimate and can confuse Congressional authorization.

d. Eligibility for substitute facility

1. Project impact
2. Compensable interest
3. Public utility or facility
4. Duty to replace
5. Fair market value too difficult to determine or its application would result in an injustice to the landowner or the public.

e. See Sections 12-8, 12-17, and 12-22 of ER 405-1-12.

17. **HTRW** and Other Environmental Considerations _X___

a. Discussion the impacts on the Real Estate acquisition process and LER value estimate due to known or suspected presence of contaminants.

b. Status of District's investigation of contaminants.

c. Are contaminants regulated under CERCLA, other statues, or State law?

d. Is clean-up or other response required of non-CERCLA regulated material?

e. If cost share, who is responsible for performing and paying cost of work?

f. Status of NEPA and NHPA compliances

g. See ER 1165-2-132, Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects.

18. **Landowner Attitude.** _X__

a. Is there support, apathy, or opposition toward the project?

b. Discuss any landowner concerns on issues such as condemnation, willing seller provisions, estates, acreages, etc.?

19. A statement that the **NFS has been notified in writing about the risks of acquiring LER before the execution of the PPA.** NA

20. **Other Relevant Real Estate Issues.** Anything material to the understanding of the RE aspects of the project. __X___

A copy of the completed Checklist is attached to the REP. _X__
(Draft REPs must contain a draft checklist and draft Technical Review Guide)

I have prepared and thoroughly reviewed the REP and all information, as required by Section 12-16 of ER 405-1-12, is contained in the Plan.

______________________________ 22-August-2012
Preparer Date

A copy of the Real Estate Internal Technical Review Guide for Civil Works Decision Documents is attached and signed by me as the Reviewer

______________________________ 22 AUGUST 2012
RE Internal Technical Reviewer Date

The REP has been signed and dated by the Preparer and the District Chief of Real Estate.
___X____

REAL ESTATE INTERNAL TECHNICAL REVIEW GUIDE FOR CIVIL WORKS DECISION DOCUMENTS

Real Estate Guide for Review of Civil Works Decision Documents

1. Initially, read the entire Real Estate Plan (REP). After reading the REP:

   a. Do you have a good idea of the scope of the project?

   b. Did you note any omissions?

   c. What questions do you have regarding the project?

   d. Were all the elements of an REP as listed in Chapter 12 covered?

   e. Do you have a completed Quality Control Plan for the REP?

2. Next, read the main body of the decision document (including the chapter on the recommended plan), paying particular attention to the overall scope of the project, proposed facility relocations, environmental investigations, mitigation requirements, navigational servitude, and possibility of induced flooding.

3. Then, read the REP again, noting any discrepancies between the REP and the main report. Pay particular attention not only to what the report says, but also to what the report does not say. Many review comments are due to items being omitted or not discussed in enough detail in the REP.

4. Finally, ask yourself specific questions about the project such as the following. You should be able to answer them by reading the REP.

   a. What is the project's purpose and have there been prior real estate planning documents for this project?

   b. Is the purpose of the report to gain Congressional authorization (e.g., a Feasibility Report)? If not, what is the real estate acquisition authority for the project and is the proper authority cited in the report?

c. Who is the sponsor that will execute the PPA? Has an assessment of the sponsor's capability been completed and included in the report? Does the sponsor have eminent domain and quick take authority? If not, does the report address how acquisition will be accomplished if condemnation is required? Does the sponsor currently own any lands required for the project? If so, were any of these lands obtained as part of another Federal project or funded with Federal funds in whole or in part?

d. Are there any lands currently owned by the Federal government involved in this project? If so, has it been coordinated with the

e. Does the project involve a navigable waterway and could the navigational servitude be utilized for purposes of the project? If the project is not a navigation project and asserting navigational servitude is proposed, does the report state the legal basis for asserting navigational servitude?

f. Is there a possibility of induced flooding, and has a taking analysis been completed? What was the outcome of that analysis? Are flowage easements required because the anticipated flooding will rise to the level of a taking?

g. Are the interests and estates sufficient to provide for construction, operation, maintenance, repair, replacement and rehabilitation (OMRR&R) of the project? Do the estates not only grant the interest needed for construction and maintenance, but do they prohibit practices that might interfere with the project in the future? Is the term for any temporary easements defined and are they for an appropriate duration?

h. How do we physically access the project site? Is an additional real estate interest required for construction access and/or OMRR&R access?

i. Is there a need to dispose of borrow material? If so, are these areas included in the report as LERRD items or, if proven cost efficient, contractor provided items? Are the environmental issues associated with borrow/disposal effectively addressed?

j. Will a contractor's staging area be required?

k. Are any persons being displaced from their homes as a result of the project? If so, how many? Is replacement housing available? Will standard PL 91-646 benefits be provided? Will any businesses require relocation assistance? Has a replacement housing survey been accomplished?

l. Are there any public facilities to be altered or relocated? Do the below relocations meet all of the following five tests?

(1) The project design requires the facility to be moved in whole or in part (temporarily or permanently), or the project will negatively impact the ongoing function or operation of the facility.

(2) The owner of the facility has a compensable real property interest in the land on which the impacted portion of the facility is located.

(3) The facility serves a public purpose.

(4) The owner of the facility has a duty to replace the facility as a result of legal or factual necessity (continuing need).

(5) The fair market value of the interest that must be acquired due to project impact is too difficult to ascertain, or payment of fair market value instead of providing a substitute facility would result in manifest injustice to the owner or the public. Have preliminary opinions of compensability be completed for each facility? If the REP is part of a decision document that will serve as the basis for Congressional authorization, does it contain the disclaimer language required by ER 405-1-12, para. 12-17c(6)?

m. Are any cemeteries in the project area? If so, how will they be impacted? If they are allowed to remain in place, how will permanent access be provided? If they are to be relocated, the report should address the preparation of a cemetery relocation plan.

n. Does the report address the types of ownership, number of tracts and acres, and estates to be acquired? Does the report address mineral activity and whether the minerals will be acquired, subordinated, or left outstanding?

o. Does the report state if any nonstandard interest or estate will be utilized? If so, is a copy of the estate in the report?

p. Do the acres, values, and estates contained in the baseline cost estimate agree with those contained in an approved gross appraisal for the project? If not, any discrepancy should be discussed with the Appraisal Branch and reconciled. Does the acreage and cost presented in the REP agree with real estate acreage and costs shown elsewhere in the main report or MCACES estimate? Does the cost estimate show the estimated cost by estate, contingency, administrative cost, and relocation assistance? The cost should be shown for both Federal and non-Federal, where appropriate.

q. Does the report address the status of all environmental considerations and approvals, HTRW assessments, NEPA compliance, and NHPA compliance? If any land required for the project is contaminated, is it CERCLA or non-CERCLA regulated material?

r. Does the report contain a reasonable schedule for acquisition, and has the schedule been coordinated with the sponsor? Is the project to be accomplished in more than one phase?

s. Does the report contain a map depicting all of the tracts and estates to be acquired? Does it show any known or potential HTRW lands?

t. Obviously, all of the above items will not apply to every project; however, if the REP fails to address an item, the reviewer does not know if it is considered. If the individual preparing the document is aware that an item is not applicable, but fails to include that information in the REP, the report should contain a statement that this item is not applicable.

u. The Reviewer should verify that the real estate requirements shown in the REP are in consort with the latest design drawings.

v. The Reviewer should consult with the other team members and Real Estate employees, as necessary, to resolve questions or misunderstandings prior to preparing comments to the Report Preparer.

I have reviewed the Huron Island Real Estate Plan and have considered all of the above.

Real Estate Internal Technical Reviewer

22 AUG 2012

Date

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND COMPLEX
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX K

ADAPTIVE MANAGEMENT AND MONITORING PLAN

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-17F)

HURON ISLAND COMPLEX
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX K

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UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-17F)

HURON ISLAND COMPLEX
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX K

ADAPTIVE MANAGEMENT AND MONITORING PLAN

1. INTRODUCTION

This appendix outlines the feasibility level monitoring and Adaptive Management Plan for the *Huron Island Habitat Rehabilitation and Enhancement Project* (Project). This Plan identifies and describes the setup of monitoring and adaptive management activities proposed for the Project. The plan includes the estimated costs and duration for implementation and technology transfer. This Adaptive Management Plan will be further developed in the preconstruction, engineering, and design (PED) phase as specific Project design details become available.

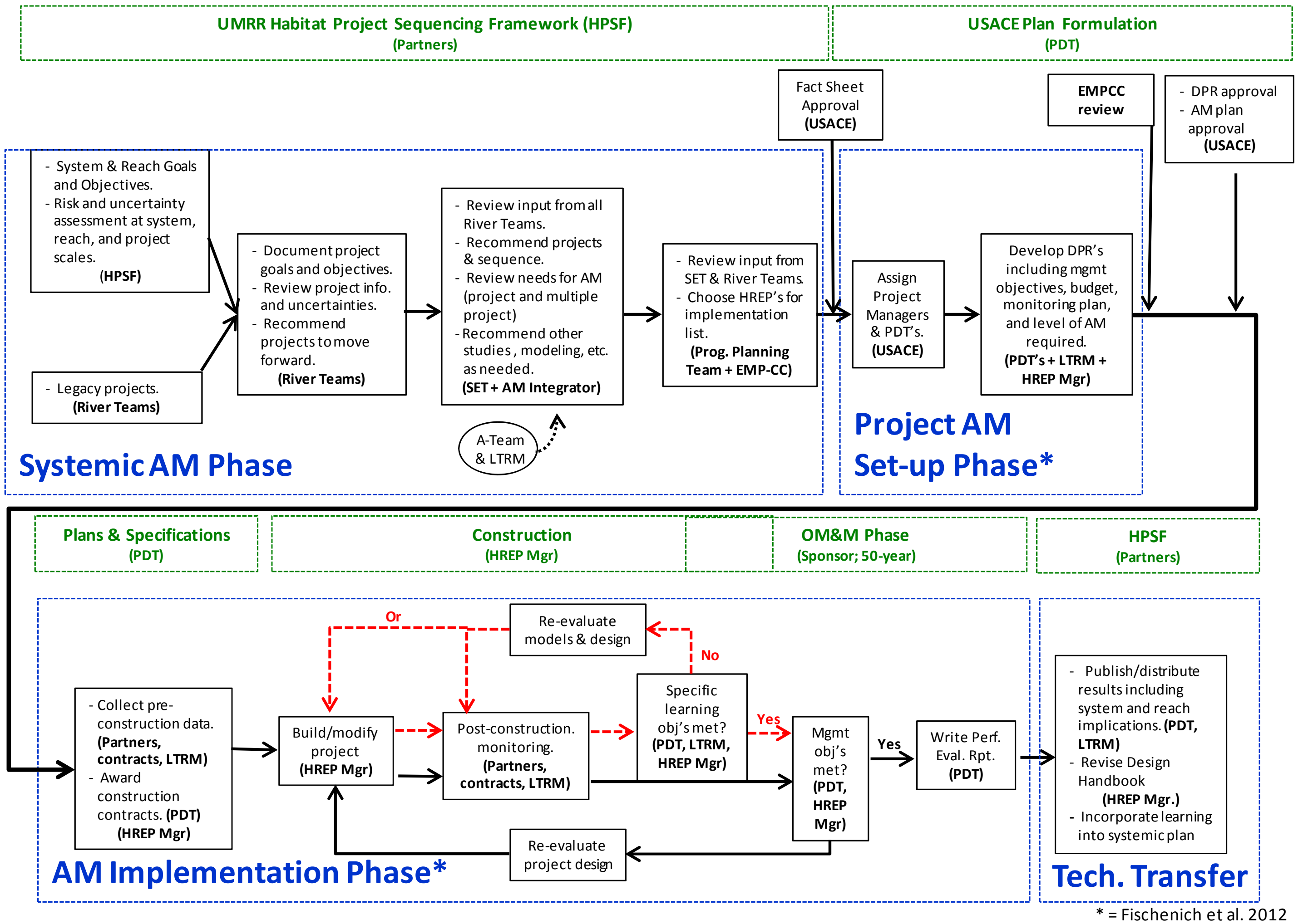
1.1. Authorization. Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure, when conducting a Feasibility Study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration. The implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires an Adaptive Management Plan be developed for all ecosystem restoration projects.

At the programmatic level for the Upper Mississippi River Restoration (UMRR) Environmental Management Program (EMP), knowledge gained from monitoring one HREP can be applied to other HREPs. Opportunities for this type of adaptive management are common within the UMRR EMP, which builds upon lessons learned from other HREPs and the Long Term Resource Monitoring Program (LTRMP).

1.2. Procedure. Drafting the Plan. The USACE Rock Island District (District), UMRR EMP Management Team, and partners collaborated to establish a general framework for adaptive management to be applied to all UMRR EMP projects. The framework for adaptive management is consistent with the implementation guidance provided in Section 2039 of WRDA 2007. The UMRR EMP adaptive management planning framework consisting of systemic, project set-up, implementation, and technology transfer phases (figure K-1).

1.3. Adaptive Management Team Structure. The UMRR EMP team structure consists of UMRR EMP Management; HREP Planning and Sequencing team consisting of the river teams (i.e., RRF, RRCT, RRAT, FWWG, FWIC, IRWG and the A-Team); the LTRMP; Project Delivery Teams (PDT); and stakeholders (figure K- 2). The structure establishes clear lines of communication and data exchange between all parties. Successful systemic and project-specific adaptive management implementation will require the right resources being coupled at the right time to support the framework components.

Figure K-1. UMRR EMP HREP Adaptive Management Planning Flowchart



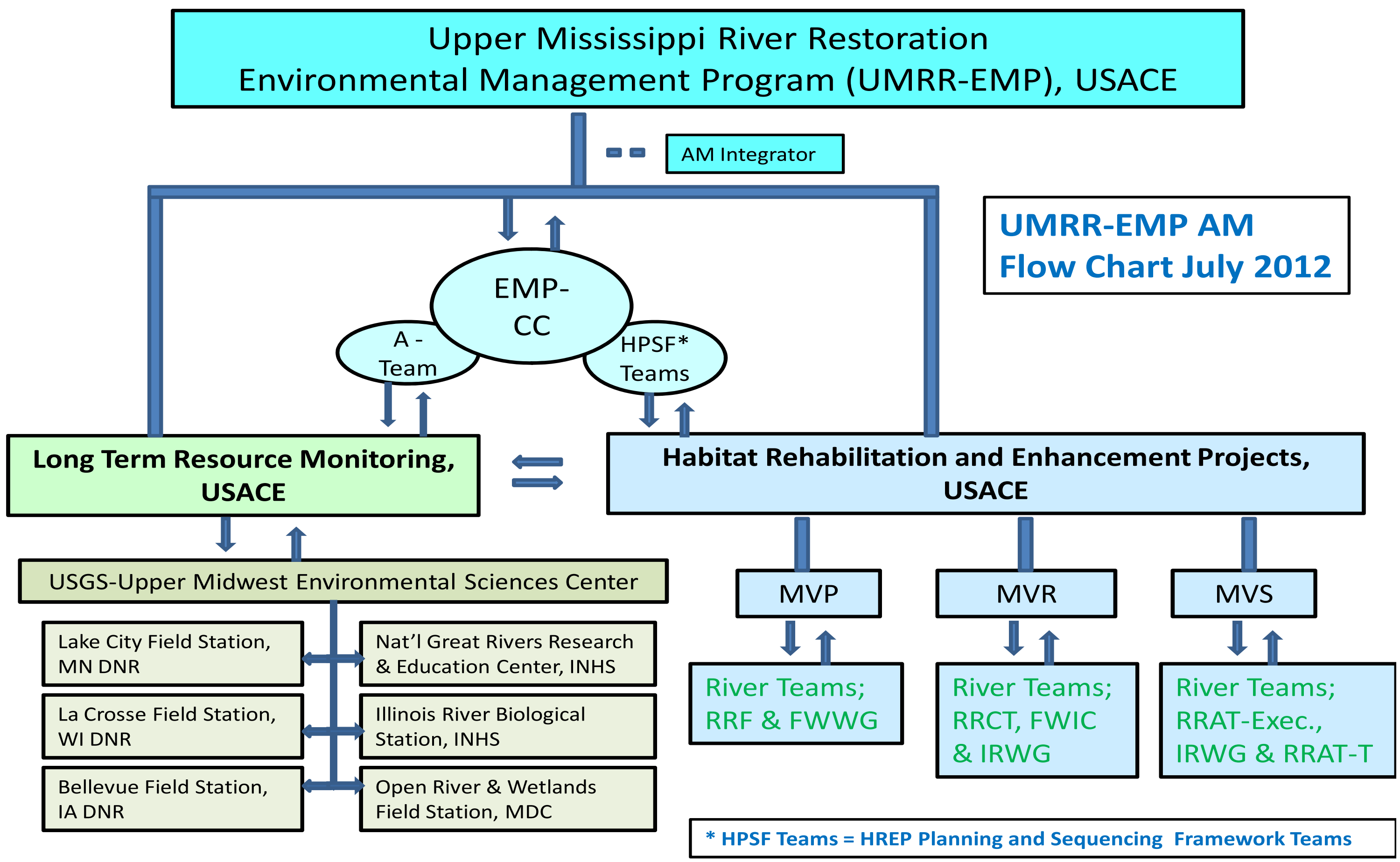


Figure K-2. UMRR EMP Adaptive Management Implementation Communication Structure

2. PROJECT ADAPTIVE MANAGEMENT PLANNING

The resulting Adaptive Management Plan for the Huron Island HREP describes and justifies whether adaptive management is needed in relation to the Recommended Plan identified in the Feasibility Study. The Plan also identifies how adaptive management would be conducted for the Project and who would be responsible for this project-specific adaptive management. The developed Plan outlines how the results of the project-specific monitoring program would be used to adaptively manage the Project, including specification of conditions that will define Project success.

This Project's Adaptive Management Plan reflects a level of detail consistent with the Project's Feasibility Study. The primary intent was to develop monitoring and adaptive management actions appropriate for the Project's restoration goals and objectives. The specified management actions permit estimation of the adaptive management program costs and duration for the Project.

The Adaptive Management Planning section

1. identifies the restoration goals and objectives identified for the Project;
2. lists sources of uncertainty which would recommend the use of Adaptive Management for the Project;
3. presents a conceptual ecological model relating management actions to desired project outcomes;
4. describes the hypotheses developed to test for statistically different outcomes as a result of the restoration actions; and
5. provides details on the experimental design which allows for the testing of our hypotheses and adaptively manage the Project.

Monitoring, Assessment, Decision-making, and Implementation in support of Adaptive Management are discussed in Sections 3, 4, 5, and 6, respectively.

The level of detail in this Plan is based on currently available data and information developed during plan formulation as part of the Feasibility Study. Uncertainties remain concerning the exact project features, monitoring elements, and Adaptive Management opportunities. Components of the monitoring and Adaptive Management Plan, including costs, were similarly estimated using currently available information. Uncertainties will be addressed in the PED phase, and a detailed monitoring and Adaptive Management Plan, including a detailed cost breakdown, will be drafted as part of the design document.

2.1. Project Goals and Objectives. This Project is unique in that the features included in the Recommended Plan are interconnected to restore, not just certain habitat types, but the natural system processes at Huron Island. The current structure of the site is one of relatively homogenous elevation absent of mast tree production, aquatic vegetation, and deep water fish habitat. The site no longer functions as a mosaic of interconnected habitat types and no longer offers the habitat diversity which was once prominent.

The goal of the Project is to restore the missing distinguishing features which collaboratively restore the interconnected transitional gradient of habitats characteristic of lacustrine and riverine systems. The following objectives are included in this Project:

- increase the areal coverage as measured in acres of emergent and submersed aquatic vegetation in backwater areas during the growing season;
- increase diversification of year round floodplain forest and scrub-shrub habitat on Huron Island, as measured in acres;
- increase the structure and function of year-round aquatic habitat diversity, as measured by acres and native fish use of spawning, rearing, and overwintering habitat in the Project area; and
- maintain side channel islands to restore riverine hydrodynamic, sediment transport and geomorphic conditions in Huron Chute

The strategic locations and design of the features included for each objective work together to restore the missing characteristics of the site. Beginning at the lowest elevation (permanently inundated wetland), deep water habitat will be restored for critical overwintering fish habitat. Adjacent to this are shallow water permanently inundated to intermittently exposed flats where restoration of aquatic vegetation (i.e., submerged and floating-leaved to emergent) will provide immediate access to spawning, foraging, and nursery habitat for fish and waterfowl. With increasing elevation on the excavated material placement site, habitat characteristics change from semi-permanently inundated to seasonally inundated emergent and scrub-shrub wetland. Finally, temporarily inundated forested wetland is incorporated.

The transitional structure between one habitat type to another which functions to provide overall habitat is broken at Huron Island. The habitat gap in the Huron Island system has had an effect on everything from overwintering fish to mast tree production. The restoration of the missing distinguishing characteristics provides overarching habitat at the ecosystem level with fish, migratory birds, and everything in-between benefiting.

2.2. Sources of Uncertainty. Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any ecosystem restoration project. Below is a list of uncertainties associated with restoration of aquatic vegetation, aquatic fish habitat, and floodplain habitat in the Huron Island HREP.

2.2.1. Aquatic Vegetation

- selection of appropriate species for the waterbody
- selection and acquisition of suitable propagules
- species specific effects of turbidity on growth
- species specific water level fluctuation tolerances
- species specific herbivory tolerance
- planting density

2.2.2. Floodplain Forest

- species specific water inundation and duration tolerances, which leads to optimal planting elevation
- species specific herbivory tolerance
- interaction of optimal tree size and optimal planting elevation

2.2.3. Aquatic Habitat

- winter dissolved oxygen (DO) concentrations
- species specific seasonal movements and site-loyalty of restored Huron Island year-round backwater habitat during the spawning, rearing, and wintering seasons

2.3. Conceptual Ecological Model (CEM). This Project's CEM is a simple, qualitative model, represented by a diagram describing the general functional relationships among the Project's essential components (figure K-3). The PDT used the CEM to identify potential sources of uncertainty and potential restoration measures and to describe ecosystem processes and functions, biological indicators, and potential Adaptive Management requirements. Most importantly the CEM allowed the PDT, resource agencies, and our stakeholders to discuss complex processes present at Huron Island.

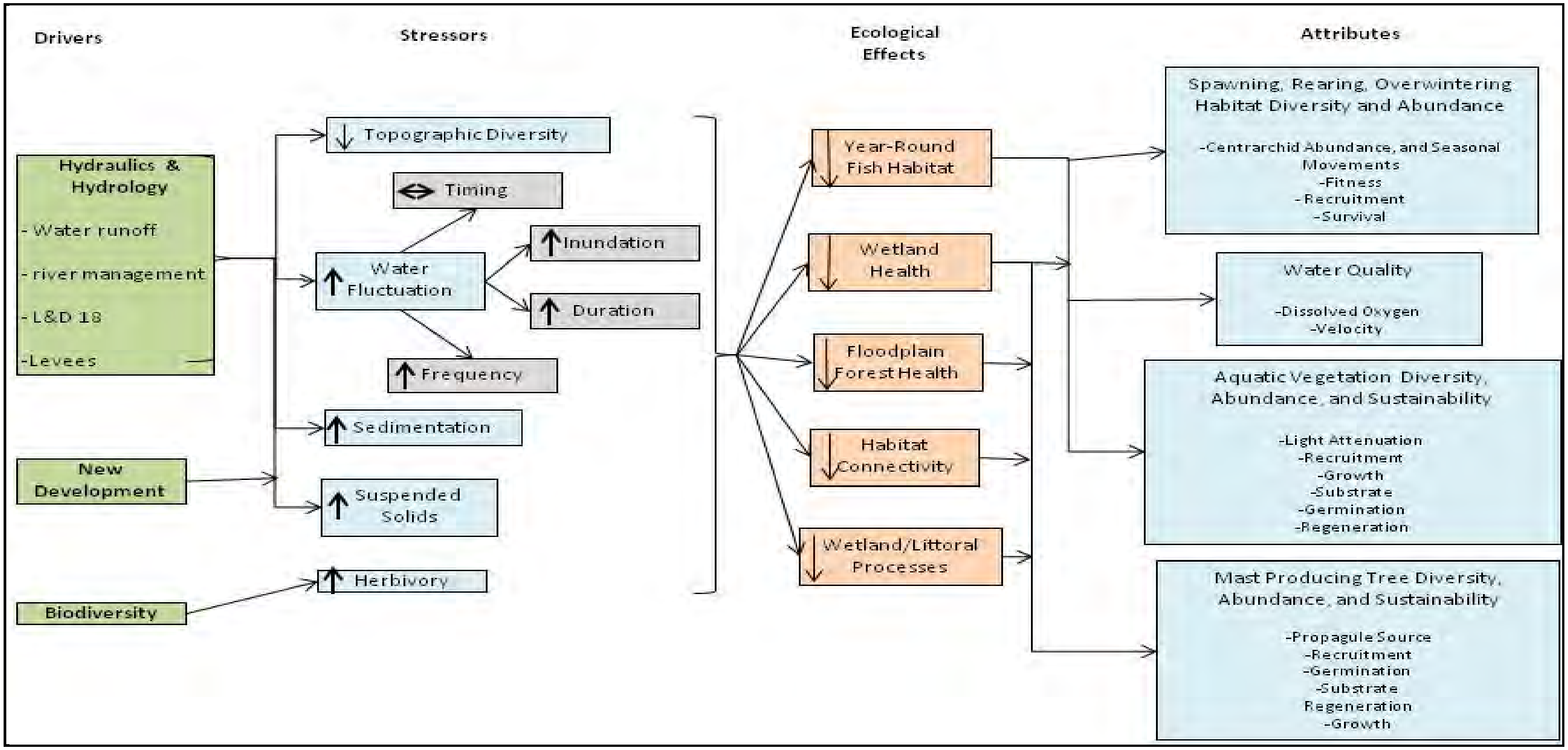


Figure K-3. Huron Island Conceptual Ecological Model

2.4. Hypotheses. Due to the uniqueness of this Project, an important overall objective is to learn about the efficiency and effectiveness of the restored habitat characteristics. Ultimately, this will lead to improved habitat within this Project and lead to greater efficiency and effectiveness in future HREP projects. Research to date was used while developing the experimental design for aquatic vegetation, forest diversification, and year-round fish habitat restoration. However, critical uncertainties (described earlier) regarding the efficiency and effectiveness of the restoration effort remain unanswered. The strategic and detailed design of the Project's features allows hypothesis testing for species specific responses to varying environmental conditions, allows for adjustments to be made to meet the Adaptive Management objectives , and permits the use of statistical analyses to inform future restoration objectives and designs.

2.4.1. Aquatic Vegetation

- Containerized plants will exhibit greater growth than bareroot stock or seed.
- Herbivory will be species specific.
- Water inundation and duration will have species specific growth impacts.

2.4.2. Floodplain Forest

- Water inundation and duration will have species specific growth impacts.
- Herbivory will be species specific.
- #15 RPM trees will exhibit greater growth than #3 or #5 RPM.
- The interaction between tree growth, size at planting, and planting elevation will be significant.

2.4.3. Aquatic Habitat

- The increased depth in Goose Lakes 1 and 2 will increase the relative abundance of overwintering centrarchids compared to pre-project conditions.
- Site-loyalty during each of the spawning, rearing, and overwintering seasons will increase in the Huron Island backwaters compared to pre-project conditions.
- The restoration of available year-round fish habitat will reduce seasonal movements compared to pre-project movements.

2.5. Experimental Design. As part of the Project adaptive management set-up phase, it is critical to develop an adequate experimental design to allow for the testing of our hypotheses and adaptively manage the Project. The stratified random designs described below will allow for post-implementation analyses to test for differences in survival and growth by treatment, and better understand the stressors and drivers affecting aquatic vegetation, mast tree production, and aquatic habitat fish use. Consequently, iterative monitoring and analyses of the results will allow for periodic adjustments to be made to meet the objectives of the Project.

2.5.1. Aquatic Vegetation. Submerged, floating-leaved and emergent aquatic bed vegetation will be planted transitionally from the excavation site to the base of the berm. Plantings will incorporate a stratified planting design which will include treatments of plant life stage, density, protection (i.e., exclosures), elevation, and species. Plant life stages include mature containerized plants, tubers (i.e., fleshy underground root of a plant bearing buds from which new plants develop), and existing seed bank. Plant life stages will be planted at densities ranging from 20 to 80 containerized plants per acre to 1000 -2000 tubers per acre. Exclosures will be installed for approximately half of the plots to protect against herbivory and destruction from common carp.

Finally, the plots described will be planted along a stratified elevation gradient to discern potential differences in survival and growth as a function of water depth, light penetration, and flow.

Emergent species will be planted from the shoreline to 12 inches deep; some species that are tolerant of deeper plantings may be used in this Project and will be planted up to depths appropriate for each species. A preliminary visit to the site indicated that most of the shorelines of both ponds are suitable for planting emergent species. Plantings will be made along the perimeters of both ponds except in areas heavily shaded by trees and shrubs, areas already supporting adequate emergent vegetation (e.g., smartweeds) or in areas in which substrates are too hard or too soft for root establishment.

During Year 1, emergent species will be planted on two occasions. First plantings will be made on 40-foot centers to evaluate their suitability for the site. A second planting will be made to increase density to 20-foot centers using those species that established successfully from the first planting. Two plantings during second year will utilize results from the first year to additionally plant for a final planting density of 10-foot centers.

Floating-leaved species (water lilies) will be planted at depths of 12 inches to 18 inches. Plants will be clustered in areas deemed suitable for their establishment where substrates are soft and flow is minimal. Six clusters (each approximately 20 feet x 20 feet) per pond will be established, with each cluster serving as immediate habitat and as founder colonies for spread to other areas of the ponds.

During Year 1, floating-leaved species will be planted on two occasions. First plantings will consist of four of each species to evaluate their suitability for the site. A second planting will be made to increase the cluster size to eight of each suitable species. Two plantings during second year will utilize results from the first year to additionally plant for a final planting of sixteen plants per species per cluster.

Submersed species will be planted from18 inches to 24 inches deep. Plants will be clustered in areas deemed suitable for their establishment where substrates are firm and flow is moderate to minimal. Six clusters (each approximately 40 feet x 40 feet) per pond will be established, with each cluster serving as immediate habitat and as founder colonies for natural spread to other areas of the ponds.

During Year 1, submersed species will be planted on two occasions. First plantings will consist of four of each species to evaluate their suitability for the site. A second planting will be made to increase the cluster size to eight of each suitable species. Two plantings during second year will utilize results from the first year to additionally plant for a final planting of sixteen plants per species per cluster. Certain species of each growth form can tolerate variances from these planting depths. ERDC will only plant outside these depths when conditions appear conducive to supporting transplants outside the standard planting depths as part of adaptive management to improve establishment of a particular species.

2.5.2. Floodplain Forest. Native temporarily inundated forested wetland trees (15 species) and scrub/shrub species (6) will be planted on each of the tiers. Plantings will incorporate a stratified random planting design of 0.5-acre plots which will include treatments of tree container size, protection, elevation, and species. Tree container sizes will include #3, #5, and #15 Root Production Method^{TM} (RPM) containers. Exclosures will be installed for approximately half of the trees to protect against herbivory and evaluate species specific herbivory tolerances. Finally, the described will be planted equally at each of the 535 and 537 tier elevations to discern potential species specific differences in survival, growth, and regeneration capabilities as a function of water inundation duration. In order of increasing elevation, seasonally inundated scrub/shrub wetland species (slope between el. 533-535), temporarily inundated forested wetland scrub/shrub species (tiers at el. 535 & 537), and temporarily inundated forested wetland trees (tiers at el. 535 & 537) will be planted for this measure. Also, to increase ground cover post-construction approximately 3 acres of an understory seed mix will be included (el. 533-537).

2.5.3. Aquatic Habitat. Although the optimal wintering condition for centrarchid fish in large river-floodplain systems has been studied extensively, relatively little data is available that describes the seasonal movements and site-loyalty of centrarchids to a backwater complex in a large river-floodplain system. This study intends to use an acoustic telemetry array within the Huron Island backwater complex to continuously monitor centrarchid movements and site-loyalty during the winter, spawning, rearing, and fall seasons. Treatment lakes will include Goose Lakes 1 and 2 and Garner Chute. Comparisons of fish habitat use during the year will be compared with pre-project habitat use and fish use of other backwaters within Huron Island.

3. MONITORING

An effective monitoring program will be required to determine whether the Project outcomes are consistent with original Project goals and objectives or whether adjustments to the measures are required (Adaptive Management). The power of a monitoring program developed to support adaptive management lies in the establishment of feedback between continued Project monitoring and corresponding Project management. A carefully designed monitoring program is a central component of the Project adaptive management program.

3.1. Aquatic Vegetation

Performance Measure. Increase diversity, abundance, and areal coverage of native submerged, floating-leaved, and emergent aquatic vegetation compared to pre-project conditions and control sites within Huron Island.

Criteria. Species richness of 5 and areal coverage of 1 acre of native submerged, floating-leaved, and emergent aquatic vegetation within 5 years. The monitoring design and associated adjustments to the planting design described below will be used to meet the decision criteria.

Monitoring Design. Ongoing evaluations of plantings and plant community development are critical in the decision-making process for implementation of scheduled and “as needed” operations required for sustained establishment of desirable species. Monitoring will follow LTRM vegetation component protocols and GIS mapping in order to facilitate assessments of plant survival, growth, and areal coverage. The analysis of the data collected will document the progress of vegetation establishment, compared to the decision criteria, and alter plans, as needed, to obtain

Project success. A monitoring schedule of 4 site visits per growing season, including planting trips, will be conducted pre-project, 3 years during construction, and 2 years following construction. Initial monitoring (Year 1 and 2) will focus on survival of species planted with and without herbivory protection. The information developed during this "learning" phase will be used to formulate subsequent planting layouts (Years 2 and 3). As plants begin to establish and spread, monitoring will focus on larger-scale plant community development to determine whether the Project has met the criteria for success. GIS maps of plant establishment and spread will be constructed from GPS information collected at the end of each growing season (Years 3-5; table K-1).

Water quality and levels will be monitored periodically by USACE ERDC and the District.

Analysis and Use of Monitoring Results. Reports detailing the monitoring results and analyses conducted at Huron Island will be developed following each monitoring site-visit, and Annual Status Reports and other pertinent deliverables provided following each FY growing season ending in November. All reports will include information pertinent to the Project goals described above. These reports will include results from plantings, monitoring activities, and timely recommendations for better management of the vegetation plantings (Adaptive Management). Better management includes decisions on the species, locations, and planting design to be used the following year to meet the objectives.

3.2. Floodplain Forest

Performance Measure. Increase species diversity, abundance, and areal coverage of native diverse mast producing tree species

Criteria. Species richness >11 species and > 7 acres of native diverse forest

Performance Measure. Determine optimal elevation, size of RPM tree, and protection from herbivory to maximize growth, survival, and seed production

Criteria. Attain an average growth rate of 0.5 in/year dbh, an average survival rate of >80 percent, and seed production within 10 years

Performance Measure. Determine optimal elevation, size of RPM tree, and protection from herbivory to initiate regeneration of mast producing trees

Criteria. Attain mast producing tree regeneration within 10 years

Monitoring Design. Prism data will be collected and is intended to capture information on the overstory canopy and includes data on count trees in the variable radius plot using a 10 factor prism or angle gauge. The data for each "count" tree will be individually recorded in a separate point or feature on the GPS unit. The GPS point does not need to be collected directly at the count tree but somewhere within the plot vicinity. The following data will be collected for every "count" tree. Plots with no count trees shall be documented by recording a Prism feature and selecting "no tree" for the tree species. Prism plot center will coincide with the similarly numbered fixed plot. Trees on the "border" of the variable radius plot (where it cannot be visually determined whether they are in or out) shall be measured and included in every second instance for data collected on or before December 7,

2011. Data collected on or after December 8, 2011 shall use the limiting distance method of determining a count tree. The following data will be collected on a yearly basis for 10 years.

- Plot number for each prism plot should coincide with fixed plot numbering. All "count" trees within an individual plot will have same plot numbering.
- Tree species of "count" tree selected from menu pick list of common names. If there are no count trees in the plot, select "no trees" in this field.
- Measurement of tree height. Height is the measurement of co-dominant canopy layer using a clinometer within plot area. There is a tolerance level of plus or minus 20 percent of tree height when determining overstory height.
- Measurement of tree diameter at breast height (DBH), 4.5 feet from ground, to nearest inch. Tools that may be used include: diameter tape, logger tape, or Biltmore stick. The US Forest Service timber cruise handbook provides protocols on the measurement of unusual situations or problem trees. If there are no count trees in the plot, select zero for this field.
- Tree canopy class menu pick list to include: dominant (top of canopy), co-dominant (top of canopy and similar height to neighbor), intermediate (top of canopy extends into lower canopy of dominant trees), suppressed (top of canopy below bottom of dominant canopy.) If there are no count trees in the plot, select "no trees" in this field.
- Tree health menu pick list to include: healthy, stressed, significant decline, and dead. If there are no count trees in the plot, select "no trees" in this field. Healthy tree has a vigorous canopy with no dieback, no epicormic branching, and no significant disease. Stressed tree has one of the following factors: dieback comprising of less than 50 percent or more of the canopy, epicormic branching, defoliation, or significant vine competition. Significant decline has one or more of the following: dieback comprising 50 percent or more of the canopy, significant epicormic branching, significant defoliation, broken top or major vine competition. Dead tree is a standing stem with no live foliage or live branches.
- Miscellaneous comments may be added as necessary allowing up to 60 characters to be entered.

Analysis and Use of Monitoring Results. Data analysis will include statistical procedures to determine significant growth, survival, seed production by treatments. If the criteria are met no additional management action is needed. If the features do not meet the criteria after within 10 years or are not on pace to meet the criteria, the following management actions may be needed.

- Replanting trees of species exhibiting the greatest growth and survival
- Replanting trees at elevations exhibiting the greatest growth and survival
- Replanting the RPM size exhibiting the greatest growth and survival
- Replanting using any combination of the species, elevations, and RPM size exhibiting the greatest growth and survival.

- Managing the level of herbivory protection (exclosures) based on signs of herbivory. This may vary by species, elevation, location, or RPM size.

3.3. Aquatic Habitat

Performance Measure. Increase abundance and site-loyalty of centrarchids during spawning, rearing, and overwintering in restored backwaters compared to pre-project conditions

Performance Measure. Decrease seasonal movements between overwintering, spawning, and foraging habitat

Criteria. Reoccurring winter DO levels below 2 mg/L

Monitoring Design. The 4-year monitoring (2 years each of pre- and post-construction) system will consist of 14 stationary, data-logging, omnidirectional hydrophones (VEMCO Model VR2) that will be used to continuously (every 2 minutes) detect individually unique transmitters implanted in largemouth bass, bluegill, and/or crappie. The VR2 receiver records the identification number and time stamp from the implanted transmitters as a fish swims within receiver range. The VR2 can detect and store up to 1-million detections which extends the time between downloads. Therefore, the receivers must be retrieved and downloaded manually approximately every month or two. Receivers will be affixed to anchored stands and submerged in strategic locations throughout the Huron Island backwater complex (table K-1).

Ultrasonic transmitters will be surgically implanted in fish and are sized such that they do not typically exceed fish weight in water by 2 to 3 percent. The transmitters (VEMCO Model V9) preliminarily determined to be used during this study have a battery life of approximately 226-591 days, depending on the size of the tag and fish (table K-1).

Manual tracking will be conducted as needed, but at least once every season. Manual tracking will gain a more detailed understanding of the tracked fish's location, movements, and habitat selection within Huron Island. Water quality parameters including dissolved oxygen, temperature, turbidity, and flow velocities will be collected.

Largemouth bass, bluegill, and/or crappie of sufficient size for tagging will be collected using an electrofishing boat provided by the Iowa Department of Natural Resources. Electrofishing will be conducted during the spring and fall months following LTRM fish survey protocols. Fish of sufficient size will be implanted with transmitters according to the procedures above. Due to the differences in tag life (236 vs 591 days) electrofishing and tag implantation will be staggered throughout the year. This will ensure at least a minimum number of fish (approximately 20 to 25) are being tracked at any given time of the year. All fish collected will be recorded and data obtained provided to LTRM for inclusion in the database.

Fish will be anesthetized and river water will be circulated over the gills during surgery. Incisions are made ventrally, anterior to the anal opening. The incision areas are disinfected with betadine. All surgical utensils are sanitized in 70 percent ethanol. A scalpel and curved hemostats are used to insert the tag and avoid damage to the organs. The transmitter is pushed down and away from the incision site to alleviate any added stress on the wound. Incisions are closed with monofilament sutures attached to a curved cutting needle using simple interrupted sutures. The incision and sutures are sealed with cyanoacrylate resin to prevent infection and to hold the wound and suture knots together securely. Immediately following the surgical procedure, fish are placed into a recovery tank supplemented with oxygen and released after normal swimming occurs.

Analysis and Use of Monitoring Results. The results obtained in this 4-year monitoring effort should demonstrate the importance of not only wintering habitat, but also spawning and rearing habitat in a large river-floodplain system. Continuous monitoring data will describe centrarchids use of the available habitat, seasonal movements, and site-loyalty. Pre-project monitoring results will be used, along with water quality data, to compare with post-project monitoring. Improvements in wintering habitat, spawning habitats, and/or site loyalty may indicate a successful Project. Additionally, results of pre- and post-project monitoring may indicate an ability to attract additional fish to the rehabilitated Project area on a local and seasonal scale.

Fish monitoring results will be used to guide the design and management of future HREPs by demonstrating the need for specific habitat types or ways to improve existing habitat. Improvements could lead to greater spawning success and, consequently, greater recruitment of centrarchids. Improving site loyalty can also lead to improvements in overall fitness and health.

Water quality measurements will be used to determine DO levels in the backwater. If a DO level of 2.0 mg/L is not routinely being met, the following adaptive management features could be employed to improve Project success:

- introduce flow into the backwater by connecting Goose Lake to Buffalo Slough
- notch the closure structure within Garner Chute to introduce more flow during the winter

Table K-1. Experimental Design and Monitoring for Aquatic Plant Establishment

Year 1 Learning Phase	**Year 2 Learning/Implementation**	**Year 3 Implementation/Meet Project Objectives**	**Year 4 Implementation/Project Success**	**Year 5 Project Success**
Plant acquisition	Additional plant acquisition if needed			
Initiate plant production	Continue plant production	Continue plant production		
Materials acquisition (nursery)	Materials acquisition (exclosures)	Materials acquisition (exclosures)		
	Planting	Planting		
	Evaluations	Evaluations	Evaluations	Evaluations
Status report	Status report	Status report	Status report	Final report

4. ASSESSMENT

4.1. Assessment Process. Appropriate statistical comparisons (e.g., hypothesis testing, ANOVA, multivariate methods, etc.) will be used to summarize monitoring data as they are obtained and compare these data summaries with the Project decision criteria. These continued assessments will be critical to determine the need to implement adaptive management features (e.g., backwater flow introduction) or actively manage the features (e.g., a change in planting design for the next year).

4.2. Variances and Success. The Adaptive Management team will collaborate with Project managers and decision-makers to define magnitudes of difference (e.g., statistical differences, significance levels) between the values of monitored performance measures and the desired values (i.e., decision criteria) that will constitute variances. Meaningful comparisons between monitoring results and desired performance will require characterization of historical and current spatial-temporal variability that define baseline conditions. Variances (or their absence) will be used to recommend adaptive management actions, including (1) continuation of the Project without modification, (2) modification of the Project within original design specifications, (3) development of new alternatives, or (4) apply lessons learned to future UMRR-EMP HREPs.

4.3. Documentation, Reporting, and Coordination. The Communication Plan for this Project includes coordination of all monitoring results, analyses, and implementation plans with the Adaptive Management team. The Adaptive Management team will work with the PDT to produce periodic reports that will measure progress towards Project goals and objectives as characterized by the selected performance measures. The results of the assessments will be communicated regularly to the Project managers, decision-makers, stakeholders, and the UMRR-EMP. Regular communication may include presentations or publications to the River Teams, LTRM representatives, the A-Team, or the EMP Coordinating Committee.

5. DECISION MAKING

5.1. Decision Process. Adaptive management is distinguished from more traditional monitoring in part through implementation of an organized, coherent, and documented decision process. For the Huron Island HREP, the decision process includes

- anticipating the kinds of management decisions that are possible within the original Project design,
- specifying values of performance measures that will be used as decision criteria,
- establishing a consensus approach to decision making, and
- devising a mechanism to document, report, and archive decisions made.

5.2. Decision Criteria and Potential Adaptive Management Measures. Decision criteria, are usually ranges of expected and/or desirable outcomes. They can be qualitative or quantitative based on the nature of the performance measure and the level of information necessary to make a decision. Three potential decision criteria are identified below, based on the Project objectives and performance measures. To meet the criteria for aquatic vegetation and floodplain forest diversity active adaptive management will be employed. Essentially this means the PDT will be regularly monitoring and analyzing the plantings, and making management decisions throughout the 10-year cycle. At the end of the 10-year cycle if the criteria are still not met lessons learned will be documented and carried to future HREPs. Aquatic fish habitat use will employ a passive adaptive management approach, which is using the results of the monitoring to inform future HREP backwater habitat designs. Water quality monitoring will inform the need for backwater flow introduction of closure structure notching (Adaptive Management features).

5.2.1. Aquatic Vegetation. Increase diversity to 5 species and areal coverage of 1 acre of native submerged, floating-leaved, and emergent aquatic vegetation within 5 years.

Based on yearly monitoring and analysis, species, densities, locations, and level of protection will be adjusted. Multiple assessments will be necessary within the first -3 years to determine the optimal combination of species, protection, and location to maximize growth and survival. For example, during Year 1, emergent species will be planted on two occasions. First plantings will be made on 40-foot centers to evaluate their suitability for the site. A second planting will be made to increase density to
20-foot centers using those species that established successfully from the first planting. Two plantings during second year will utilize results from the first year to additionally plant for a final planting density of 10-f00t centers.

If after 5-years the criteria are not met, further management of aquatic vegetation will not occur at Huron Island. Rather, the results of the monitoring and adaptive management strategy will be published in a report and presented to the Adaptive Management Team to discuss the lessons learned. Lessons learned from the Project will be appropriately used in subsequent HREPs.

5.2.2. Floodplain Forest

- Increase diversity to at least 12 species and > 7 acres of native diverse forest.
- Attain an average growth rate of 0.5 in/year dbh, an average survival rate of >80 percent, and seed production within 10 years.

Yearly monitoring and analyses will be used to determine the need to adjust the management of the floodplain forest feature to achieve the criteria above. The following adjustments may be needed if the trees are not on pace to achieve at least 12 species and >7acres of native diverse forest.

- Replanting trees of species exhibiting the greatest growth and survival
- Replanting trees at elevations exhibiting the greatest growth and survival
- Replanting the RPM size exhibiting the greatest growth and survival
- Replanting using any combination of the species, elevations, and RPM size exhibiting the greatest growth and survival.
- Managing the level of herbivory protection (exclosures) based on signs of herbivory. This may vary by species, elevation, location, or RPM size.

If after 10-years of monitoring, learning, and adjusting the feature, the criteria are not met, further management of floodplain mast producing trees will not occur at Huron Island. Rather, the results of the monitoring and adaptive management strategy will be published in a report and presented to the Adaptive Management Team to discuss the lessons learned. Lessons learned from the Project will be appropriately used in subsequent HREPs.

5.2.3. Aquatic Habitat - Reoccurring Winter DO Levels Below 2 mg/L. Aquatic fish habitat use will employ a passive adaptive management approach, which is using the results of the monitoring to inform future HREP backwater habitat designs. However, if DO levels in excess of at least 2 mg/L are not routinely met, a successful Project is impossible because of lethal DO levels. Monitoring of the DO will inform the need for backwater flow introduction of closure structure notching (Adaptive Management features).

5.3. Project Close-Out. Close-out of the Project would occur when it is determined that the Project is successful or when the maximum 10-year monitoring period has been reached. Success would be considered to have been achieved when the Project objectives have been met, or when it is clear that they will be met based upon the trends for the site conditions and processes. Project success would be based on the following:

- Stabilization of islands
- Stabilization of plant and tree relative abundance
- Stabilized DO levels
- Stabilized water velocities

Additionally, Project close-out will include the last step in the UMRR EMP Adaptive Management Framework which is technology transfer. This includes the dissemination of Project monitoring results, analyses performed, management decisions made (Adaptive Management features or adjustments), and lessons learned. Technology transfer will occur via publications, presentations, and discussions with the Adaptive Management Team, LTRM, River Teams, EMP-CC, and stakeholders.

6. IMPLEMENTATION COSTS, SCHEDULE, AND RESPONSIBILITIES FOR MONITORING AND ADAPTIVE MANAGEMENT

6.1. Costs. The costs associated with implementing these monitoring and Adaptive Management Plans were estimated based on currently available data and information developed during plan formulation as part of the Feasibility Study. Because uncertainties remain as to the exact Project features, monitoring elements, and adaptive management opportunities, the costs estimated will be need to be refined in PED during the development of the detailed Monitoring and Adaptive Management Plans (table K-2).

Table K-2. Huron Island Estimated Work Activities, Primary Responsibility for Implementation, Costs, and Duration for Adaptive Management and Monitoring Activities

Objective	Work Category	Activity	Primary Responsibility	PED	Post Construction Years 1-5	Post Construction Years 5-10	Total
Aquatic Vegetation	Plant Production	Propagule collection Sediment bioassay Plant grow-out	USACE ERDC LAERF [1]		$15,000		$15,000
	Materials	Protective Exclosures Grow-out materials			$10,000		$10,000
	Planting	Exclosure construction Containerized plants Tubers			$25,000		$25,000
	Monitoring & Analysis	GIS coverage mapping Water Quality [2] LTRM Veg Protocols		$5,000	$50,000	$25,000	$80,000
	Reporting	Quarterly and Annual		$5,000	$35,000	$25,000	$65,000
						Aquatic Vegetation Subtotal	**$195,000**
Floodplain Forest	Plant Acquisition	New RPM trees for replanting (if needed)	USACE Mississippi River Project Office Foresters		$15,000	$15,000	$30,000
	Materials	Protective Exclosures			$10,000	$10,000	$20,000
	Planting	Exclosure construction RPM Tree Planting			$10,000	$10,000	$20,000
	Monitoring & Analysis	Prism plot surveys LTRM Forest Protocols		$5,000	$30,000	$30,000	$65,000
	Reporting	Quarterly and Annual		$5,000	$15,000	$15,000	$35,000
						Floodplain Forest Subtotal	**$170,000**

[1] LAERF - Lewisville Aquatic Ecosystem Research Facility
[2] Water quality survey schedules (Table 32 of the Main Report) and stations (Plate 36) will be used.

Table K-2. Huron Island Estimated Work Activities, Primary Responsibility for Implementation, Costs, and Duration for Adaptive Management and Monitoring Activities

Objective	Work Category	Activity	Primary Responsibility	PED	Post Construction Years 1-5	Post Construction Years 5-10	Total
Aquatic Habitat	Materials	VEMCO Receivers VEMCO Transmitters Floy Tags Manual Tracking Equip Laptop Surgical supplies	USACE MVR	$80,000	$30,000		$110,000
	Labor	Acoustic Array Deploy Fish Collection Surgical implantation Data Downloads Manual Tracking	IA DNR, USFWS, & USACE	$15,000	$30,000		$45,000
	Data Analysis	Water Quality[2]	USACE	$1,000	$1,000		$2,000
		Fish Movements	IA DNR& USFWS	$4,000	$9,000		$13,000
	Reports	Quarterly and Annual		$5,000	$10,000		$15,000
	AM Feature: Notch Garner Chute Closure		USACE MVR	$34,516			$34,516
	AM Feature: Backwater Flow Introduction			$52,368			$52,368
						Aquatic Habitat Subtotal	**$271,884**
						TOTAL	**$636,884**

[1] LAERF - Lewisville Aquatic Ecosystem Research Facility
[2] Water quality survey schedules (Table 32 of the Main Report) and stations (Plate 36) will be used.

6.2. Schedule and Responsibilities

6.2.1. Aquatic Vegetation. PED activities will be limited to one evaluation to reassess existing vegetation at the Site. Following construction, active adaptive management activities will be evaluated and implemented during the first 5 years. Yearly evaluations and re-plantings will be required during this time. Years 5-10 will include additional yearly evaluations and report write-up. Responsibility for aquatic vegetation adaptive management and monitoring will be with the USACE ERDC Lewisville Aquatic Ecosystem Research Facility.

6.2.2. Floodplain Forest. PED activities will be limited to one evaluation to reassess existing vegetation at the Site. Following construction, active adaptive management activities will be evaluated and implemented for 10 years. Yearly evaluations, re-plantings, or exclosure replacement may be needed during this time. Responsibility for these features will be a coordinated effort between the USACE Mississippi River Project Office Forestry staff, IADNR, and USFWS.

6.2.3. Aquatic Habitat. PED activities will be the establishment of the telemetry network, 2 years of pre-project telemetry data collection and analyses, and concurrent fish community sampling (following LTRMP fish sampling protocols). Following construction, fish community sampling will continue by the IA DNR for at least 5 years, while post-construction telemetry efforts are scheduled for a 2-year period. Fish to tag for both pre- and post-construction telemetry monitoring will be obtained concurrently with fish sampling conducted by the IA DNR. The telemetry effort is required to increase our sampling power to effectively evaluate the effectiveness of this Project in providing year round fish habitat. The need for a flow through channel will regularly be evaluated and if needed would occur within 5 years of construction. Responsibility for fish community sampling will be with the IA DNR. Telemetry equipment will be purchased by the District and implemented jointly among the IA DNR, the USFWS, and the District.

UPPER MISSISSIPPI RIVER RESTORATION ENVIRONMENTAL MANAGEMENT PROGRAM DEFINITE PROJECT REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND COMPLEX HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX L

LITERATURE CITED

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-17F)

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX L

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UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX M

DESIGN

Measure I1: Huron Chute Diversity, Bank Stabilization

9/27/12 12:29 PM

Objective
Calculate quantities for clearing, grading, bedding stone placement, riprap placement.

References

Publications

Title	Source	Publication Date	Link
Huron Island HREP DPR		Draft	
Upper Mississippi River Environmental Management Program Environmental Design Handbook		August-06	
Upper Mississippi River Environmental Management Program Environmental Design Handbook	(Shoreline Protection and applicable resources)	Draft 2012	
INROADS Prints are located here:			INROADS PRINTS

Survey Datums and Conversions

NAD 83 IL West - 1202 MSL 1912 GEO 09
Orthophotography from March 2005 (Plates)
Flat Pool at El 528.0 (approx)

Software

Name	Version	Notes
Microstation	V8i (select Series 2)	

Data Files

File Name	File Extension	ProjectWise URN	Notes
N/A			

APPENDIX M

Measure I1: Huron Chute Diversity, Bank Stabilization

9/27/12 12:29 PM

Assumptions				
	Item	Number	Units	Notes
	Upstream Island Bankline to Be Protected	300	FT	Rough estimate for top of island measured from photo
	Downstream Ilsnad Bankline to Be Protected	300	FT	Rough estimate for top of island measured from photo
	Length of Shoreline Requiring Protection	600	FT	based on Spring 2012 Survey of observable erosion
	Slopes for Protection	2H:1V		Per Felix Casto, EC-G
	Bedding Stone Thickness	1	FT	Per Felix Casto, EC-G
	Riprap Thickness	2	FT	Per Felix Casto, EC-G
	Top Tie In Length (Into Bank)	6	FT	Per Felix Casto, EC-G
	Toe Length (out to River)	6	FT	Per Felix Casto, EC-G
	Average Top Elevation of bankline	534		
	Average Bottom Elevation where river flattens out	520		
	Conversion RIPRAP	1.65	TN/CY	
	Conversion Bedding Stone	1.8	TN/CY	
	Area Conversion	43560	FT/AC	

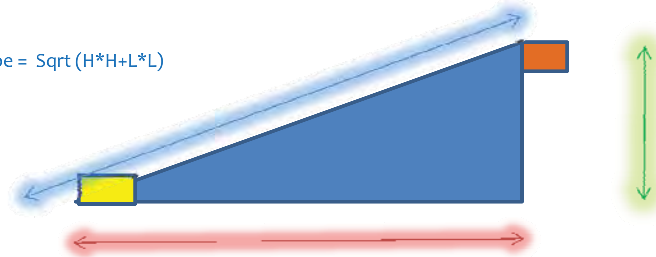
Measure I1: Huron Chute Diversity, Bank Stabilization

9/27/12 12:29 PM

Analysis and Design

Riprap and Bedding

Hand Calculation



	RIPRAP	BEDDING	
Length Requiring Protection per Linear Foot of Shorline (slope plus toe plus Tie In)	43.3	43.3	Feet
Area per Linear Foot of Shoreline	86.6	43.30495168	SF
Volume per Area Needing Protection	51,965.9	25,983.0	CF
	1,924.7	962.3	CY
	3,175.7	1,732.2	TN
Contingency	0.2	0.2	
Total	3,810.8	2,078.6	TN
ROUNDUP	3,900.0	2,100.0	TN

INROADS CALCULATION

No INROADS RUN TO DATE

Clearing

Hand Calculation

Protection Length	600	FT	
Distance into shore	20	FT	Similar to T1, total of 20 feet from top of bank to require clearing
Area Requiring Clearing	12000	SF	
	0.2755	AC	
Contingency	0.2000		
Total	0.330578512	AC	
	0.3	AC	

Measure I1: Huron Chute Diversity, Bank Stabilization

9/27/12 12:29 PM

Conclusions							
ITEM NO.	DESCRIPTION	QTY	UNIT	UNIT PRICE	AMOUNT		
I1	Bank Stabilization - Riprap (Step 4)	3,900	TN	[redacted]			
I1	Bank Stabilization - Bedding (Step 3)	2,100	TN				
I1	Bank Stabilization - Clearing (Step 1)	1	AC				
I1	Bank Stabilization -Bankline Shaping (Step 2)	1	LS				

Measure I1: Huron Chute Diversity, Bank Stabilization

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Computation Checks	
Review Stage	DPR DQCR
Check Comments	Make sure to add information and any data files; Assumptions-Notes-add how you measured the bankline-survey or photo; Clearing-your distance into shore note states 6 foot tie in and a total of 20 feet. Is this enough room to move equipment. T1 used 20 feet for equipment. Reviewed by Julie Millhollin, EC-DN, August 28, 2012
Resolution of Comments	information and data files updated. Measurements for bankline added. Distance updated to 20 feet total, matching T1 (This is what had been used for calculations here, but updated note). KNM 9/4/2012
Checked By:	MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 14:57:57 -05'00'
Submitted By:	MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:47:32 -05'00'

Huron Island HREP - DPR

Computations By: Kara N. Mitvalsky, P.E.

Measure T9: Topographic Diversity and Overwintering, Garner Chute Closure Structure

9/27/12 12:32 PM

Objective

Calculate quantities for riprap placement.

References

Publications

Title	Source	Publication Date	Link
Huron Island HREP DPR		Draft	
Upper Mississippi River Environmental Management Program Environmental Design Handbook		August-06	
Upper Mississippi River Environmental Management Program Environmental Design Handbook	(Shoreline Protection and applicable resources)	Draft 2012	
INROADS Prints are located here:			INROADS PRINTS

Survey Datums and Conversions

NAD 83 IL West - 1202 MSL 1912 GEO 09

Orthophotography from March 2005 (Plates)

Flat Pool at El 528.0 (approx)

Software

Name	Version	Notes
Microstation	**V8i (select Series 2)**	

Data Files

Cross Section Name	Alignment Name	ProjectWise URN	Notes
Garner Chute Closre Strur_2	**Garner Chute Closure Structure**	**Above: Huron Garner Chute Closure Structure 03222012.pdf**	

Assumptions

Item	Number	Units	Notes
Estimated Length of Structure (shore to shore)	250	FT	INROADS indicates about 4+00 stations, but that is due to the section being cut through the channel then up into the woods.
Slopes for Protection	2H:1V		Per Felix Casto, EC-G
Average Top Elevation	532		Above flat pool. Elevation to later be coordinated with H&H model
Average Bottom Elevation	513		This is the lowest point, and is a conservative assumption for hand calcs.
Conversion RIPRAP	1.65	TN/CY	
Area Conversion	43560	FT/AC	

APPENDIX M

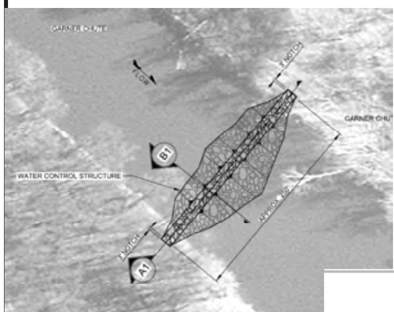
Measure T9: Topographic Diversity and Overwintering, Garner Chute Closure Structure

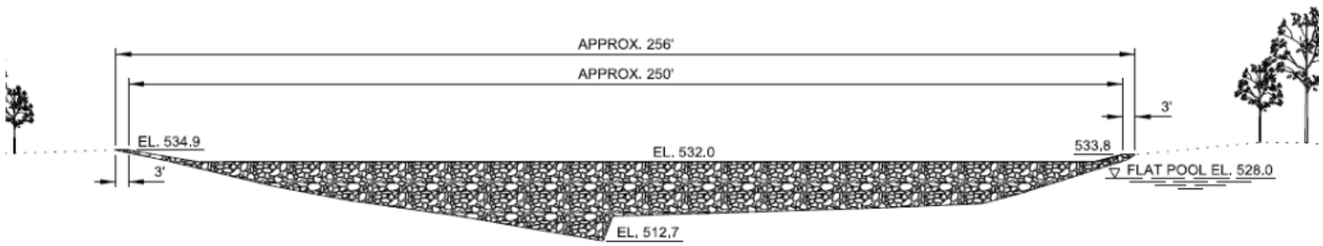
9/27/12 12:32 PM

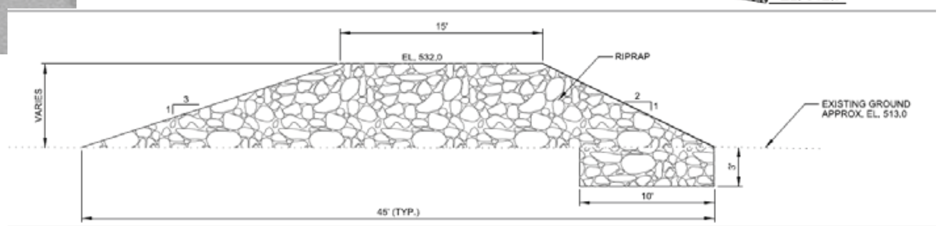
Analysis and Design

Stone

Hand Calculation







	RIPRAP	
Proposed Structure Length = L	250.0	FT
Top elevation	532.0	
Bottom Elevation	513.0	FT
Structure Height	19.0	FT
Structure Top Width	15.0	FT
Center Cross Sectional Area	*285.0*	*SF*
Side Slope Cross Sectional Area (U/S)	*361.0*	*SF*
Side Slope Cross Sectional Area (D/S)	*541.5*	*SF*
Keyed in Cross Sectional Area	*30.0*	*SF*
Total Cross Sectional Volume = CSV	1,217.5	SF
Structure Volume = CSV x L	304,375.0	CF
	11,273.1	CY
	18,600.7	TN
Contingency	0.2	
Total	22,320.8	TN
ROUNDUP	22,400.0	TN

Note, did not add in the keyed in ends into the shoreline, since assuming a 513 bottom across (conservative). Added volume for key in would have been
*3' into the shore X 2' of depth * 15 ' along the crown on 2 sides or*
180 CF
11 TN extra for key ins

TOTAL 22,400.0 TN

APPENDIX M

Huron Island HREP - DPR
Computations By: Kara N. Mitvalsky, P.E.

Measure T9: Topographic Diversity and Overwintering, Garner Chute Closure Structure

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INROADS CALCULATION

	INROADS RAN march 22, 2012		
Volume per Area Needing Protection	3,653.6	CY	
Keyed In Volume (Hand Calculation)	7,500.0	CY	
Total Volume	11,153.6		
	18,403.4	TN	
Contingency	0.2		
Total	22,084.1	TN	
ROUNDUP	22,100.0	TN	

TOTAL **22,100.0** **TN**

Clearing

Hand Calculation

Protection Length	20.0	FT	15 feet along the top, plus a little more for each side
	20.0		3 feet in plus extra for equipment access
Distance into shore		FT	
Area Requiring Clearing	400.0	SF	
Number of Sides	2.0		
	0.018	AC	
Contingency	0.200		
Total	0.022	AC	
	0.023	AC	

When calculated on the drawings, it was estimated as follows 0.35 AC

APPENDIX M

Measure T9: Topographic Diversity and Overwintering, Garner Chute Closure Structure

9/27/12 12:32 PM

Conclusions

ITEM NO.	DESCRIPTION	QTY	UNIT	[redacted]		
T9	Garner Closure - Riprap	22,100	TN			
T9	Garmder Closure - Clearing	1	AC			

APPENDIX M

Measure T9: Topographic Diversity and Overwintering, Garner Chute Closure Structure

9/27/12 12:32 PM

Computation Checks	
Review Stage	DPR DQCR
Check Comments	Make sure to add information and any data files; Assumptions-Notes-add how you figured out average top elevation; Conclusion-update Riprap QTY-22,400 TNs. Reviewed by Julie Millhollin, EC-DN, August 28, 2012
Resolution of Comments	Information and data files were added. The 22,400 TN was based on rough estimates. We have survey of the area, and the assumption of the bottom ground did no specifically match existing conditions. The 22,100 is more accurate and will be kept as the quantity. KNM 9/4/2012
Checked By:	MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 15:03:25 -05'00'
Submitted By:	MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:49:38 -05'00'

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Objective

Goose Lake Pool 1 Topo Diversity (537 Top) with 75 foot dredge cut. Calculate quantity for dredge cut and placement site clearing. Also includes access dredging from Huron Chute to the beginning of the environmental dredging for barge access. Wetland plantings are also included.

References

Publications

Title	Source	Publication Date	Link
Huron Island HREP DPR		DRAFT	
Planting design was based on Nate Richards, CEMVP-PD-P, Project Biologist and Jon Schulz, OD-MN, Project Forestor			##################
Upper Mississippi River Environmental Management Program		August-06	http://www.mvr.usace.army.mil/EMP/designhandbook.htm
U.S. Army Corps of Engineers, *EM 1110-2-5025, Dredging and*		March-83	
U.S. Army Corps of Engineers, Dredging Operations Technical			http://el.erdc.usace.ar
Project Boring Data	Draft Geotech Data		
INROADS Prints are located here:			INROADS PRINTS

Survey Datums and Conversions

7. HORIZONTAL DATUM IS STATE PLANE COORDINATE SYSTEM, IL WEST, NAD 83, US SURVEY FOOT, VERTICAL DATUM IS MSL 1912.
8. ORTHO PHOTOGRAPHY FROM MARCH 2005
9. FLAT POOL IS AT EL. 528.0.

Horizontal Datum	**State Plane**
	IL West
	NAD 83
	US Survey Foot
Vertical Datum	MSL 1912

Software

Name	Version	Notes
Microstation	**V8i (select Series 2)**	

Data Files

Cross Section Name	Alignment Name	ProjectWise URN	Notes
Combined Pool 1_3	**Combined Pool 1**	**Above: Huron T1 75 Ft 537 top 03082012.pdf**	
Extended Dredge Cut_1	**Extended Dredge Cut**	**Above: Huron Access Dredge Cut Quantities 06202012.pdf**	

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Assumptions				
	Item	**Number**	**Units**	Notes
Deep Dredge Cut				
	Length of Dredge Cut (Pool 1 Upper, Pool 1 Lower, and Connection)	2402	feet	Length encompasses most of the Pool, length as measured in INROADS: Note that the placement sites are disconnected since there is a channel
	Width of Dredge Cut	75	feet	Width to ensure sufficient material for forest features
	Depth of Dredge Cut	520	ft MSL	Depth to address future sedimentation and to ensure deep fish habitat
	Side Slopes	4H:1V		per Felix Castro, EC-G
Shallow Dredge Cut				
	Length of Dredge Cut (Pool 1 Upper, Pool 1 Lower, and Connection)	2402	feet	See above for dredge cut
	Width of Dredge Cut	20	feet	Width selected for aquatic habitat
	Depth of Dredge Cut	526	ft MSL	Depth to allow for shallow fish habitat and SAV/EAV
	Side Slopes	4H:1V		per Felix Castro, CEMVR-EC-G
Placement Site (Upper Pool)				
	Upper Pool Placement Site	1163	feet	Length encompasses most of the Pool
	Placement Site Shaping is covered under Measure F1. Dimensions are provided to indicate amount of clearing required.			
	Lower Shelf Width	30	feet	Min width for tree survivability per Jon schulz, CEMVR-OD-MN
	Lower Shelf Elevation	535	ft MSL	To meet forest index requirements. Per PDT requirements.
	Upper Shelf Width	30	feet	Minimum width for tree survivability per Jon schulz, CEMVR-OD-MN
	Upper Shelf Elevation	537	ft MSL	To meet forest index requirements. Per PDT requirements.
	Side Slopes	4H:1V		per Felix Castro, EC-G

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Placement Site (Lower Pool)				
	Lower Pool Placement Site	1002	feet	Length encompasses most of the Pool
	Placement Site Shaping is covered under Measure F1. Dimensions are provided to indicate amount of clearing required.			
	Lower Shelf Width	30	feet	Minimum width for
	Lower Shelf Elevation	535	ft MSL	To meet forest index requirements. Per PDT requirements.
	Upper Shelf Width	30	feet	Minimum width for tree survivability per Jon schulz, CEMVR-OD-MN
	Upper Shelf Elevation	537	ft MSL	To meet forest index requirements. Per PDT requirements.
Access Dredge Cut				
	Length	1488.74	Feet	This will get us to deep water in Huron Chute to the beginning of the dredge cut
	Width	30	feet	bottom dredge cut for equipment access
	Depth of dredge cut	524	ft MSL	4 feet below flat pool should be accessible for crane on a barge during
	Slope	4H:1V		Per EC-G for slope stability
	For Planting information refer to sheet F Plantings			
	Note that 3 exclosures were chosen by Nate Richards, PM-A			
Constants				
	Area Conversion	43,560	SF/AC	
	Volume Conversion	27	CF/CY	

Analysis and Design

Dredge Cut

INROADS

INROADS Quantity For Pool 1 Cut (3/8/2012)	54,211.00	CY	This is the quantity to get from Huron Chute into the proposed dredge cut. Material will be dredged and sidecast.
ACCESS DREDGE QUANTITY (6/20/2012)	4,022.30	CY	
UNKNOWN FOR SURVEY/Realignment	20%		
	69,879.96	CY	
	69,900.00	**CY**	

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

End Area Volume Report — Page 1 of 2

End Area Volume Report

Report Created: 3/8/2012
Time: 10:27am

75 Bottom
537.0 Top
T1

Cross Section Set Name: Combined Pool 1_3
Alignment Name: Combined Pool 1
Input Grid Factor: 1.000000 Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise

Baseline Station	Station Quantities: Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities: Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
0+00.00	1.00	667.2	0.0	0.0	1.00	627.1	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	0.0
0+50.00	1.00	661.5	1230.2	1230.2	1.00	612.8	1148.1	1148.1	1.00	0.0	0.0	1.00	0.0	0.0	82.1
1+00.00	1.00	659.1	1222.7	1222.7	1.00	594.8	1118.2	1118.2	1.00	0.0	0.0	1.00	0.0	0.0	186.7
1+50.00	1.00	578.7	1146.1	1146.1	1.00	617.7	1122.6	1122.6	1.00	0.0	0.0	1.00	0.0	0.0	210.2
2+00.00	1.00	638.4	1127.0	1127.0	1.00	628.8	1154.1	1154.1	1.00	0.0	0.0	1.00	0.0	0.0	183.0
2+50.00	1.00	595.7	1142.7	1142.7	1.00	622.1	1158.3	1158.3	1.00	0.0	0.0	1.00	0.0	0.0	167.4
3+00.00	1.00	540.1	1051.7	1051.7	1.00	537.9	1074.1	1074.1	1.00	0.0	0.0	1.00	0.0	0.0	145.0
3+50.00	1.00	558.3	1017.1	1017.1	1.00	546.3	1003.9	1003.9	1.00	0.0	0.0	1.00	0.0	0.0	158.1
4+00.00	1.00	587.1	1060.5	1060.5	1.00	556.2	1020.9	1020.9	1.00	0.0	0.0	1.00	0.0	0.0	197.8
4+50.00	1.00	575.9	1076.8	1076.8	1.00	654.7	1121.2	1121.2	1.00	0.0	0.0	1.00	0.0	0.0	153.4
5+00.00	1.00	570.4	1061.4	1061.4	1.00	630.1	1189.6	1189.6	1.00	0.0	0.0	1.00	0.0	0.0	25.2
5+11.88															0.0
5+50.00	1.00	552.5	1039.8	1039.8	1.00	607.5	1146.0	1146.0	1.00	0.0	0.0	1.00	0.0	0.0	-81.0
6+00.00	1.00	553.2	1023.8	1023.8	1.00	599.6	1117.7	1117.7	1.00	0.0	0.0	1.00	0.0	0.0	-174.9
6+50.00	1.00	547.0	1018.7	1018.7	1.00	621.8	1130.9	1130.9	1.00	0.0	0.0	1.00	0.0	0.0	-287.2
7+00.00	1.00	548.7	1014.5	1014.5	1.00	577.7	1110.7	1110.7	1.00	0.0	0.0	1.00	0.0	0.0	-383.3
7+50.00	1.00	526.4	995.5	995.5	1.00	626.4	1114.9	1114.9	1.00	0.0	0.0	1.00	0.0	0.0	-502.7
8+00.00	1.00	487.0	938.4	938.4	1.00	639.1	1171.8	1171.8	1.00	0.0	0.0	1.00	0.0	0.0	-736.2
8+50.00	1.00	444.6	862.6	862.6	1.00	571.6	1121.0	1121.0	1.00	0.0	0.0	1.00	0.0	0.0	-994.6
9+00.00	1.00	468.1	845.1	845.1	1.00	519.4	1010.2	1010.2	1.00	0.0	0.0	1.00	0.0	0.0	-1159.6
9+50.00	1.00	481.7	879.5	879.5	1.00	545.1	985.7	985.7	1.00	0.0	0.0	1.00	0.0	0.0	-1265.8
10+00.00	1.00	575.8	979.2	979.2	1.00	0.0	504.8	504.8	1.00	0.0	0.0	1.00	0.0	0.0	-791.4
10+37.83															0.0
10+50.00	1.00	553.8	1045.9	1045.9	1.00	0.0	0.1	0.1	1.00	0.0	0.0	1.00	0.0	0.0	254.5
11+00.00	1.00	444.0	923.9	923.9	1.00	5.2	4.8	4.8	1.00	0.0	0.0	1.00	0.0	0.0	1173.6
11+50.00	1.00	433.1	812.1	812.1	1.00	14.7	18.3	18.3	1.00	0.0	0.0	1.00	0.0	0.0	1967.3
12+00.00	1.00	435.8	804.5	804.5	1.00	15.8	28.2	28.2	1.00	0.0	0.0	1.00	0.0	0.0	2743.7
12+50.00	1.00	447.7	818.0	818.0	1.00	660.7	626.4	626.4	1.00	0.0	0.0	1.00	0.0	0.0	2935.3
13+00.00	1.00	459.8	840.3	840.3	1.00	609.0	1175.7	1175.7	1.00	0.0	0.0	1.00	0.0	0.0	2599.9
13+50.00	1.00	459.2	851.0	851.0	1.00	734.0	1243.6	1243.6	1.00	0.0	0.0	1.00	0.0	0.0	2207.3
14+00.00	1.00	469.4	859.8	859.8	1.00	788.7	1409.9	1409.9	1.00	0.0	0.0	1.00	0.0	0.0	1657.2
14+50.00	1.00	485.0	883.7	883.7	1.00	699.7	1378.1	1378.1	1.00	0.0	0.0	1.00	0.0	0.0	1162.9
15+00.00	1.00	587.4	993.0	993.0	1.00	627.7	1229.1	1229.1	1.00	0.0	0.0	1.00	0.0	0.0	926.8
15+50.00	1.00	654.6	1150.0	1150.0	1.00	605.2	1141.6	1141.6	1.00	0.0	0.0	1.00	0.0	0.0	935.2
16+00.00	1.00	703.3	1257.3	1257.3	1.00	635.7	1149.0	1149.0	1.00	0.0	0.0	1.00	0.0	0.0	1043.6
16+50.00	1.00	648.0	1251.1	1251.1	1.00	522.0	1071.9	1071.9	1.00	0.0	0.0	1.00	0.0	0.0	1222.8
17+00.00	1.00	761.4	1305.0	1305.0	1.00	599.9	1038.8	1038.8	1.00	0.0	0.0	1.00	0.0	0.0	1489.0
17+50.00	1.00	806.2	1451.5	1451.5	1.00	565.6	1079.2	1079.2	1.00	0.0	0.0	1.00	0.0	0.0	1861.3
18+00.00	1.00	851.6	1535.0	1535.0	1.00	552.5	1035.2	1035.2	1.00	0.0	0.0	1.00	0.0	0.0	2361.0
18+50.00	1.00	855.7	1580.8	1580.8	1.00	567.8	1037.3	1037.3	1.00	0.0	0.0	1.00	0.0	0.0	2904.5
19+00.00	1.00	793.5	1527.0	1527.0	1.00	614.3	1094.5	1094.5	1.00	0.0	0.0	1.00	0.0	0.0	3337.1
19+50.00	1.00	697.5	1380.6	1380.6	1.00	615.0	1138.2	1138.2	1.00	0.0	0.0	1.00	0.0	0.0	3579.5
20+00.00	1.00	675.9	1271.7	1271.7	1.00	654.2	1175.2	1175.2	1.00	0.0	0.0	1.00	0.0	0.0	3676.0

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End Area Volume Report — Page 2 of 2

Baseline Station	Station Quantities: Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities: Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
20+50.00	1.00	679.2	1246.4	1246.4	1.00	679.0	1234.5	1234.5	1.00	0.0	0.0	1.00	0.0	0.0	3687.9
21+00.00	1.00	667.2	1236.4	1236.4	1.00	684.0	1262.1	1262.1	1.00	0.0	0.0	1.00	0.0	0.0	[illegible]
21+50.00	1.00	679.1	1240.6	1240.6	1.00	623.6	1210.9	1210.9	1.00	0.0	0.0	1.00	0.0	0.0	[illegible]
22+00.00	1.00	681.6	1259.9	1259.9	1.00	661.7	1195.9	1195.9	1.00	0.0	0.0	1.00	0.0	0.0	[illegible]
22+50.00	1.00	621.7	1291.0	1291.0	1.00	654.5	1224.5	1224.5	1.00	0.0	0.0	1.00	0.0	0.0	[illegible]
23+00.00	1.00	641.7	1540.2	1540.2	1.00	[illegible]	1173.7	1173.7	1.00	0.0	0.0	1.00	0.0	0.0	[illegible]
23+50.00	1.00	799.4	1519.6	1519.6	1.00	598.8	1121.9	1121.9	1.00	0.0	0.0	1.00	0.0	0.0	[illegible]
24+00.00	1.00	752.9	1437.3	1437.3	1.00	576.3	1068.0	1068.0	1.00	0.0	0.0	1.00	0.0	0.0	5044.3
24+01.96	1.00	753.1	55.1	55.1	1.00	572.3	42.0	42.0	1.00	0.0	0.0	1.00	0.0	0.0	[illegible]
Grand Total:			54211.0	54211.0			49153.0	49153.0		0.0	0.0		0.0	0.0	

T175

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End Area Volume Report — Page 1 of 1

End Area Volume Report

Report Created: 6/20/2012
Time: 12:08pm

524
1 4 542.0 30' 4 1

Cross Section Set Name: Extended Dredge Cut_1
Alignment Name: Extended Dredge Cut
Input Grid Factor: 1.000000 Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise

Baseline Station	Station Quantities: Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities: Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
0+00.00	1.00	92.1	0.0	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	0.0
0+50.00	1.00	63.2	143.8	143.8	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	143.8
1+00.00	1.00	59.4	113.5	113.5	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	257.4
1+50.00	1.00	61.3	111.8	111.8	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	369.1
2+00.00	1.00	95.8	145.4	145.4	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	514.6
2+50.00	1.00	155.7	232.8	232.8	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	747.4
3+00.00	1.00	132.6	267.0	267.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	1014.4
3+50.00	1.00	117.7	231.8	231.8	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	1246.2
4+00.00	1.00	114.8	215.3	215.3	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	1461.5
4+50.00	1.00	118.8	216.3	216.3	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	1677.8
5+00.00	1.00	112.8	214.4	214.4	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	1892.2
5+50.00	1.00	115.5	211.4	211.4	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	2103.6
6+00.00	1.00	108.6	207.4	207.4	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	2311.1
6+50.00	1.00	94.7	188.2	188.2	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	2499.3
7+00.00	1.00	91.0	171.9	171.9	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	2671.2
7+50.00	1.00	93.9	171.2	171.2	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	2842.4
8+00.00	1.00	86.7	167.3	167.3	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3009.7
8+50.00	1.00	86.2	160.2	160.2	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3169.8
9+00.00	1.00	79.6	153.7	153.7	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3323.5
9+50.00	1.00	62.3	131.6	131.6	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3455.1
10+00.00	1.00	59.4	112.7	112.7	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3567.8
10+50.00	1.00	43.4	95.2	95.2	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3663.0
11+00.00	1.00	40.6	77.8	77.8	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3740.8
11+50.00	1.00	28.9	64.4	64.4	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3805.2
12+00.00	1.00	23.0	48.1	48.1	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3853.3
12+50.00	1.00	18.2	38.2	38.2	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3891.5
13+00.00	1.00	24.9	39.9	39.9	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3931.4
13+50.00	1.00	32.0	52.7	52.7	1.00	0.0	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	3984.1
14+00.00	1.00	4.6	34.0	34.0	1.00	9.1	8.4	8.4	1.00	0.0	0.0	1.00	0.0	0.0	4009.6
14+50.00	1.00	0.0	4.3	4.3	1.00	16.2	23.4	23.4	1.00	0.0	0.0	1.00	0.0	0.0	3990.4
15+00.00	1.00	0.0	0.0	0.0	1.00	57.3	68.1	68.1	1.00	0.0	0.0	1.00	0.0	0.0	3922.4
15+47.59	1.00	0.0	0.0	0.0	1.00	81.5	122.4	122.4	1.00	0.0	0.0	1.00	0.0	0.0	3800.0
Grand Total:			4022.3	4022.3			222.3	222.3		0.0	0.0		0.0	0.0	

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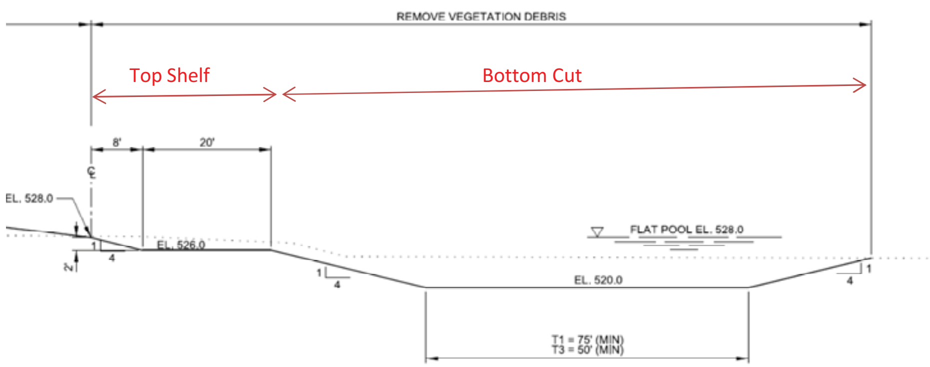
APPENDIX M

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Hand Calculation

DREDGE CUT



Worst Case assume that the existing ground where the dredge cut goes is at elevation	527.00	**assume this as worst case since most of this area is still water when at flat pool.**	
Distance to Top Shelf = DT	**1.00**	**FT**	
1. Cross Sectional Area to cut toTop Shelf	**20.00**	**SF**	=DT*Width of top shelf
			=1/2 (DT+1)*(DT+1)*4 selected since some of these areas may be at 528 n
2. Cross sectional Area from 528 to Top Shelf	**8.00**	**SF**	
Distance to Bottom Cut=DB	**7.00**	**FT**	
3. Cross Sectional Area of Bottom Cut	**525.00**	**SF**	=DB*width of cut
4. Slope to Bottom Cut	**98.00**	**Sf**	=1/2 (DB)*(DB)*4
5. Other Slope to Bottom Cut	**98.00**	**SF**	=1/2 (DB)*(DB)*4
Total Cross Sectional Area Per Linear Foot	**749.00**	**SF**	1+2+3+4+5
Volume to Dredge	**1,799,098.00**	**CF**	total cross sectional area * length of dredge cut
	66,633.26	**CY**	CF/27

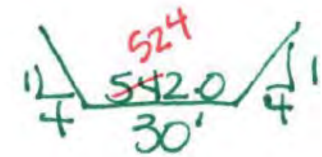
Hand Calculation is higher than inroads value of ***54,211.00*** ***which is expected since much of the area being dredged is deeper than*** ***527.00***

APPENDIX M

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

ACCESS DREDGE CHECK



	Bottom Elevation	**524.00**		
	Bottom Width required	**30.00**	**FT**	
AL	Access Length Required	**1,450.00**	**FT**	
	Distance to Bottom Cut=DB	**3.00**	**FT**	
6	6. Cross Sectional Area of Bottom Cut	**90.00**	**SF**	=DB*width of cut
7	7. Slope to Bottom Cut	**18.00**	**Sf**	=1/2 (DB)*(DB)*4
8	8. Other Slope to Bottom Cut	**18.00**	**SF**	=1/2 (DB)*(DB)*4
	Total Cross Sectional Area Per Linear Foot	**126.00**	**SF**	6+7+8
	Volume to Dredge	**182,700.00**	**CF**	total cross sectional area *AL
		6,766.67	**CY**	CF/27

Hand Calculation is higher than inroads value of ***4,022.30*** ***which is expected since much of the area being dredged is deeper than*** ***527.00***

However, close matches and decent survey indicates we should choose the INROADS QUANTITY

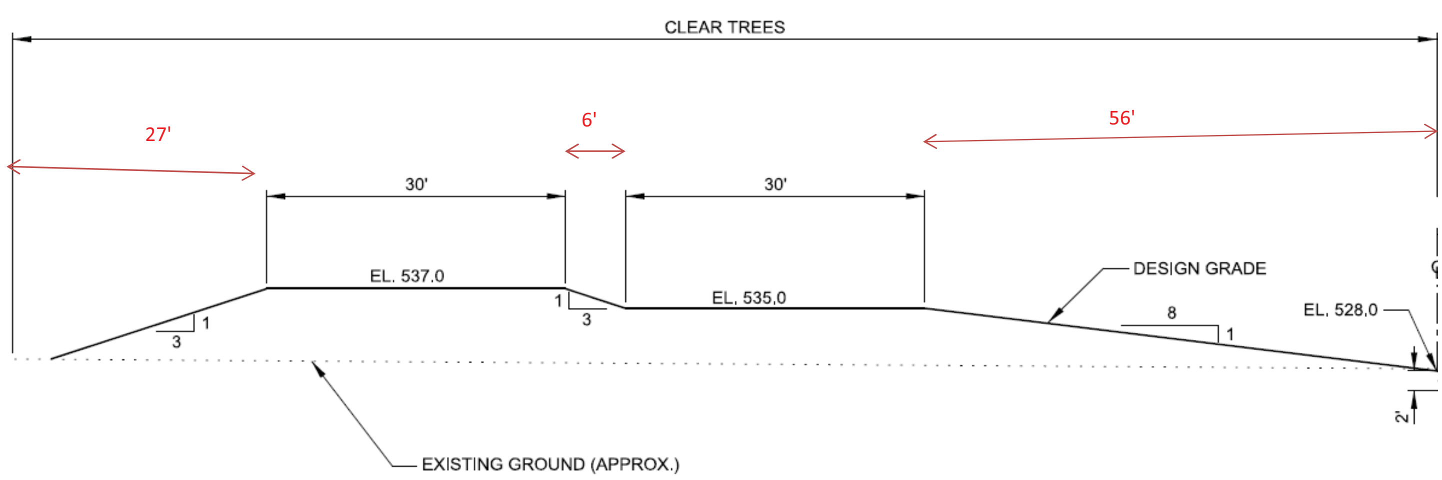
APPENDIX M

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

CLEARING

Hand Calculationis



27.0	6.0	56.0	Slope Distances in FEET (add to shelves)

Note that the placement site development is covered in Measure F1. However, the clearing required uses some information from the final design, as is shown here.

Total Placement Length	2,165.0	FT	based on Upper and Lower Placement sites
Width	149.0	FT	
Additional Width for Equipment	20.0	FT	
Area of Impact	365,885.0	SF	
	8.4	AC	
Continengency	20%		

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

		10.1	AC	
	Clearing Required	**10.1**	**AC**	
	ACCESS DREDGE PLACEMENT SITE			

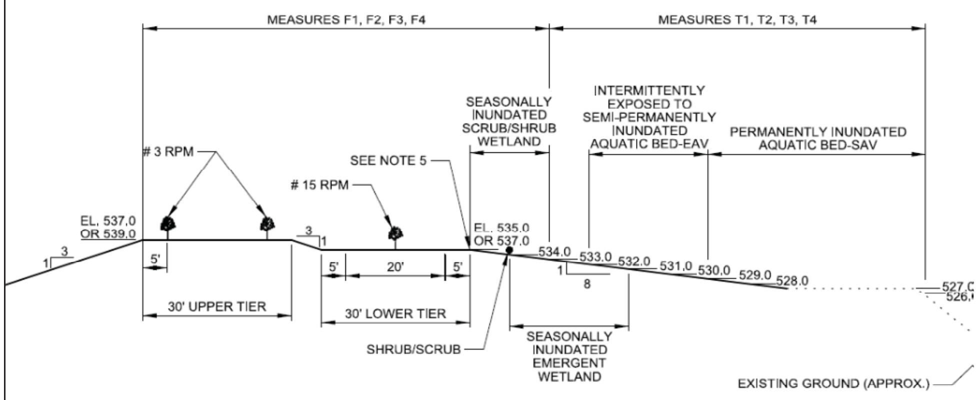
APTW	Top Width	5.0	Feet	
APS	Side Slopes	3.0	H:1V	
	Top Elevation	535.0		
	AVERAGE ExISTING GROUND	525.0	(this varies, some spots are lower, some higher)	
APH	Max Height	10.0	FT	
	Center Area	**7,250.0**	SF	**APTW*AL**
	Side Slope	**43,500.0**	SF	**APS*APH*AL**
		43,500.0	SF	**APS*APH*AL**
	Area of Impact	94,250.0	SF	
		2.2	AC	
	Continengency	20%		
		2.6	AC	
	Clearing Required	**2.6**	**AC**	
	TOTAL CLEARING REQUIRED	**12.7**	**AC**	

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Plantings

Hand Calculationis

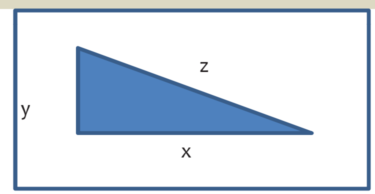


Seasonally Inundated Emergent Wetland - EAV EL. 531-534

SIEW TOP Elevation	534.0	
SIEW Bottom Elevation	531.0	
Elevation Change	3.0	FT
Slope	8.0	H:1V
	24.0	FT
Slope Distance	24.2	FT
AREA	52,364.4	SF
	1.2	AC
Contingency	20%	
	1.4	AC
Acres to Plant	**1.5**	AC

Y

X



Z = square root (X squared plus Y squared)

A = Z*Length of Lower Pool Placement +L Upper Pool Placement site

APPLY VALUE TO PLANTING SHEET

APPENDIX M

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed - EAV(EL. 529 - 532)

IE to SPIAB TOP Elevation	532.0			
IE to SPIAB Bottom Elevation	529.0			
Elevation Change	3.0	FT	Y	
Slope	8.0	H:1V		
	24.0	FT	X	
Slope Distance	24.2	FT	Z = square root (X squared plus Y squared)	
AREA	52,364.4	SF	A = Z*Length of Lower Pool Placement +L Upper Pool Placement site	
	1.2	AC		
Continency	20%			
	1.4	AC		
Acres to Plant	**1.5**	AC	APPLY VALUE TO PLANTING SHEET	

Permanently Inundated Aquatic Bed - SAV(EL. 526-529; lower dredge shelf)

PIAB TOP Elevation	529.0			
PIAB Bottom Elevation first slope change	528.0			
Elevation Change	1.0	FT	Y	
Slope	8.0	H:1V		
	8.0		X	
Slope Distance	**8.1**	FT	Z1	Z = square root (X squared plus Y squared)
First Slope Change	528.0			
Second slope change	526.0			
Elevation Change	2.0	FT	Y	
Slope	8.0	H:1V		
	16.0		X	
Slope Distance	**16.1**	FT	Z2	Z = square root (X squared plus Y squared)
SHELF Width at 526	**20.0**	FT	Z3	z = shelf width

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Total Length	**44.2**	FT	Z = Z1+Z2+Z3
AREA	95,664.4	SF	A = Z*Length of Lower Pool Placement +L Upper Pool Placement site
	2.2	AC	
Continency	20%		
	2.6	AC	
Acres to Plant	**2.6**	AC	APPLY VALUE TO PLANTING SHEET

REFER TO SHEET CALLED T PLANTINGS TO SEE HOW THESE ACREAGES ARE CHANGED TO NUMBERS OF PLANTS

PIAB = ***Permanently Inundated Aquatic Bed - SAV***
IE to SPIAB = ***Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed - EAV***
SIEW = ***Seasonally Inundated Emergent Wetland***

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Conclusions

ITEM NO.	DESCRIPTION	QTY	UNIT	[redacted]		
T1	Topographic Diversity - Dredging	69,900	CY			
T1	Topographic Diversity - Clearing	13	AC			
T1	Seed Mix of seasonally inundated emergent wetland species (planted at 10 pounds per acre)	2	AC			
T1	Plant Exclosure	3	EA			
T1	Aquatic container Plants (ERDC)	1	EA			
T1	IE to SPIAB - Waterwillow -Tuber	544	EA			
T1	IE to SPIAB - Arrowhead - Tuber	544	EA			
T1	IE to SPIAB - Pickerelweed - Tuber	544	EA			
T1	IE to SPIAB - Smartweed - Tuber	544	EA			
T1	PIAB - Illinois Pondweed - Tuber	792	EA			
T1	PIAB - Sago Pondweed - Tuber	792	EA			
T1	PIAB - American Wild Celery -Tuber	792	EA			
T1	PIAB - Coontail - Tuber	792	EA			
T1	PIAB - American Elodea - Tuber	792	EA			
T1	SIEW - Sedges -Tuber	544	EA			
T1	SIEW - Bulrush -Tuber	544	EA			
T1	SIEW - Blueflag Iris -Tuber	544	EA			
T1	SIEW - Sweet Flag -Tuber	544	EA			

Measure T1: Topographic Diversity and Overwintering, Goose Lake Pool 1 Topographic Diversity (537 Top)

9/27/12 12:03 PM

Computation Checks	
Review Stage	DPR DQCR
Check Comments	Make sure to add inroads information and any data files; Add access dredging information to assumptions (where did the slope and length come from, no drawing); Hand Calculation: the dredge cut drawing does not show shallow cut and deep cut. The hand check for dredging talks about top shelf and bottom shelf show on drawing. I believe those refer to shallow cut and deep cut. ;The C column has two different shaded cells explain what they mean.; Check the side slope calculations in the Access dredge placement site; The acres for planting were estimated to the tenths however in the T plantings they where to one hundredths place, not sure why they are different. Reviewed by Julie Millhollin, EC-DN, August 27, 2012
Resolution of Comments	Inroads information was added. Added access dredging assumptions, and sketches. Added shallow cut and deep cut to the drawing. Removed shading (Had helped me propogate copied sheets earlier). Values were copied from sheet to sheet and differences were based on cell formating. Final numbers should translate appropriate, are just not visually shown. KNM 9/4/2012
Checked By:	MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 15:00:09 -05'00'
Submitted By:	MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:48:27 -05'00'

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

9/27/12 12:03 PM

Objective

Floodplain Forest Diversity Adjacent to Pool 1 (537 Top). This measure includes shaping the dredged material into tiers and side slopes to accomadate planting, as well as tree and scrub shrub plantings

References

Publications

Title	Source	Publication Date	Link
Huron Island HREP DPR		DRAFT	
Planting design was based on Nate Richards, CEMVP-PD-P, Project Biologist and Jon Schulz, OD-MN, Project Forestor			##################
Upper Mississippi River Environmental Management Program Environmental Design Handbook		August-06	http://www.mvr.usace.army.mil/EMP/designhandbook.htm
U.S. Army Corps of Engineers, *EM 1110-2-5025, Dredging and*		March-83	
U.S. Army Corps of Engineers, Dredging Operations Technical			http://el.erdc.usace.ar
Project Boring Data	Draft Geotech Data		
Upper Mississippi River Environmental Management Program Environmental Design Handbook	Floodplain Restoration Chapter and Applicable References	2012 DRAFT	
INROADS Prints are located here:			INROADS PRINTS

Survey Datums and Conversions

7. HORIZONTAL DATUM IS STATE PLANE COORDINATE SYSTEM, IL WEST, NAD 83, US SURVEY FOOT, VERTICAL DATUM IS MSL 1912.
8. ORTHO PHOTOGRAPHY FROM MARCH 2005
9. FLAT POOL IS AT EL. 528.0.

Horizontal Datum	**State Plane**
	IL West
	NAD 83
	US Survey Foot
Vertical Datum	MSL 1912

Software

Name	Version	Notes
Microstation	**V8i (select Series 2)**	

Data Files

Cross Section Name	Alignment Name	ProjectWise URN	Notes
Combined Pool 1_3	**Combined Pool 1**	**Above: Huron T1 75 Ft 537 top 03082012.pdf**	

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

9/27/12 12:03 PM

Assumptions				
	Item	**Number**	**Units**	Notes
Placement Site (Upper Pool)				
	Upper Pool Placement Site	1163	feet	Length encompasses most of the Pool (INROADS)
	Slope from 526 to 528	4H:1V		stability under water per Felix Castro, CEMVR-EC-G
	Slope from 528 to 535	8H:1V		for better EAV habitat per Nate Richards, CEMVR-PD-P
	Slope from 535 to 537	3H:1V		per Felix Castro, CEMVR-EC-G
	Slope from 537 to existing ground	3H:1V		per Felix Castro, CEMVR-EC-G
	Lower Shelf Width	30	feet	Minimum width for
	Lower Shelf Elevation	535	ft MSL	To meet forest index requirements. Per PDT requirements.
	Upper Shelf Width	30	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Upper Shelf Elevation	537	ft MSL	To meet forest index requirements. Per PDT requirements.
	Side Slopes	4H:1V	per Felix Castro, EC-G	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
Placement Site (Lower Pool)				
	Lower Pool Placement Site	1002	feet	Length encompasses most of the Pool (INROADS)
	Slope from 526 to 528	4H:1V		stability under water per Felix Castro, CEMVR-EC-G
	Slope from 528 to 535	8H:1V		for better EAV habitat per Nate Richards, CEMVR-PD-P
	Slope from 535 to 537	3H:1V		per Felix Castro, CEMVR-EC-G
	Slope from 537 to existing ground	3H:1V		per Felix Castro, CEMVR-EC-G
	Lower Shelf Width	30	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Lower Shelf Elevation	535	ft MSL	To meet forest index requirements. Per PDT requirements.
	Upper Shelf Width	30	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Upper Shelf Elevation	537	ft MSL	To meet forest index requirements. Per PDT requirements.

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

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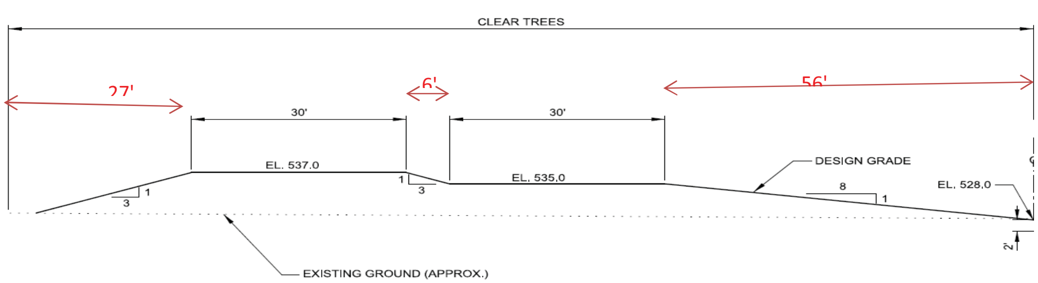
Analysis and Design

Dredge Material Available for Placement Site

INROADS



Placement Site Design

INROADS Quantity For Pool 1 Cut (3/8/2012)	54,211.00	CY
Access cut (not used)	0.00	CY
UNKNOWN FOR SURVEY/Realignment	20%	
	65,053.20	CY
	65,100.00	**CY**
Quantity Required to meet the placement site design		
INROADS Ran on 3/8/2012	49,153.00	CY
TOTAL QUANTITY	49,153.00	
UNKNOWN FOR SURVEY, settling	20%	
	58,983.60	CY
	59,000	**CY**

Refer to sheet T1 for copy of INROADS file.

While there are quantities for this (see measure T1) this material will be sidecast and will not be transported to site to construct berms. (Refer to sheet T1)

Assume some settlement prior to placement (est. up to one foot by EC-G).

Excess material can be used to create flatter back slope or larger tiers. Final design in P&S.

based on this, sufficient material available to build berms

Contractor to shaped dredged material to the slopes and shelves shown in the design.

Contractor will allow the material to be dredged and placed. After the material has settled for a short period of time (TBD by EC-G), material will be shaped to the slopes and dimenstions shown

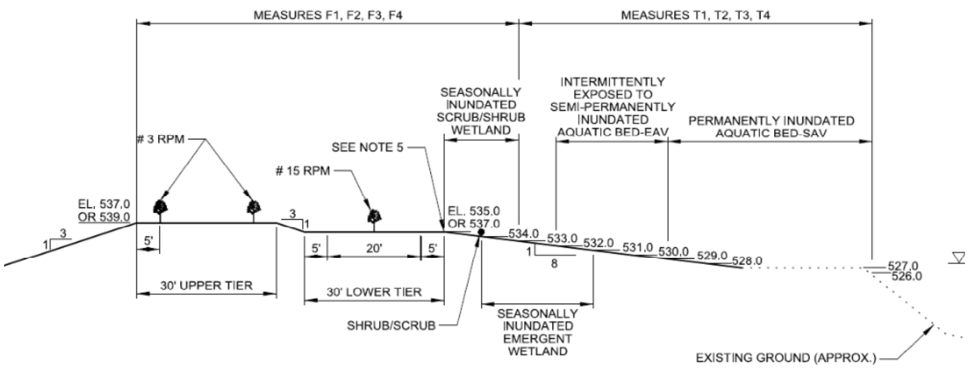
APPENDIX M

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

9/27/12 12:03 PM

Planting

Seasonally Inundated Scrub/Shrub Wetland (SISSW) - EAV
EL. 533-535



SISSW TOP Elevation	535.0		
SISSW Bottom Elevation	533.0		
Elevation Change	2.0	FT	Y
Slope	8.0	H:1V	
	16.0	FT	X
Slope Distance	16.1	FT	Z = square root (X squared plus Y squared)
AREA	34,909.6	SF	A = Z*Length of Lower Pool Placement +L Upper Pool Placement site
	0.8	AC	
Continency	20%		
	1.0	AC	
Acres to Plant	**1.0**	AC	APPLY VALUE TO F PLANTING SHEET

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

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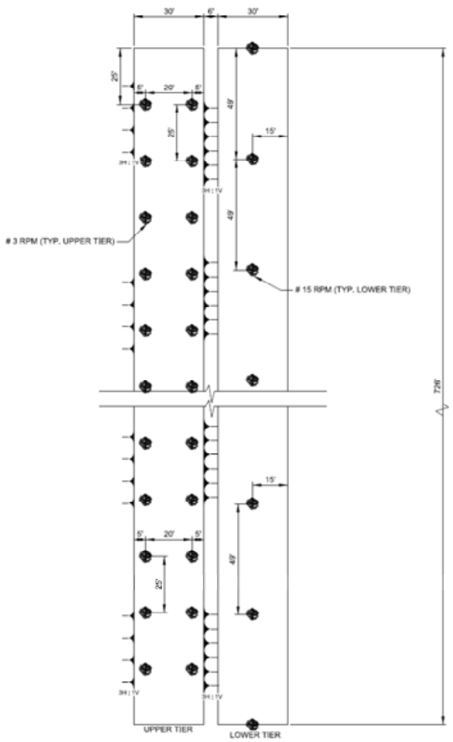
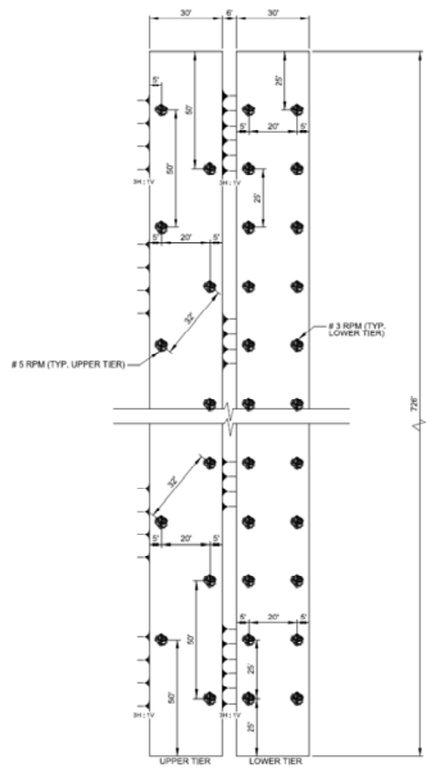
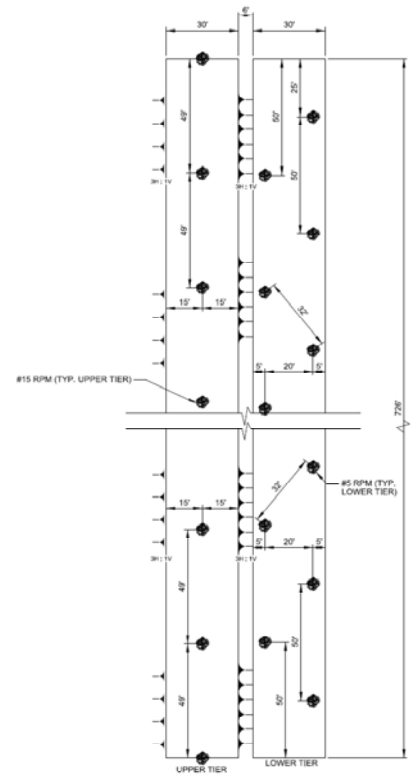
Trees



DWG REF(s) :
A1 TREE PLANTING PLANS - PLOT 1 (MEASURES F1, F2, F3, AND F4



DWG REF(s) :
A3 TREE PLANTING PLANS - PLOT 2 (MEASURES F1, F2, F3, AND F4)



; F1, F2, F3 AND F4) - PLOT 3

Number of Trees per plot is shown on sheet called "Tree Layout"

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

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Temporarily Inundated Forested Wetland Trees

This shows just one tier. There is an associated tier of the same size next to it which will carry the sister plot.

Tier Width	30.0	FT		
Tier Area	64,950.0	SF		
	1.5	AC		
Tier Combinations are for 1/2 acre plots, so can plant	3.0	PLOTS		
	#3 RPM	#5 RPM	# 15 RPM	
PLOT 1	4.0	0.0	1.0	trees per species
PLOT 2	4.0	2.0	0.0	trees per species
PLOT 3	0.0	2.0	1.0	trees per species
TOTAL TREES SIZES PER SPECIES	**8.0**	**4.0**	**2.0**	**Trees per species**
Total Trees	**14.0**			

Termporarily Inundated Forested Wetland Shrubs (TIFWS)

Top Tier Width	30.0	FT
Lower Tier Width	30.0	FT
Total Tier Width	60.0	FT
Tier Area	129,900.0	SF
	3.0	**AC**
HERBICIDE TREATMENT and PLANTINGS APPLIED TO THESE ACREAG	**3.0**	**AC**

REFER TO SHEET CALLED F PLANTINGS TO SEE HOW THESE ACREAGES ARE CHANGED TO NUMBERS OF PLANTS

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

9/27/12 12:03 PM

Conclusions						
ITEM NO.	DESCRIPTION	QTY	UNIT	[redacted]		
F1	Shape Dredge Cut to desired slopes and elevations	1	LS			
F1	SISSW - Hibiscus - #3 RPM	10	EA			
F1	SISSW - Commone Elderberry - #3 RPM	10	EA			
F1	SISSW - Buttonbush - #3 RPM	10	EA			
F1	SISSW - Dogwood - #3 RPM	10	EA			
F1	SISSW - Sandbar Willow -#3 RPM	10	EA			
F1	Pounds per acre seed SISSW Seed Mix	1	AC			
F1	River Birch #3 RPM	8	EA			
F1	Bitternut Hickory #3 RPM	8	EA			
F1	Northern Pecan #3 RPM	8	EA			
F1	Shellbark Hickory #3 RPM	8	EA			
F1	Common Hackberry #3 RPM	8	EA			
F1	Common Persimmon #3 RPM	8	EA			
F1	Honey Locust #3 RPM	8	EA			
F1	Kentucky Coffeetree #3 RPM	8	EA			
F1	Black Walnut #3 RPM	8	EA			
F1	American Sycamore #3 RPM	8	EA			
F1	Swamp White Oak #3 RPM	8	EA			
F1	Bur Oak #3 RPM	8	EA			
F1	Pin Oak #3 RPM	8	EA			
F1	American Basswood #3 RPM	8	EA			
F1	Overcup Oak #3 RPM	8	EA			
F1	River Birch #5 RPM	4	EA			
F1	Bitternut Hickory #5 RPM	4	EA			
F1	Northern Pecan #5 RPM	4	EA			
F1	Shellbark Hickory #5 RPM	4	EA			
F1	Common Hackberry #5 RPM	4	EA			
F1	Common Persimmon #5 RPM	4	EA			
F1	Honey Locust #5 RPM	4	EA			
F1	Kentucky Coffeetree #5 RPM	4	EA			
F1	Black Walnut #5 RPM	4	EA			
F1	American Sycamore #5 RPM	4	EA			
F1	Swamp White Oak #5 RPM	4	EA			
F1	Bur Oak #5 RPM	4	EA			
F1	Pin Oak #5 RPM	4	EA			
F1	American Basswood #5 RPM	4	EA			
F1	Overcup Oak #5 RPM	4	EA			

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

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F1	River Birch #15 RPM	2	EA	[redacted]			
F1	Bitternut Hickory #15 RPM	2	EA				
F1	Northern Pecan #15 RPM	2	EA				
F1	Shellbark Hickory #15 RPM	2	EA				
F1	Common Hackberry #15 RPM	2	EA				
F1	Common Persimmon #15 RPM	2	EA				
F1	Honey Locust #15 RPM	2	EA				
F1	Kentucky Coffeetree #15 RPM	2	EA				
F1	Black Walnut #15 RPM	2	EA				
F1	American Sycamore #15 RPM	2	EA				
F1	Swamp White Oak #15 RPM	2	EA				
F1	Bur Oak #15 RPM	2	EA				
F1	Pin Oak #15 RPM	2	EA				
F1	American Basswood #15 RPM	2	EA				
F1	Overcup Oak #15 RPM	2	EA				
F1	Tree Wrap - Each	210	EA				
F1	Tree Exclsoure - Each	210	EA				
F1	Herbicide Treatment - ACRES	3	EA				
F1	TIFWS Common Buttonbush - #3 RPM Shrub	30	EA				
F1	TIFWS Easterm Redbud - #3 RPM Shrub	30	EA				
F1	TIFWS Red - Osier Dogwood - #3 RPM Shrub	30	EA				
F1	TIFWS Green Hawthorn - #3 RPM Shrub	30	EA				
F1	TIFWS Elderberry - #3 RPM Shrub	30	EA				
F1	Understory seed mixture at 10 pounds per acre	3	AC				

APPENDIX M

Measure F1 : Floodplain Forest Diversity, Forest Diversity adjacent to Goose Lake Pool 1 (537 Top)

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Computation Checks	
Review Stage	DPR DQCR
Check Comments	Make sure to add inroads information and any data files; No shaping calculation was shown; Add tree assumptions (not sure where the # of trees per species came from under temporarily inundated forested wetland trees); Check the qty for tree wrap and tree exclosure. Reviewed by Julie Millhollin, EC-DN, August 27, 2012
Resolution of Comments	Inroads information and data files were added. Some description and drawings for shaping were included. # tree species calculations added as a new sheet, and drawing added. Quantity for tree wrap and tree exclosures were calculated and checked out. KNM 9/5/2012
Checked By:	MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 14:47:08 -05'00'
Submitted By:	MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:45:13 -05'00'

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

9/27/12 12:08 PM

Objective

Goose Lake Pool 2 Topo Diversity (537 Top) with 50 foot dredge cut. Calculate quantity for dredge cut and placement site clearing. Wetland Plantings are also included

References

Publications

	Title	Source	Publication Date	Link
	Huron Island HREP DPR		DRAFT	
	Planting design was based on Nate Richards, CEMVP-PD-P, Project Biologist and Jon Schulz, OD-MN, Project Forestor			#################
	Upper Mississippi River Environmental Management Program		August-06	http://www.mvr.usace.army.mil/EMP/designhandbook.htm
	U.S. Army Corps of Engineers, *EM 1110-2-5025, Dredging*		March-83	
	U.S. Army Corps of Engineers, Dredging Operations Technical			http://el.erdc.usace.a
	Project Boring Data	Draft Geotech Data		
	INROADS Prints are located here:			INROADS PRINTS

Survey Datums and Conversions

7. HORIZONTAL DATUM IS STATE PLANE COORDINATE SYSTEM, IL WEST, NAD 83, US SURVEY FOOT, VERTICAL DATUM IS MSL 1912.
8. ORTHO PHOTOGRAPHY FROM MARCH 2005
9. FLAT POOL IS AT EL. 528.0.

Horizontal Datum	**State Plane**
	IL West
	NAD 83
	US Survey Foot
Vertical Datum	MSL 1912

Software

	Name	Version	Notes
	Microstation	**V8i (select Series 2)**	

Data Files

	Cross Section Name	Alignment Name	ProjectWise URN	Notes
	Selected Plan T3	**Selected Plan T3**	**Huron T3 50 ft 537 top 06232012.pdf**	**Revised after selected plan to add placement site entire length**

Assumptions

	Item	Number	Units	Notes
Deep Dredge Cut				
	Length of Dredge Cut (Pool 2)	2642	feet	Length encompasses most of the Pool (INROADS 6/23/12) and attaches to Pool 1 cut
	Width of Dredge Cut	50	feet	Width to ensure sufficient material for forest features
	Depth of Dredge Cut	520	ft MSL	Depth to address future sedimentation and to ensure deep fish habitat
	Side Slopes	4	H:1V	per Felix Castro, EC-G
Shallow Dredge Cut				

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

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	Length of Dredge Cut (Pool 2)	2642	feet	Length encompasses most of the Pool (INROADS 6/23/12) and attaches to Pool 1 cut
	Width of Dredge Cut	20	feet	Width selected for aquatic habitat
	Depth of Dredge Cut	526	ft MSL	Depth to allow for shallow fish habitat and SAV/EAV
	Side Slopes	4	H:1V	per Felix Castro, CEMVR-EC-G
	Placement Site			
	Placement Site	2642	feet	Revised in June 2012 to add side placement along entire stretch of dredge cut (INROADS 6/23/12)
	Slope from 526 to 528	4	H:1V	per Felix Castro, CEMVR-EC-G
	Lower Shelf Width	30	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Lower Shelf Elevation	535	ft MSL	To meet forest index requirements. Per PDT requirements.
	Upper Shelf Width	30	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Upper Shelf Elevation	537	ft MSL	To meet forest index requirements. Per PDT requirements.
	Constants			
	Area Conversion	43,560	SF/AC	
	Analysis and Design			
	Dredge Cut			
	INROADS			
	INROADS Quantity For Pool 1 Cut (6/23/2012)	62,477.10	CY	
	ACCESS DREDGE QUANTITY (4/3/2012)	0.00	CY	Pool 2 will only be dredged if Pool 1 is also dredged, so the access dredging is already accounted for in Measure T1
	UNKNOWN FOR SURVEY/Realignment	20%		
		74,972.52	CY	
		75,000.00	**CY**	

APPENDIX M

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

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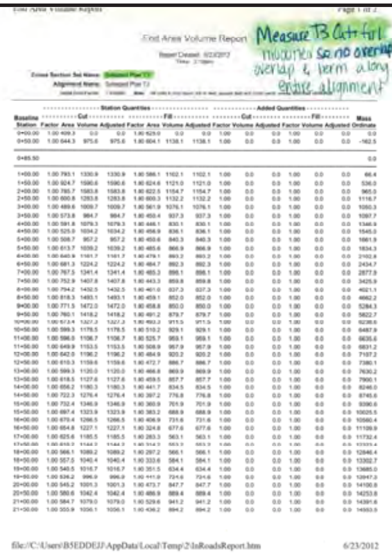
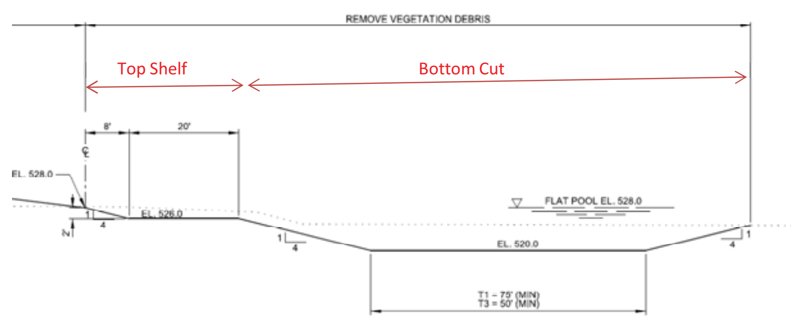


Baseline Station	Station Quantities – Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities – Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
22+00.00	1.00	538.1	1013.0	1013.0	1.00	465.5	834.9	834.9	1.00	0.0	0.0	1.00	0.0	0.0	14731.6
22+50.00	1.00	578.9	1034.3	1034.3	1.00	453.9	851.4	851.4	1.00	0.0	0.0	1.00	0.0	0.0	14914.5
23+00.00	1.00	603.3	1094.6	1094.6	1.00	425.2	814.0	814.0	1.00	0.0	0.0	1.00	0.0	0.0	15195.1
23+50.00	1.00	567.2	1083.7	1083.7	1.00	393.0	757.6	757.6	1.00	0.0	0.0	1.00	0.0	0.0	15521.2
24+00.00	1.00	604.7	1085.0	1085.0	1.00	422.3	755.0	755.0	1.00	0.0	0.0	1.00	0.0	0.0	15851.3
24+50.00	1.00	533.7	1054.0	1054.0	1.00	477.6	833.3	833.3	1.00	0.0	0.0	1.00	0.0	0.0	16072.0
25+00.00	1.00	631.9	1079.3	1079.3	1.00	462.6	870.6	870.6	1.00	0.0	0.0	1.00	0.0	0.0	16280.7
25+50.00	1.00	659.6	1195.9	1195.9	1.00	491.7	883.7	883.7	1.00	0.0	0.0	1.00	0.0	0.0	16592.9
26+00.00	1.00	711.7	1269.7	1269.7	1.00	535.5	951.2	951.2	1.00	0.0	0.0	1.00	0.0	0.0	16911.5
26+42.04	1.00	708.5	1105.5	1105.5	1.00	494.7	802.0	802.0	1.00	0.0	0.0	1.00	0.0	0.0	17215.0
Grand Total:			62477.1	62477.1			45262.2	45262.2		0.0	0.0		0.0	0.0	

Hand Calculation



Worst Case assume that the existing ground where the dredge cut goes is at elevation

	528.00	sume that the elevation here is a bit closer to 528 at flat pool. Pool 2 is generally shallower than Poo	
Distance to Top Shelf = DT	2.00	FT	
1. Cross Sectional Area to cut toTop Shelf	40.00	SF	=DT*Width of top shelf
2. Cross sectional Area from 528 to Top Shelf	8.00	SF	=1/2 (DT)*(DT)*4

APPENDIX M

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

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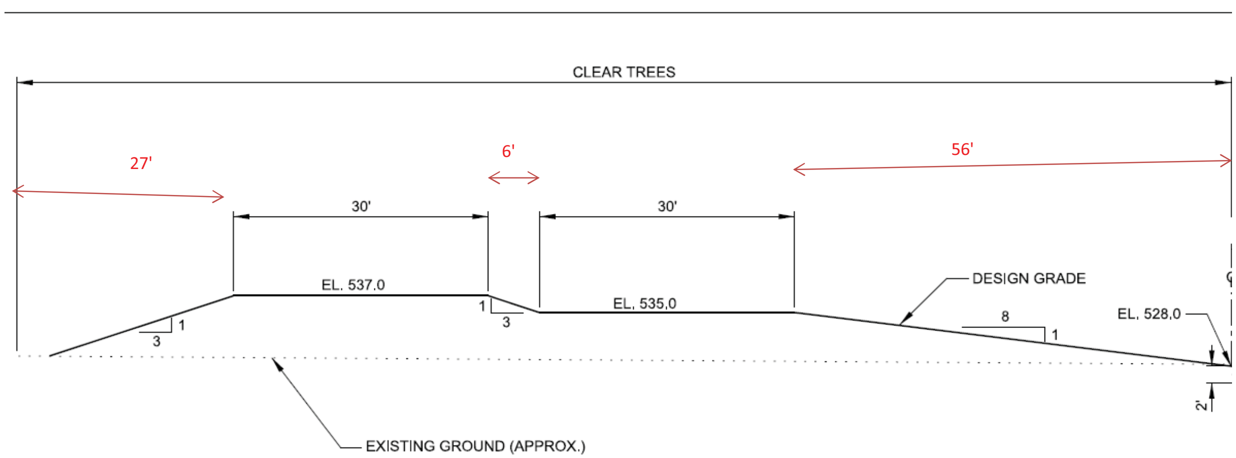
Distance to Bottom Cut=DB	**8.00**	**FT**	
3. Cross Sectional Area of Bottom Cut	**400.00**	**SF**	=DB*width of cut
4. Slope to Bottom Cut	**128.00**	**Sf**	=1/2 (DB)*(DB)*4
5. Other Slope to Bottom Cut	**128.00**	**SF**	=1/2 (DB)*(DB)*4
Total Cross Sectional Area Per Linear Foot	**704.00**	**SF**	1+2+3+4+5
Volume to Dredge	**1,859,968.00**	**CF**	total cross sectional area * length of dredge cut
	68,887.70	**CY**	CF/27

Hand Calculation is higher than inroads value of ***62,477.10*** ***which is expected since much of the area being dredged is deeper than*** ***528.00***

However, close matches and decent survey indicates we should choose the INROADS QUANTITY

CLEARING

Hand Calculationis



Note that the placement site development is covered in Measure F3. However, the clearing required uses some information from the final design, as is shown here.

APPENDIX M

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

9/27/12 12:08 PM

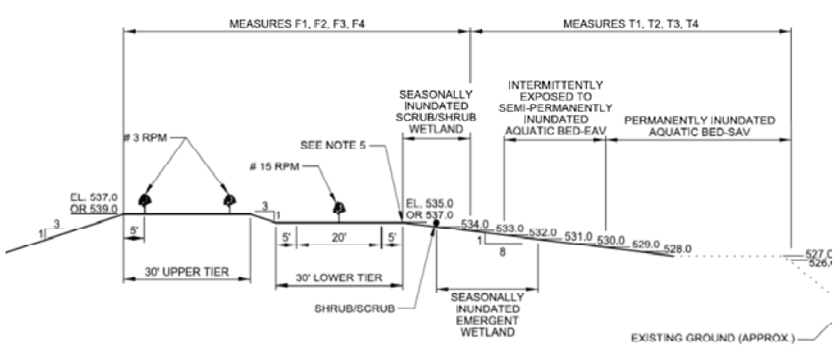
Placement Site

27.0	6.0	56.0	Slope Distances in FEET (add to shelves)

Total Placement Length	2,642.0	FT
Width	149.0	FT
Additional Width for Equipment	20.0	FT
Area of Impact	446,498.0	SF
	10.3	AC
Clearing Required	10.3	AC

Planting

Hand Calculationis

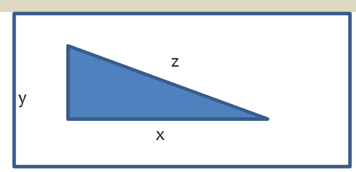


Seasonally Inundated Emergent Wetland (SIEW)- EAV
EL. 531-534

SIEW TOP Elevation	534.0	
SIEW Bottom Elevation	531.0	
Elevation Change	3.0	FT
Slope	8.0	H:1V
	24.0	FT
Slope Distance	24.2	FT

Y

X



Z = square root (X squared plus Y squared)

APPENDIX M

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

9/27/12 12:08 PM

AREA	63,901.5	SF	A = Z*Length of Lower Pool Placement +L Upper Pool Placement site
	1.5	AC	
Contingency	20%		
	1.8	AC	
Acres to Plant	**1.8**	AC	APPLY VALUE TO PLANTING SHEET

Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed (IESPIAV)- EAV (EL. 529 - 532)

IE to SPIAB TOP Elevation	532.0		
IE to SPIAB Bottom Elevation	529.0		
Elevation Change	3.0	FT	Y
Slope	8.0	H:1V	
	24.0	FT	X
Slope Distance	24.2	FT	Z = square root (X squared plus Y squared)
AREA	63,901.5	SF	A = Z*Length of Lower Pool Placement +L Upper Pool Placement site
	1.5	AC	
Continency	20%		
	1.8	AC	
Acres to Plant	**1.8**	AC	APPLY VALUE TO PLANTING SHEET

Permanently Inundated Aquatic Bed (PIAB)- SAV (EL. 526-529; lower dredge shelf)

PIAB TOP Elevation	529.0			
PIAB Bottom Elevation first slope change	528.0			
Elevation Change	1.0	FT	Y	
Slope	8.0	H:1V		
	8.0		X	
Slope Distance	**8.1**	FT	Z1	Z = square root (X squared plus Y squared)
First Slope Change	528.0			
Second slope change	526.0			
Elevation Change	2.0	FT	Y	

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

9/27/12 12:08 PM

Slope	8.0	H:1V	
	16.0		X
Slope Distance	**16.1**	FT	Z2 Z = square root (X squared plus Y squared)
SHELF Width at 526	**20.0**	FT	Z3 z = shelf width
Total Length	**44.2**	FT	Z = Z1+Z2+Z3
AREA	116,741.5	SF	A = Z*Length of Lower Pool Placement +L Upper Pool Placement site
	2.7	AC	
Continency	20%		
	3.2	AC	
Acres to Plant	**3.2**	AC	APPLY VALUE TO PLANTING SHEET

REFER TO SHEET CALLED T PLANTINGS TO SEE HOW THESE ACREAGES ARE CHANGED TO NUMBERS OF PLANTS

PIAB = ***Permanently Inundated Aquatic Bed - SAV***

IE to SPIAB = ***Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed - EAV***

SIEW = ***Seasonally Inundated Emergent Wetland***

Conclusions

ITEM NO.	DESCRIPTION	QTY	UNIT	[redacted]		
T3	Topographic Diversity - Dredging	75,000	CY			
T3	Topographic Diversity - Clearing	10	AC			
T3	Seed Mix of seasonally inundated emergent wetland species (planted at 10 pounds per acre)	2	AC			
T3	Plant Exclosure	3	EA			
T3	Aquatic container Plants (ERDC)	1	EA			
T3	SIEW - Sedges -Tuber	664	EA			
T3	SIEW - Bulrush -Tuber	664	EA			
T3	SIEW - Blueflag Iris -Tuber	664	EA			
T3	SIEW - Sweet Flag -Tuber	664	EA			
T3	IE to SPIAB - Waterwillow -Tuber	664	EA			
T3	IE to SPIAB - Arrowhead - Tuber	664	EA			
T3	IE to SPIAB - Pickerelweed - Tuber	664	EA			
T3	IE to SPIAB - Smartweed - Tuber	664	EA			
T3	PIAB - Illinois Pondweed - Tuber	966	EA			

Measure T3: Topographic Diversity and Overwintering, Goose Lake Pool 2 Topographic Diversity (537 Top)

9/27/12 12:08 PM

T3	PIAB - Sago Pondweed - Tuber	966	EA	[redacted]	
T3	PIAB - American Wild Celery -Tuber	966	EA		
T3	PIAB - Coontail - Tuber	966	EA		
T3	PIAB - American Elodea - Tuber	966	EA		

Computation Checks

Review Stage	DPR DQCR
Check Comments	Make sure to add inroads information and any data files; Hand Calculation: the dredge cut drawing does not show shallow cut and deep cut. The hand check for dredging talks about top shelf and bottom shelf show on drawing. I believe those refer to shallow cut and deep cut. ;The C column has two different shaded cells explain what they mean.; The acres for planting were estimated to the tenths however in the T plantings they where to one hundredths place, not sure why they are different. Reviewed by Julie Millhollin, EC-DN, August 27, 2012
Resolution of Comments	Inroads information was added. Added shallow cut and deep cut to the drawing. Removed shading (Had helped me propogate copied sheets earlier). Values were copied from sheet to sheet and differences were based on cell formating. Final numbers should translate appropriate, are just not visually shown. KNM 9/5/2012
Checked By:	MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 15:01:52 -05'00'
Submitted By:	MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:49:06 -05'00'

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

Objective

Floodplain Forest Diversity Adjacent to Pool 2 (537 Top). This measure includes shaping the dredged material into tiers and side slopes to accomadate planting, as well as tree and scrub shrub plantings

References

Publications

Title	Source	Publication Date	Link
Huron Island HREP DPR		DRAFT	
Planting design was based on Nate Richards, CEMVP-PD-P, Project Biologist and Jon Schulz, OD-MN, Project Forestor			#################
Upper Mississippi River Environmental Management Program Environmental Design Handbook		August-06	http://www.mvr.usace.army.mil/EMP/designhandbook.htm
U.S. Army Corps of Engineers, *EM 1110-2-5025, Dredging and*		March-83	
U.S. Army Corps of Engineers, Dredging Operations Technical			http://el.erdc.usace.ar
Project Boring Data	Draft Geotech Data		
Upper Mississippi River Environmental Management Program Environmental Design Handbook	Floodplain Restoration Chapter and Applicable References	2012 DRAFT	
INROADS Prints are located here:			INROADS PRINTS

Survey Datums and Conversions

7. HORIZONTAL DATUM IS STATE PLANE COORDINATE SYSTEM, IL WEST, NAD 83, US SURVEY FOOT, VERTICAL DATUM IS MSL 1912.
8. ORTHO PHOTOGRAPHY FROM MARCH 2005
9. FLAT POOL IS AT EL. 528.0.

Horizontal Datum	**State Plane**
	IL West
	NAD 83
	US Survey Foot
Vertical Datum	MSL 1912

Software

Name	Version	Notes
Microstation	**V8i (select Series 2)**	

Data Files

Cross Section Name	Alignment Name	ProjectWise URN	Notes
Selected Plan T3	**Selected Plan T3**	**Huron T3 50 ft 537 top 06232012.pdf**	**Revised after selected plan to add placement site entire length**

APPENDIX M

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

Assumptions				
	Item	**Number**	**Units**	Notes
Placement Site				
	Placement Site	2642	feet	Length encompasses most of the Pool
	Slope from 526 to 528	4H:1V		per Felix Castro, CEMVR-EC-G
	Slope from 528 to 535	8H:1V		for better EAV habitat per Nate Richards, CEMVR-PD-P
	Slope from 535 to 537	3H:1V		per Felix Castro, CEMVR-EC-G
	Slope from 537 to existing ground	3H:1V		per Felix Castro, CEMVR-EC-G
	Lower Shelf Width	30	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Lower Shelf Elevation	535	ft MSL	To meet forest index requirements. Per PDT requirements.
	Upper Shelf Width	30	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Upper Shelf Elevation	537	ft MSL	To meet forest index requirements. Per PDT requirements.
	Side Slopes	4H:1V	per Felix Castro, EC-G	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN

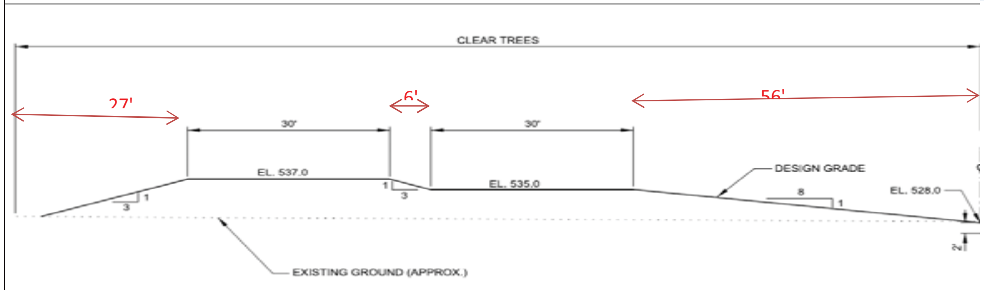
Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

Analysis and Design

Dredge Material Available for Placement Site

INROADS



Placement Site Design

INROADS Quantity For Pool 2 Cut (6/23/2012)	62,477.10	CY
ACCESS DREDGE QUANTITY (4/3/2012)	0.00	CY
UNKNOWN FOR SURVEY/Realignment	20%	
	74,972.52	CY
	75,000.00	**CY**

Pool 2 will only be dredged if Pool 1 is also dredged. Refer to INROADS sheet on T3.

EXTENDED IN JUNE AFTER SELECTED PLAN SINCE MORE MATERIAL AVAILABLE WITH LOWER TOP HEIGHT SELECTED ON BERM

Quantity Required to meet the placement site design

INROADS Ran on 6/23/2012	45,262.20	CY
TOTAL QUANTITY	45,262.20	
UNKNOWN FOR SURVEY, settling	20%	
	54,314.64	CY
	54,400	**CY**

based on this, sufficient material available to build berms **20,600** extra material

Assume some settlement prior to placement. (1 foot)

Excess material can be used to create flatter back slope or larger tiers. Final design in P&S.

Contractor will allow the material to be dredged and placed. After the material has settled for a short period of time (TBD by EC-G), material will be shaped to the slopes and dimenstions shown

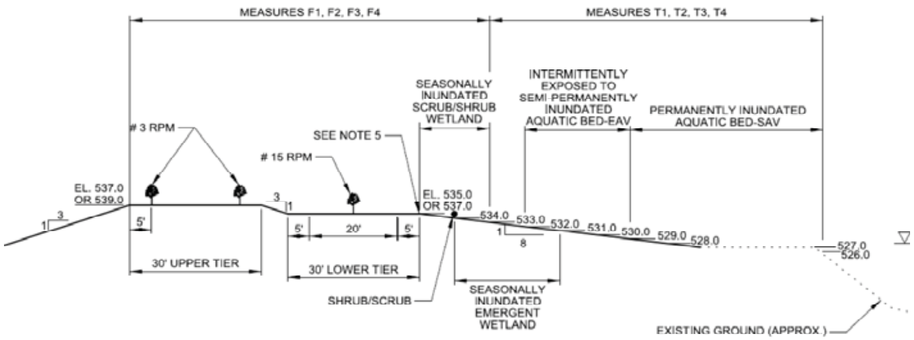
APPENDIX M

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

Planting

Hand Calculationis



Seasonally Inundated Scrub/Shrub Wetland - EAV⍰EL. 533-535

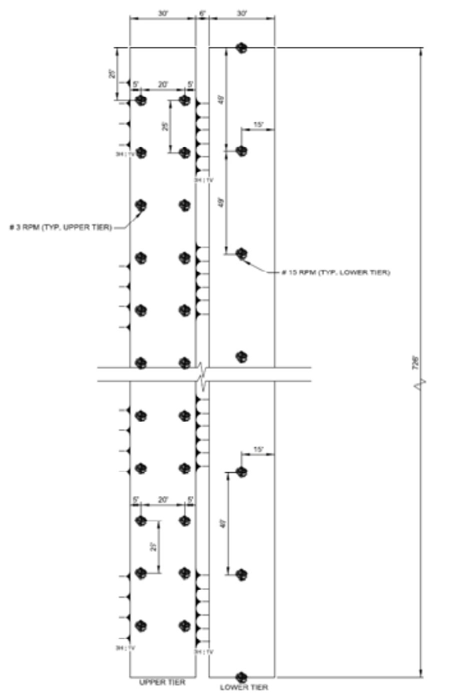
SISSW TOP Elevation	535.0		
SISSW Bottom Elevation	533.0		
Elevation Change	2.0	FT	Y
Slope	8.0	H:1V	
	16.0	FT	X
Slope Distance	16.1	FT	Z = square root (X squared plus Y squared)
AREA	42,601.0	SF	A = Z*Length of Placement Site
	1.0	AC	
Continency	20%		
	1.2	AC	
Acres to Plant	**1.2**	AC	APPLY VALUE TO PLANTING SHEET

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

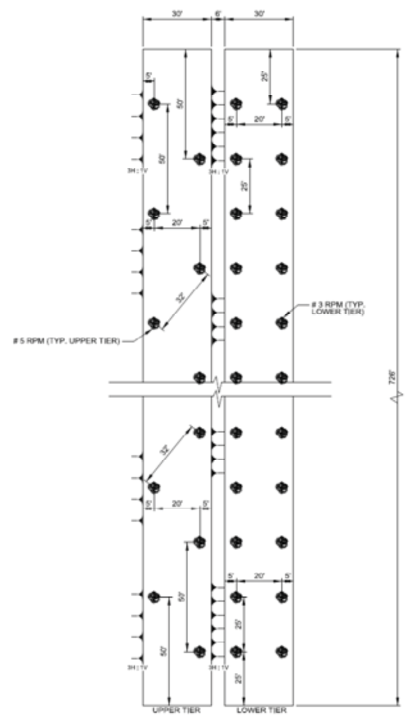
9/27/12 12:12 PM

Temporarily Inundated Forested Wetland Trees

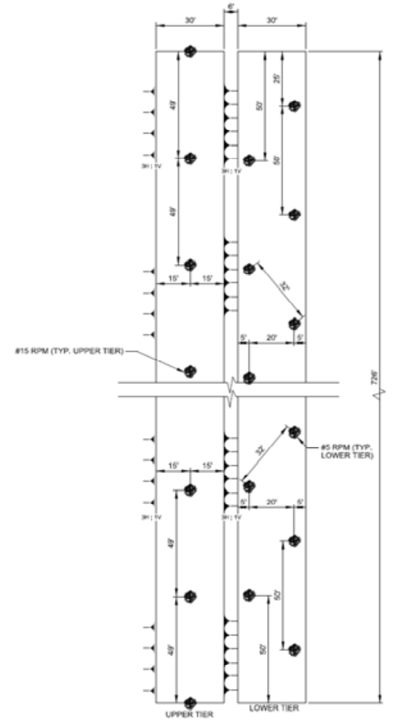
Trees



DWG REF(s) :
A1 TREE PLANTING PLANS - PLOT 1 (MEASURES F1, F2, F3, AND F4



DWG REF(s) :
A3 TREE PLANTING PLANS - PLOT 2 (MEASURES F1, F2, F3, AND F4)



; F1, F2, F3 AND F4) - PLOT 3

Number of Trees per plot is shown on sheet called "Tree Layout"

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

This shows just one tier. There is an associated tier of the same size next to it which will carry the sister plot.

Tier Width	30.0	FT		
Tier Area	79,260.0	SF		
	1.8	AC		
Tier Combinations are for 1/2 acre plots, so can plant	3.6	PLOTS		
	#3 RPM	#5 RPM	# 15 RPM	
PLOT 1	4.0	0.0	1.0	trees per species
PLOT 2	4.0	2.0	0.0	trees per species
PLOT 3	0.0	2.0	1.0	trees per species
PLOT 4 (1/2 Plot 2)	2.0	1.0	0.0	Trees per species
TOTAL TREES SIZES PER SPECIES	**10.0**	**5.0**	**2.0**	**Trees per species**
Total Trees	**17.0**			

Termporarily Inundated Forested Wetland Shrubs (Top Tiers

Top Tier Width	30.0	FT
Lower Tier Width	30.0	FT
Total Tier Width	60.0	FT
Tier Area	158,520.0	SF
	3.6	**AC**

REFER TO SHEET CALLED F PLANTINGS TO SEE HOW THESE ACREAGES ARE CHANGED TO NUMBERS OF PLANTS

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

Conclusions						
ITEM NO.	DESCRIPTION	QTY	UNIT	[redacted]		
F3	Shape Dredge Cut to desired slopes and elevations	1	LS			
F3	SISSW - Hibiscus - #3 RPM	12	EA			
F3	SISSW - Commone Elderberry - #3 RPM	12	EA			
F3	SISSW - Buttonbush - #3 RPM	12	EA			
F3	SISSW - Dogwood - #3 RPM	12	EA			
F3	SISSW - Sandbar Willow -#3 RPM	12	EA			
F3						
F3	Pounds per acre seed SISSW Seed Mix	2.0	AC			
F3						
F3	River Birch #3 RPM	10	EA			
F3	Bitternut Hickory #3 RPM	10	EA			
F3	Northern Pecan #3 RPM	10	EA			
F3	Shellbark Hickory #3 RPM	10	EA			
F3	Common Hackberry #3 RPM	10	EA			
F3	Common Persimmon #3 RPM	10	EA			
F3	Honey Locust #3 RPM	10	EA			
F3	Kentucky Coffeetree #3 RPM	10	EA			
F3	Black Walnut #3 RPM	10	EA			
F3	American Sycamore #3 RPM	10	EA			
F3	Swamp White Oak #3 RPM	10	EA			
F3	Bur Oak #3 RPM	10	EA			
F3	Pin Oak #3 RPM	10	EA			
F3	American Basswood #3 RPM	10	EA			
F3	Overcup Oak #3 RPM	10	EA			
F3						
F3						
F3	River Birch #5 RPM	5	EA			
F3	Bitternut Hickory #5 RPM	5	EA			
F3	Northern Pecan #5 RPM	5	EA			
F3	Shellbark Hickory #5 RPM	5	EA			
F3	Common Hackberry #5 RPM	5	EA			
F3	Common Persimmon #5 RPM	5	EA			
F3	Honey Locust #5 RPM	5	EA			
F3	Kentucky Coffeetree #5 RPM	5	EA			
F3	Black Walnut #5 RPM	5	EA			
F3	American Sycamore #5 RPM	5	EA			
F3	Swamp White Oak #5 RPM	5	EA			
F3	Bur Oak #5 RPM	5	EA			
F3	Pin Oak #5 RPM	5	EA			
F3	American Basswood #5 RPM	5	EA			
F3	Overcup Oak #5 RPM	5	EA			
F3						
F3						

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

F3	River Birch #15 RPM	2	EA	[redacted]			
F3	Bitternut Hickory #15 RPM	2	EA				
F3	Northern Pecan #15 RPM	2	EA				
F3	Shellbark Hickory #15 RPM	2	EA				
F3	Common Hackberry #15 RPM	2	EA				
F3	Common Persimmon #15 RPM	2	EA				
F3	Honey Locust #15 RPM	2	EA				
F3	Kentucky Coffeetree #15 RPM	2	EA				
F3	Black Walnut #15 RPM	2	EA				
F3	American Sycamore #15 RPM	2	EA				
F3	Swamp White Oak #15 RPM	2	EA				
F3	Bur Oak #15 RPM	2	EA				
F3	Pin Oak #15 RPM	2	EA				
F3	American Basswood #15 RPM	2	EA				
F3	Overcup Oak #15 RPM	2	EA				
F3							
F3	Tree Wrap - Each	255	EA				
F3	Tree Exclsoure - Each	255	EA				
F3	Herbicide Treatment - ACRES	4	EA				
F3	TIFWS Common Buttonbush - #3 RPM Shrub	40	EA				
F3	TIFWS Easterm Redbud - #3 RPM Shrub	40	EA				
F3	TIFWS Red - Osier Dogwood - #3 RPM Shrub	40	EA				
F3	TIFWS Green Hawthorn - #3 RPM Shrub	40	EA				
F3	TIFWS Elderberry - #3 RPM Shrub	40	EA				
F3	Understory seed mixture at 10 pounds per acre	4	AC				

APPENDIX M

Measure F3: Floodplain Forest Diversity, Forest Diversity Adjacent to Goose Lake Pool 2 (537 top)

9/27/12 12:12 PM

Computation Checks	
Review Stage	DPR DQCR
Check Comments	Make sure to add inroads information and any data files; Show shaping QTY; Add tree assumptions (not sure where the # of trees per species came from under temporarily inundated forested wetland trees); Check the qty for tree wrap and tree exclosure. Reviewed by Julie Millhollin, EC-DN, August 28, 2012
Resolution of Comments	Inroads information and data files were added. Some description and drawings for shaping were included. # tree species calculations added as a new sheet, and drawing added. Quantity for tree wrap and tree exclosures were calculated and checked out. KNM 9/5/2012
Checked By:	MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 14:55:27 -05'00'
Submitted By:	MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:45:54 -05'00'

T1/T3 Bank Stabilization (Formerly Measure E1): Forested Wetland Protection (Huron Island), Bank Stabilization

9/27/12 12:19 PM

Objective							
Calculate quantities for clearing, grading, bedding stone placement, riprap placement.							
References							
Publications							
	Title	**Source**	**Publication Date**	**Link**			
	Huron Island HREP DPR		Draft				
	Upper Mississippi River Environmental Management Program Environmental Design Handbook		August-06				
	Upper Mississippi River Environmental Management Program Environmental Design Handbook	(Shoreline Protection and applicable resources)	Draft 2012				
	Longitudinal Peaked Stone Toe Protection and Longitudinal Fill Stone Toe Protection	Prospect Course 285 Streambank Stabilization	September-09				
				- Longitudinal Peaked and Fill Stone Toe Protection (LPSTP)-UPDATED 9-11-20			
	INROADS Prints are located here:			INROADS PRINTS			
Survey Datums and Conversions							
	NAD 83 IL West - 1202 MSL 1912 GEO 09						
	Orthophotography from March 2005 (Plates)						
	Flat Pool at El 528.0 (approx)						

Software			
	Name	**Version**	**Notes**
	Microstation	**V8i (select Series 2)**	

Data Files				
	File Name	**File Extension**	**ProjectWise URN**	**Notes**

APPENDIX M

T1/T3 Bank Stabilization (Formerly Measure E1): Forested Wetland Protection (Huron Island), Bank Stabilization

9/27/12 12:19 PM

Assumptions				
	Item	Number	Units	Notes
	Length of Shoreline Requiring Protection	2,415	FT	based on Spring 2012 Survey of observable erosion
	Slopes for Protection	2H:1V		Per Felix Casto, EC-G
	Bedding Stone Thickness	1	FT	Per Felix Casto, EC-G
	Riprap Thickness	2	FT	Per Felix Casto, EC-G
	Top Tie In Length (Into Bank)	6	FT	Per Felix Casto, EC-G
	Toe Length (out to River)	6	FT	Per Felix Casto, EC-G
	Average Top Elevation	534		
	Average Bottom Elevation	520		
	Conversion RIPRAP	1.65	TN/CY	
	Conversion Bedding Stone	1.8	TN/CY	
	Area Conversion	43560	FT/AC	

Huron Island HREP - DPR
Computations By: Kara N. Mitvalsky, P.E.

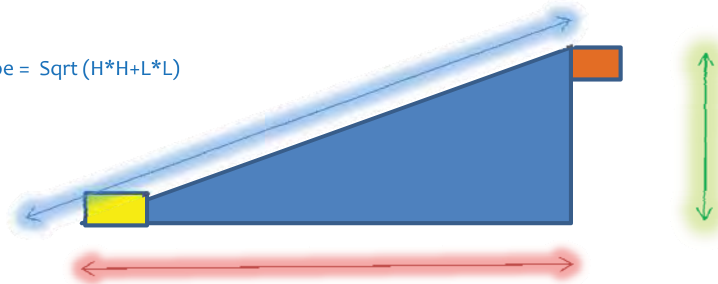
T1/T3 Bank Stabilization (Formerly Measure E1): Forested Wetland Protection (Huron Island), Bank Stabilization

9/27/12 12:19 PM

Analysis and Design

Riprap and Bedding

Hand Calculation



	RIPRAP	BEDDING	
Length Requiring Protection per Linear Foot of Shorline (slope plus toe plus Tie In)	43.3	43.3	Feet
Area per Linear Foot of Shoreline	86.6	43.30495168	SF
Volume per Area Needing Protection	209,162.9	104,581.5	CF
	7,746.8	3,873.4	CY
	12,782.2	6,972.1	TN
Contingency	0.2	0.2	
Total	15,338.6	8,366.5	TN
ROUNDUP	15,400.0	8,400.0	TN

INROADS CALCULATION

INROADS RAN IN MAY 2012
Huron Island Bank Stabilization
Set Top of Bank at 535.05
length of Erosion 2,415.0 FT

	RIPRAP	BEDDING	
Total Cut (one Typical Cross Section)	36.9	34.02	SF
Total Fill (one typical cross section)	46.6	9.3	SF
Area per Linear Foot of Shoreline	83.5	43.3	SF
Volume per Area Needing Protection	201,628.4	104,617.8	CF
	7,467.7	3,874.7	CY
	12,321.7	6,974.5	TN
Contingency	0.2	0.2	
Total	14,786.1	8,369.4	TN
ROUNDUP	14,800.0	8,400.0	TN

T1/T3 Bank Stabilization (Formerly Measure E1): Forested Wetland Protection (Huron Island), Bank Stabilization

9/27/12 12:19 PM

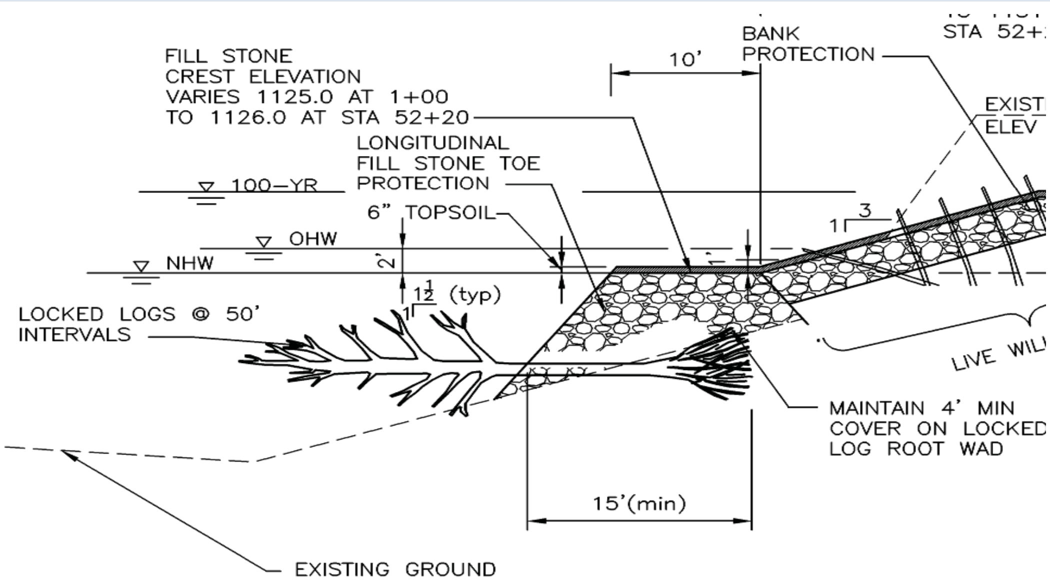
Clearing

Hand Calculation

Protection Length	2,415	FT	
			Use this to have enough room for 6 foot tie in and equipment accessibility
Distance into shore	20	FT	
Area Requiring Clearing	48300	SF	
	1.1088	AC	
Contingency	0.2000		
Total	1.330578512	AC	
	1.3	AC	
When calculated on the drawings it was shown as	1.7	AC	

LOG JAMS

Hand Calculation



Design would be similar to attached drawing for tree placement.

Design would match plates for riprap placment

Place log jams along 1/3 of bankline protection area to see habitat impacts/differences	805	FT
Interval Placement	50	Ft
Total Trees	17	TREES

APPENDIX M

T1/T3 Bank Stabilization (Formerly Measure E1): Forested Wetland Protection (Huron Island), Bank Stabilization

9/27/12 12:19 PM

Conclusions

ITEM NO.	DESCRIPTION	QTY	UNIT	[redacted]			
E1	Bank Stabilization - Riprap (Step 4)	15,400	TN				
E1	Bank Stabilization - Bedding (Step 3)	8,400	TN				
E1	Bank Stabilization - Clearing (Step 1)	2	AC				
E1	Bank Stabilization -Bankline Shaping (Step 2)	1	LS				
E1	Bankline Stabilization-Locked Logs (Step 4)	17	EA				

T1/T3 Bank Stabilization (Formerly Measure E1): Forested Wetland Protection (Huron Island), Bank Stabilization

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Computation Checks	
Review Stage	DPR DQCR
Check Comments	Make sure to add inroads information and any data files, Reviewed by Julie Millhollin, EC-DN, August 27, 2012
Resolution of Comments	Additional information was added as requested. KNM 9/25/2012
Checked By:	(electronic signature with date stamp) MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 14:44:09 -05'00'
Submitted By:	(electronic signature with date stamp) MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:50:00 -05'00'

Huron Island Habitat Rehabilitation and Enhancment Project DPR
Computations By: Kara N. Mitvalsky, PE

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

9/27/12 12:17 PM

Objective

Forest Diversity in Non-Diverse Forest Location Using Existing Soil (537 Top). This has also been referred to as the PAD. Located Upstream of the Pools.

References

Publications

	Title	Source	Publication Date	Link
	Huron Island HREP DPR		DRAFT	
	Planting design was based on Nate Richards, CEMVP-PD-P, Project Biologist and Jon Schulz, OD-MN, Project Forestor			##################
	Upper Mississippi River Environmental Management Program Environmental Design Handbook		August-06	http://www.mvr.usace.army.mil/EMP/designhandbook.htm
	U.S. Army Corps of Engineers, *EM 1110-2-5025, Dredging and*		March-83	
	U.S. Army Corps of Engineers, Dredging Operations Technical			http://el.erdc.usace.ar
	Project Boring Data	Draft Geotech Data		
	Upper Mississippi River Environmental Management Program Environmental Design Handbook	Floodplain Restoration Chapter and Applicable References	2012 DRAFT	
	Draft Indiana Bat Survey Data	Nate Richards	June-12	
	INROADS Prints are located here:			INROADS PRINTS

Survey Datums and Conversions

7. HORIZONTAL DATUM IS STATE PLANE COORDINATE SYSTEM, IL WEST, NAD 83, US SURVEY FOOT, VERTICAL DATUM IS MSL 1912.
8. ORTHO PHOTOGRAPHY FROM MARCH 2005
9. FLAT POOL IS AT EL. 528.0.

Horizontal Datum	**State Plane**
	IL West
	NAD 83
	US Survey Foot
Vertical Datum	MSL 1912

Software

	Name	Version	Notes
	Microstation	**V8i (select Series 2)**	

Data Files

	Cross Section Name	Alignment Name	ProjectWise URN	Notes
	Measure F5_1	**Measure F5**	**Above: Huron F5 Revised Placement Fill Only 06202012.pdf**	

APPENDIX M

Huron Island Habitat Rehabilitation and Enhancment Project DPR
Computations By: Kara N. Mitvalsky, PE

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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	Item	Number	Units	Notes
Assumptions				
Pad Dimenstions				
	Pad Length	1,056	feet	Based on INROADS run on 6/20/2012. Pad was resituated in June 2012 to address Indiana bat habitat on the U/S end of the land mass.
	Existing Ground	530	feet	
	Slope from 530 to 535	3	H:1V	per Felix Castro, CEMVR-EC-G
	Slope from 535 to 537	3	H:1V	per Felix Castro, CEMVR-EC-G
	Lower Shelf Width (Huron Chute Side)	50	feet	Width for Tree Planting
	Lower Shelf Width (Nav Channel Side)	50	Feet	Width for Tree Planting
	Lower Shelf Elevation	535	ft MSL	To meet forest index requirements. Per PDT requirements.
	Upper Shelf Width	80	feet	Minimum width for tree survivability per Jon Schulz, CEMVR-OD-MN
	Upper Shelf Elevation	537	ft MSL	To meet forest index requirements. Per PDT requirements.
Borrow Site Dimensions				
	Minimum Distance from Pad	20	feet	To prevent sluffing
	Allowable Borrow Depth	6	feet	satistfactory material per Felix Castro, CEMVR-EC-G. While this will cut below flat pool, the material type indicates that it should not hold too much moisture and can therefore be removed and placed.
	Borrow Side Slopes	3	H:1V	
	Borrow Site Width (Huron Chute Side)	0	feet	Originally, the pad had been designed to run generally N-S and was situated higher in the land mass. Based on discovered Indiana Bat habitat, the pad was repositioned and only one borrow site could be placed adjacent to the
first slope then go left	Borrow 18" Shallow (Nav Side)	50	feet	Scraping here will create shallow habitat.
	Borrow Site Width (Nav Channel Side)	150	feet	The most space we could get to ensure that we could get borrow for the pad before running into Buffalo Slough. 150 feet is a large distance to move borrow.
Constants				
	Area Conversion	43,560	SF/AC	

APPENDIX M

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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Analysis and Design

Placement Site Material Needs

INROADS

INROADS QUANTITY	44,910.00	CY	From INROADS run on 6/20/12	This is the quantity we will need to construct the berm
Contingency	20%			
Total	53,892.0	CY		
ROUNDUP	53,900.0	**CY**		

End Area Volume Report Page 1 of 1

End Area Volume Report

Report Created: 6/20/2012
Time: 3:05pm

Measure F5
Placement Fill only

Cross Section Set Name: Measure F5
Alignment Name: Measure F5
Input Grid Factor: 1.000000 Note: [illegible]

Baseline Station	Station Quantities Cut Factor	Cut Area	Cut Volume	Cut Adjusted	Fill Factor	Fill Area	Fill Volume	Fill Adjusted	Added Quantities Cut Factor	Cut Volume	Cut Adjusted	Fill Factor	Fill Volume	Fill Adjusted	Mass Ordinate
0+00.00	1.00	0.0	0.0	0.0	1.00	1167.3	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	0.0
0+50.00	1.00	0.0	0.0	0.0	1.00	1117.3	2485.8	2485.8	1.00	0.0	0.0	1.00	0.0	0.0	-2485.8
1+00.00	1.00	0.0	0.0	0.0	1.00	1273.3	2398.7	2398.7	1.00	0.0	0.0	1.00	0.0	0.0	-4884.5
1+50.00	1.00	0.0	0.0	0.0	1.00	1285.8	2369.5	2369.5	1.00	0.0	0.0	1.00	0.0	0.0	-7254.0
2+00.00	1.00	0.0	0.0	0.0	1.00	1132.6	2424.5	2424.5	1.00	0.0	0.0	1.00	0.0	0.0	-9678.5
2+50.00	1.00	0.0	0.0	0.0	1.00	1214.6	2358.6	2358.6	1.00	0.0	0.0	1.00	0.0	0.0	-12037.1
3+00.00	1.00	0.0	0.0	0.0	1.00	1157.9	2196.5	2196.5	1.00	0.0	0.0	1.00	0.0	0.0	-14233.6
3+50.00	1.00	0.0	0.0	0.0	1.00	1121.9	2120.1	2120.1	1.00	0.0	0.0	1.00	0.0	0.0	-16354.0
4+00.00	1.00	0.0	0.0	0.0	1.00	1084.4	2052.1	2052.1	1.00	0.0	0.0	1.00	0.0	0.0	-18406.1
4+50.00	1.00	0.0	0.0	0.0	1.00	1090.9	2014.2	2014.2	1.00	0.0	0.0	1.00	0.0	0.0	-20420.3
5+00.00	1.00	0.0	0.0	0.0	1.00	1131.5	2057.8	2057.8	1.00	0.0	0.0	1.00	0.0	0.0	-22478.1
5+50.00	1.00	0.0	0.0	0.0	1.00	1081.4	2058.2	2058.2	1.00	0.0	0.0	1.00	0.0	0.0	-24536.3
6+00.00	1.00	0.0	0.0	0.0	1.00	1066.6	1998.2	1998.2	1.00	0.0	0.0	1.00	0.0	0.0	-26534.5
6+50.00	1.00	0.0	0.0	0.0	1.00	1087.2	1994.2	1994.2	1.00	0.0	0.0	1.00	0.0	0.0	-28528.8
7+00.00	1.00	0.0	0.0	0.0	1.00	1085.4	2011.6	2011.6	1.00	0.0	0.0	1.00	0.0	0.0	-30540.4
7+50.00	1.00	0.0	0.0	0.0	1.00	1085.5	2010.1	2010.1	1.00	0.0	0.0	1.00	0.0	0.0	-32550.4
8+00.00	1.00	0.0	0.0	0.0	1.00	1016.8	1946.6	1946.6	1.00	0.0	0.0	1.00	0.0	0.0	-34497.0
8+50.00	1.00	0.0	0.0	0.0	1.00	1255.5	2104.0	2104.0	1.00	0.0	0.0	1.00	0.0	0.0	-36601.0
9+00.00	1.00	0.0	0.0	0.0	1.00	1040.1	2125.5	2125.5	1.00	0.0	0.0	1.00	0.0	0.0	-38726.5
9+50.00	1.00	0.0	0.0	0.0	1.00	1030.6	1917.3	1917.3	1.00	0.0	0.0	1.00	0.0	0.0	-40643.9
10+00.00	1.00	0.0	0.0	0.0	1.00	1094.7	1967.9	1967.9	1.00	0.0	0.0	1.00	0.0	0.0	-42611.8
10+50.00	1.00	0.0	0.0	0.0	1.00	1112.4	2043.6	2043.6	1.00	0.0	0.0	1.00	0.0	0.0	-44655.4
10+56.17	1.00	0.0	0.0	0.0	1.00	1118.6	255.1	255.1	1.00	0.0	0.0	1.00	0.0	0.0	-44910.5
Grand Total:			0.0	0.0			44910.5	44910.5		0.0	0.0		0.0	0.0	

file:///C:/Users/B5EDDEJJ/AppData/Local/Temp/1/InRoadsReport.htm 6/20/2012

10+00.00	1.00	0.0	0.0	0.0	1.00	1094.7	1967.9	1967.9	1.00	0.0	0.0	1.00	0.0	0.0	-42611.8
10+50.00	1.00	0.0	0.0	0.0	1.00	1112.4	2043.6	2043.6	1.00	0.0	0.0	1.00	0.0	0.0	-44655.4
10+56.17	1.00	0.0	0.0	0.0	1.00	1118.6	255.1	255.1	1.00	0.0	0.0	1.00	0.0	0.0	-44910.5
Grand Total:			0.0	0.0			44910.5	44910.5		0.0	0.0		0.0	0.0	

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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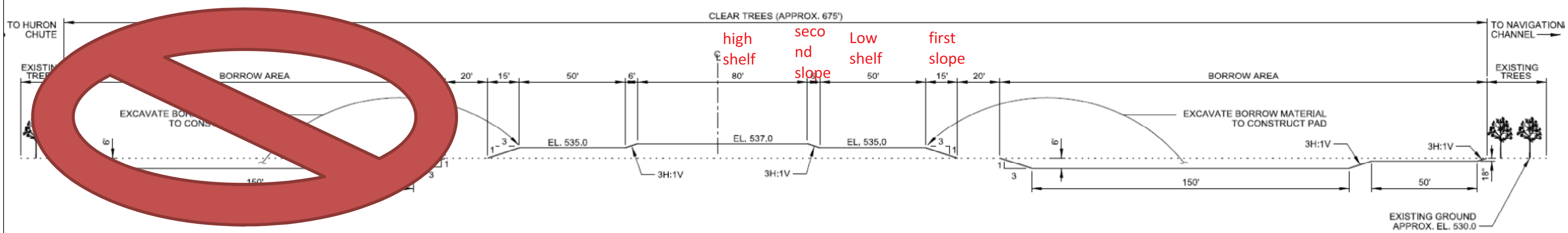
Hand Calculations



NOTE THAT THIS DRAWING SHOWS BORROW ON 2 SIDES, BUT RECOMMENDED PLAN HAS BORROW ONLY ON NAVIGATION CHANNEL SIDE (INDIANA BAT CHANGE IN JUNE 2012)

			Total Number at this elevatio	Cross sectional areas
Pad Slopes	**3.00**	**H:1V**		
Height of first slope	*5.00*	*FT*		
Cross sectional Area of first slope	**37.50**	**SF**	**2**	**75.00**
Low shelf height	*5.00*	*FT*		
Cross sectional area of low shelf	**250.00**	**SF**	**2**	**500.00**
Height of second slope	*2.00*	*FT*		
Cross sectional Area of second slope	**6.00**	**SF**	**2**	**12.00**
height of material under second slope	*5.00*	*FT*		
Cross sectiona area of material under second slope	**30.00**	**SF**	**2**	**60.00**
Second shelf height	*7.00*	*FT*		
Cross sectional area of high shelf	**560.00**	**SF**	**1**	**560.00**
Total Cross Sectinal Area of Structure	**1,207.00**	**SF**		
Volume of Structure	**1,274,592.00**	**CF**		
	47,207.11	**CY**		

Note that this value is generally close to the INROADS value. INROADS value used since the existing ground likely varies.

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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Land Borrow Material

INROADS

Borrow Available (Existing ground to 6 feet below existing ground)	**41,527.40**	**CY**	per INROADS on 6/20/2012
HOWEVER, have to remove 1.5/6 feet for clearing and grubbing	**31,145.55**	**CY**	Actual amount available after clearing and grubbing
MATERIAL NEEDS FROM OTHER THAN BORROW SITE	**22,754.45**	**CY**	(Amount required for placement to build pad minus amount available from borrow site)

Hand Calculations

Depth Removed From Clearing and Grubbing	1.50	FT
Amount of Borrow Depth left (Big Pits)	4.50	FT
Amount of Borrow Depth Left (Shallow Pit)	0.00	FT

	Huron Side	Nav side	Shallow Nav Side	
Borrow Width (do Not include Side slopes	0.00	150	50	FT
Borrow Cross Sectional Area	0.00	158,400.00	52,800.00	SF
Vol;ume of Borrow Available	0.00	712,800.00	0.00	CF
	0.00	26,400.00	0.00	CY

Total Borrow available	**26,400.00**	**CY**	Instead, use INROADS quantity since better survey data.

APPENDIX M

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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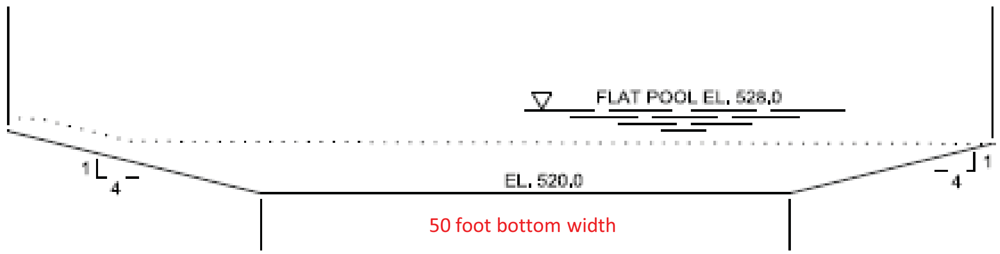
Pool Borrow Material

INROADS

INROADS CALCULATIONS

Not run to date since final location not shown. Use Hand Calculations.

Hand Calculations



Worst Case assume that the existing ground where the dredge cut goes is at elevation	528.00		assume this as worst case since most of this area is still water when at flat pool.
Dredge Bottom Elevation	520.00		to match existing dredge vuts
Distance to Bottom Cut=DB	8.00	FT	
Bottom Width	50.00	FT	Selected to match smallest dredge width (T3)
3. Cross Sectional Area of Bottom Cut	400.00	SF	=DB*width of cut
4. Slope to Bottom Cut	128.00	Sf	=1/2 (DB)*(DB)*4 assume a 4H:1V cut
5. Other Slope to Bottom Cut	128.00	SF	=1/2 (DB)*(DB)*4
Total Cross Sectional Area Per Linear Foot	656.00	SF	3+4+5
LENGTH	1,000.00	FT	Selected to get sufficient quantities, based on aerial photos for accessible area
Volume to Dredge	656,000.00	CF	total cross sectional area * length of dredge cut
	24,296.30	CY	CF/27
	(1,541.85)	*CY*	*PAD QUANTITY NEEDS - DREDGE VOLUME (Needs to be <= 0)*

APPENDIX M

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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BORROW SUMMARY

TERRESTRIAL LAND FILL	**22,800.00**	**CY**
DREDGED MATERIAL	**24,300.00**	**CY**

Clearing Requirements

Hand Calculations

Required for Pad Construction

Pad Width	222.00	FT
Seperation between Pad and Borrow	40.00	FT
Total Width to Clear	262.00	FT
Area to clear	276,672.00	SF
	6.35	AC
Contingency	0.20	
Total	7.62	AC
	8.00	**AC**

Clear, Grub and Strip

Hand Calculations

Required for Borrow Areas

Borrow Width	236.00	FT
Area to clear	249,216.00	SF
	5.72	AC
Contingency	0.20	
Total	6.87	AC
	7.00	**AC**

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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Seeding		
Hand Calculations		
Lower Shelves	**100.00**	**FT**
Upper Shelves	**80.00**	**FT**
Lower Side Shelves	**31.62**	**FT**
Upper Side Shelves	**12.65**	**FT**
Seperation between borrow and Pad	**20.00**	**FT**
Total Width	**244.27**	**FT**
Area	**257,951.11**	**SF**
	5.92	AC
Contingency	0.20	
Total	7.11	AC
	8.00	**AC**

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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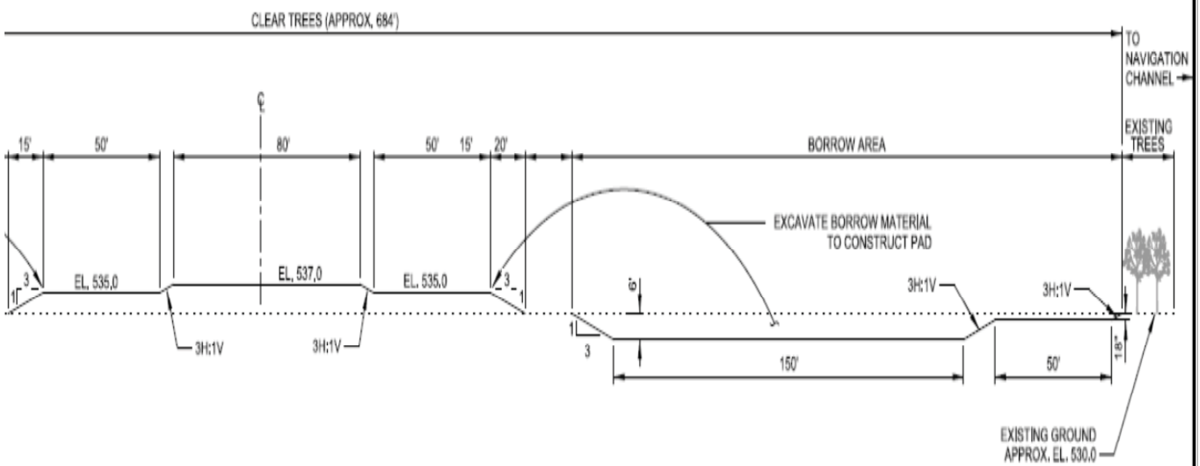
Planting

Hand Calculationis



APPENDIX M

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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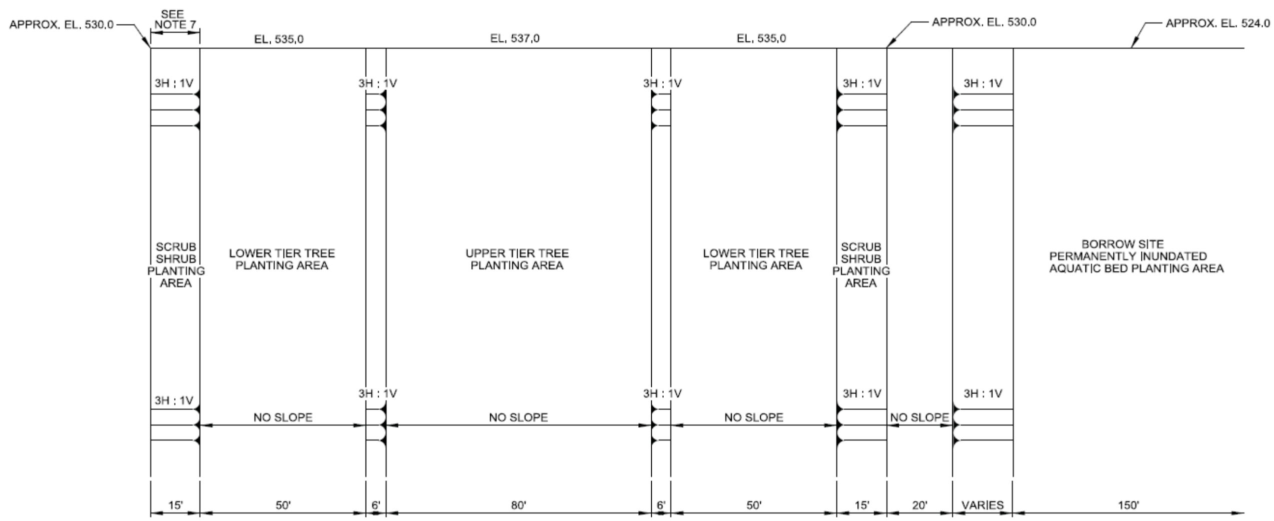
Seasonally Inundated Scrub/Shrub Wetland - EAV EL. 533-535



SISSW TOP Elevation	535.0		
			This will be plantined on the two slopes leading up from existing ground to the first tier
SISSW Bottom Elevation	533.0		
Elevation Change	2.0	FT	Y
Slope	3.0	H:1V	
	6.0	FT	X
Slope Distance	6.3	FT	Z = square root (X squared plus Y squared)
AREA	6,678.7	SF	A = Z*Length of Placement Site
Number of slopes	2.0		
Total Area	13,357.5	SF	
	0.2	AC	
Continency	20%		
	0.2	AC	
Acres to Plant	**0.2**	AC	APPLY VALUE TO PLANTING SHEET

APPENDIX M

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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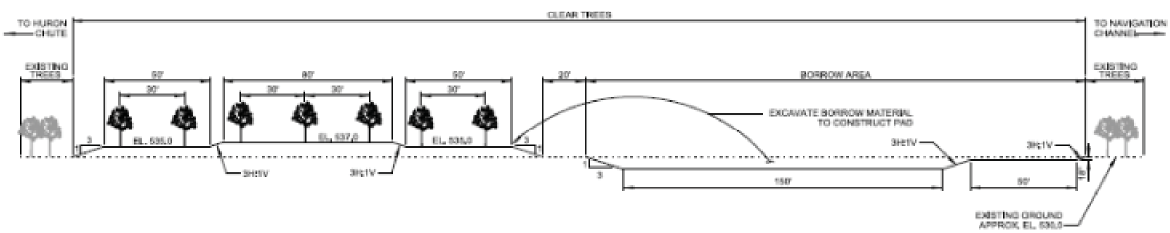
Temporarily Inundated Forested Wetland Trees



Top Tier	80.0	FT		
Bottom Tier Nav	50.0	FT		
Bottom Tier Huron	50.0	FT		
Total Width	180.0	FT		
Tier Area	190,080.0	SF		length of pad * Total Tier width
	4.4	AC		
One plot is one acre total so assume we can have	4.4	PLOTS		

REVIEW TREE LAYOUT SHEET FOR # TREES PER SPECIES PER PLOT

Tier Combinations are for 1/2 acre plots, so can plant	8.7	PLOTS		
	#3 RPM	#5 RPM	# 15 RPM	
PLOT 1	4.0	0.0	1.0	trees per species
PLOT 2	4.0	2.0	0.0	trees per species
PLOT 3	0.0	2.0	1.0	trees per species
PLOT 4	4.0	2.0	0.0	Trees per species
PLOT 5 (1/2 Plot 1)	4.0	0.0	1.0	Trees per species
TOTAL TREES SIZES PER SPECIES	**16.0**	**6.0**	**3.0**	**Trees per species**

APPENDIX M

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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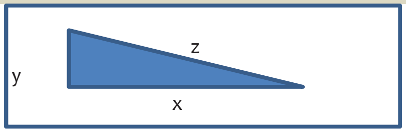
Termporarily Inundated Forested Wetland Shrubs

Top Tier Width	80.0	FT	
Huron Tier Width	50.0	FT	
Navigation Tier Width	50.0	FT	
Total Tier Width	180.0	FT	
Tier Area	190,080.0	SF	Tier width * length of pad
	4.4	**AC**	

Seasonally Inundated Emergent Wetland - EAV



SIEW TOP Elevation	534.0		
SIEW Bottom Elevation	531.0		
Elevation Change	3.0	FT	Y
Slope	3.0	H:1V	
	9.0	FT	X
Slope Distance	9.5	FT	Z = square root (X squared plus Y squared)
AREA	10,018.1	SF	A = Z*Length of Pad
	0.2	AC	
Contingency	20%		
	0.3	AC	
Acres to Plant	**0.3**	AC	APPLY VALUE TO PLANTING SHEET

Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed - EAV

IE to SPIAB TOP Elevation	532.0		
IE to SPIAB Bottom Elevation	530.0	Should be 529 but existing ground closer to 530 so use this	
Elevation Change	2.0	FT	Y
Slope	3.0	H:1V	
	6.0	FT	X
Slope Distance	6.3	FT	Z = square root (X squared plus Y squared)
AREA	6,678.7	SF	A = Z*Length of Pad
	0.2	AC	
Continency	20%		
	0.2	AC	
Acres to Plant	**0.2**	AC	APPLY VALUE TO PLANTING SHEET

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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Permanently Inundated Aquatic Bed - SAV
(EL. 526-529; Borrow Site Bottom

PIAB TOP Elevation	529.0		
PIAB Bottom Elevation	526.0	Should be 529 but existing ground closer to 530 so use this	
Elevation Change	3.0	FT	Y
Slope	3.0	H:1V	
	9.0	FT	X
Slope Distance	9.5	FT	Z = square root (X squared plus Y squared)
AREA	10,018.1	SF	A = Z*Length of Pad
Nav side slope	0.2	AC	
Huron side slope	0.2		
Total slope area	0.5		
Continency	20%		
	0.6	AC	
Acres to Plant	**0.6**	AC	APPLY VALUE TO PLANTING SHEET

REFER TO SHEET CALLED T PLANTINGS TO SEE HOW THESE ACREAGES ARE CHANGED TO NUMBERS OF PLANTS

PIAB = ***Permanently Inundated Aquatic Bed - SAV***
IE to SPIAB = ***Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed - EAV***
SIEW = ***Seasonally Inundated Emergent Wetland***

REFER TO SHEET CALLED F PLANTINGS TO SEE HOW THESE ACREAGES ARE CHANGED TO NUMBERS OF PLANTS

SISSW refers to Seasonally Inundated Scrub Shrub Wetland

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

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Conclusions

ITEM NO.	DESCRIPTION	QTY	UNIT	[redacted]		
F5	Forest Pad - Trees Cleared	8	AC			
F5	Forest Pad - Trees Cleared Grubbed and Stripped	7	AC			
F5	Forest Pad - Terrestrial Fill Borrowed and Placed	22,800	CY			
F5	Forest Pad - Dredged Material Fill Borrowes and Placed	24,300	CY			
F5	Forest Pad - Shape to desired slopes elevations	1	LS			
F5	SISSW - Hibiscus - #3 RPM	2	EA			
F5	SISSW - Commone Elderberry - #3 RPM	2	EA			
F5	SISSW - Buttonbush - #3 RPM	2	EA			
F5	SISSW - Dogwood - #3 RPM	2	EA			
F5	SISSW - Sandbar Willow -#3 RPM	2	EA			
F5	Pounds per acre seed SISSW Seed Mix	1	EA			
F5	River Birch #3 RPM	16	EA			
F5	Bitternut Hickory #3 RPM	16	EA			
F5	Northern Pecan #3 RPM	16	EA			
F5	Shellbark Hickory #3 RPM	16	EA			
F5	Common Hackberry #3 RPM	16	EA			
F5	Common Persimmon #3 RPM	16	EA			
F5	Honey Locust #3 RPM	16	EA			
F5	Kentucky Coffeetree #3 RPM	16	EA			
F5	Black Walnut #3 RPM	16	EA			
F5	American Sycamore #3 RPM	16	EA			
F5	Swamp White Oak #3 RPM	16	EA			
F5	Bur Oak #3 RPM	16	EA			
F5	Pin Oak #3 RPM	16	EA			
F5	American Basswood #3 RPM	16	EA			
F5	Overcup Oak #3 RPM	16	EA			

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

9/27/12 12:17 PM

F5	River Birch #5 RPM	6	EA	[redacted]		
F5	Bitternut Hickory #5 RPM	6	EA	[redacted]		
F5	Northern Pecan #5 RPM	6	EA	[redacted]		
F5	Shellbark Hickory #5 RPM	6	EA	[redacted]		
F5	Common Hackberry #5 RPM	6	EA	[redacted]		
F5	Common Persimmon #5 RPM	6	EA	[redacted]		
F5	Honey Locust #5 RPM	6	EA	[redacted]		
F5	Kentucky Coffeetree #5 RPM	6	EA	[redacted]		
F5	Black Walnut #5 RPM	6	EA	[redacted]		
F5	American Sycamore #5 RPM	6	EA	[redacted]		
F5	Swamp White Oak #5 RPM	6	EA	[redacted]		
F5	Bur Oak #5 RPM	6	EA	[redacted]		
F5	Pin Oak #5 RPM	6	EA	[redacted]		
F5	American Basswood #5 RPM	6	EA	[redacted]		
F5	Overcup Oak #5 RPM	6	EA	[redacted]		
F5	River Birch #15 RPM	3	EA	[redacted]		
F5	Bitternut Hickory #15 RPM	3	EA	[redacted]		
F5	Northern Pecan #15 RPM	3	EA	[redacted]		
F5	Shellbark Hickory #15 RPM	3	EA	[redacted]		
F5	Common Hackberry #15 RPM	3	EA	[redacted]		
F5	Common Persimmon #15 RPM	3	EA	[redacted]		
F5	Honey Locust #15 RPM	3	EA	[redacted]		
F5	Kentucky Coffeetree #15 RPM	3	EA	[redacted]		
F5	Black Walnut #15 RPM	3	EA	[redacted]		
F5	American Sycamore #15 RPM	3	EA	[redacted]		
F5	Swamp White Oak #15 RPM	3	EA	[redacted]		
F5	Bur Oak #15 RPM	3	EA	[redacted]		
F5	Pin Oak #15 RPM	3	EA	[redacted]		
F5	American Basswood #15 RPM	3	EA	[redacted]		
F5	Overcup Oak #15 RPM	3	EA	[redacted]		
F5	Tree Wrap - Each	375	EA	[redacted]		
F5	Tree Exclsoure - Each	375	EA	[redacted]		
F5	Herbicide Treatment - ACRES	5	EA	[redacted]		
F5	Understory seed mixture at 10 pounds per acre	5	AC	[redacted]		
F5	SIEW - Sedges -Tuber	105	EA	[redacted]		
F5	SIEW - Bulrush -Tuber	105	EA	[redacted]		
F5	SIEW - Blueflag Iris -Tuber	105	EA	[redacted]		
F5	SIEW - Sweet Flag -Tuber	105	EA	[redacted]		

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

9/27/12 12:17 PM

F5	Pounds per acre seed SIEW Seed Mix	1	EA	[redacted]			
F5	IE to SPIAB - Waterwillow -Tuber	72	EA	[redacted]			
F5	IE to SPIAB - Arrowhead - Tuber	72	EA	[redacted]			
F5	IE to SPIAB - Pickerelweed - Tuber	72	EA	[redacted]			
F5	IE to SPIAB - Smartweed - Tuber	72	EA	[redacted]			
F5	PIAB - Illinois Pondweed - Tuber	168	EA	[redacted]			
F5	PIAB - Sago Pondweed - Tuber	168	EA	[redacted]			
F5	PIAB - American Wild Celery -Tuber	168	EA	[redacted]			
F5	PIAB - Coontail - Tuber	168	EA	[redacted]			
F5	PIAB - American Elodea - Tuber	168	EA	[redacted]			
F5	PIAB and others, including testing and analysis	1	LS	[redacted]			

APPENDIX M

F5: Floodplain Forest Diversity, Forest Diversity in Non-Diverse Forsest Location Using Existing Soil (537 Top)

9/27/12 12:17 PM

Computation Checks	
Review Stage	DPR DQCR
Check Comments	Make sure to add inroads information and any data files; Add tree assumptions (not sure where the # of trees per species came from under temporarily inundated forested wetland trees); Check the qty for tree wrap and tree exclosure. Clearing requirement - hand calculations-checked the pad width; Seeding-hand calculations- check the lower side and upper side shelves, Reviewed by Julie Millhollin, EC-DN, August 28, 2012
Resolution of Comments	Inroads information and data files added. Trees assumption added to tree layout sheet, and added drawing, Updated pad width (change 5 to 50 for one of the tier widths). Checked quantity for tree wrap and calculated out. Rounded up seeding requiremesnt to 1 acre. KNM 9/5/2012
Checked By:	MILLHOLLIN.JULIE.L.1147612512 Digitally signed by MILLHOLLIN.JULIE.L.1147612512 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=OSD, cn=MILLHOLLIN.JULIE.L.1147612512 Date: 2012.09.27 14:56:41 -05'00'
Submitted By:	MITVALSKY.KARA.N.1230379137 Digitally signed by MITVALSKY.KARA.N.1230379137 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MITVALSKY.KARA.N.1230379137 Date: 2012.10.09 11:46:46 -05'00'

"F" Plantings

9/27/12 12:36 PM

Seasonally Inundated Scrub/Shrub Wetland - EAV EL. 533-535									
Potted Plant density TBD by ERDC									
#3 Size RPM (container at 10-1/8" diameter, 7-1/2" depth) density at 50 shrubs per acre									
Common	**Scientific**	**RPM**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Per acre		(acres -->)			0.97	1.18	0.19
Hibiscus	*Hibiscus lasiocarpos*	*10*	SISSW - Hibiscus - #3 RPM	$ 23.54	[redacted]	[redacted]	10	12	2
Common Elderberry	*Sambucus canadensis*	*10*	SISSW - Commone Elderberry - #3 RPM	$ 23.54	[redacted]	[redacted]	10	12	2
Buttonbush	*Cephalanthus occidentalis*	*10*	SISSW - Buttonbush - #3 RPM	$ 23.54	[redacted]	[redacted]	10	12	2
Dogwood	*Cornus stolonifera*	*10*	SISSW - Dogwood - #3 RPM	$ 23.54	[redacted]	[redacted]	10	12	2
Sandbar Willow	*Salix interior*	*10*	SISSW - Sandbar Willow -#3 RPM	$ 23.54	[redacted]	[redacted]	10	12	2
SISSW Seed Mix	*seed mixture of the above*	*10*	Pounds per acre seed SISSW Seed Mix	$ 171.83	[redacted]	[redacted]	1	2	1

Temporarily Inundated Forested Wetland Trees (EL. 535 - 537; top tiers)									
#3 Size RPM (container at 10-1/8" diameter, 7-1/2" depth) density at 120 trees per acre spaced 20' x 20'									
#5 Size RPM (container at 11-7/8" diameter, 11" depth) density at 60 trees per acre spaced 30' x 30'									
#15 Size RPM (container at 18-3/8" diameter, 12-1/8" depth) density at 30 trees per acre spaced 40' x 40'									
Common	**Scientific**	**#3 Density**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Tree Species Per Acre		(acres -->)			Yes	Yes	Yes
River Birch	*Betula nigra*		River Birch #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Bitternut Hickory	*Carya cordiformis*		Bitternut Hickory #3 RPM	$ 25.77	[redacted]	[redacted]	8	10	16
Northern Pecan	*Carya illinoinensis*		Northern Pecan #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Shellbark Hickory	*Carya laciniosa*		Shellbark Hickory #3 RPM	$ 25.77	[redacted]	[redacted]	8	10	16
Common Hackberry	*Celtis occidentalis*		Common Hackberry #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Common Persimmon	*Diospyros virginiana*		Common Persimmon #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Honey Locust	*Gleditsia triacanthos*		Honey Locust #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Kentucky Coffeetree	*Gymnocladus dioicus*		Kentucky Coffeetree #3 RPM	$ 25.77	[redacted]	[redacted]	8	10	16
Black Walnut	*Juglans nigra*		Black Walnut #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
American Sycamore	*Platanus occidentalis*		American Sycamore #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Swamp White Oak	*Quercus bicolor*		Swamp White Oak #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Bur Oak	*Quercus macrocarpa*		Bur Oak #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Pin Oak	*Quercus palustris*		Pin Oak #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
American Basswood	*Tilia americana*		American Basswood #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Overcup Oak	*Quercus lyrata*		Overcup Oak #3 RPM	$ 25.26	[redacted]	[redacted]	8	10	16
Common	**Scientific**	**#5 Density**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Tree Species Per Acre		(acres -->)			Yes	Yes	Yes
River Birch	*Betula nigra*		River Birch #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Bitternut Hickory	*Carya cordiformis*		Bitternut Hickory #5 RPM	$ 29.21	[redacted]	[redacted]	4	5	6
Northern Pecan	*Carya illinoinensis*		Northern Pecan #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Shellbark Hickory	*Carya laciniosa*		Shellbark Hickory #5 RPM	$ 29.21	[redacted]	[redacted]	4	5	6
Common Hackberry	*Celtis occidentalis*		Common Hackberry #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Common Persimmon	*Diospyros virginiana*		Common Persimmon #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Honey Locust	*Gleditsia triacanthos*		Honey Locust #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Kentucky Coffeetree	*Gymnocladus dioicus*		Kentucky Coffeetree #5 RPM	$ 45.79	[redacted]	[redacted]	4	5	6
Black Walnut	*Juglans nigra*		Black Walnut #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
American Sycamore	*Platanus occidentalis*		American Sycamore #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Swamp White Oak	*Quercus bicolor*		Swamp White Oak #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Bur Oak	*Quercus macrocarpa*		Bur Oak #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Pin Oak	*Quercus palustris*		Pin Oak #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
American Basswood	*Tilia americana*		American Basswood #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Overcup Oak	*Quercus lyrata*		Overcup Oak #5 RPM	$ 43.82	[redacted]	[redacted]	4	5	6
Common	**Scientific**	**#15 Density**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Tree Species Per Acre		(acres -->)			Yes	Yes	Yes
River Birch	*Betula nigra*		River Birch #15 RPM	$ 132.31	[redacted]	[redacted]	2	2	3
Bitternut Hickory	*Carya cordiformis*		Bitternut Hickory #15 RPM	$ 51.98	[redacted]	[redacted]	2	2	3
Northern Pecan	*Carya illinoinensis*		Northern Pecan #15 RPM	$ 132.31	[redacted]	[redacted]	2	2	3
Shellbark Hickory	*Carya laciniosa*		Shellbark Hickory #15 RPM	$ 51.98	[redacted]	[redacted]	2	2	3
Common Hackberry	*Celtis occidentalis*		Common Hackberry #15 RPM	$ 132.31	[redacted]	[redacted]	2	2	3

APPENDIX M

Common Persimmon	*Diospyros virginiana*		Common Persimmon #15 RPM	$ 132.31	[redacted]		2	2	3
Honey Locust	*Gleditsia triacanthos*		Honey Locust #15 RPM	$ 142.62	[redacted]		2	2	3
Kentucky Coffeetree	*Gymnocladus dioicus*		Kentucky Coffeetree #15 RPM	$ 142.62	[redacted]		2	2	3
Black Walnut	*Juglans nigra*		Black Walnut #15 RPM	$ 132.31	[redacted]		2	2	3
American Sycamore	*Platanus occidentalis*		American Sycamore #15 RPM	$ 132.31	[redacted]		2	2	3
Swamp White Oak	*Quercus bicolor*		Swamp White Oak #15 RPM	$ 132.31	[redacted]		2	2	3
Bur Oak	*Quercus macrocarpa*		Bur Oak #15 RPM	$ 132.31	[redacted]		2	2	3
Pin Oak	*Quercus palustris*		Pin Oak #15 RPM	$ 132.31	[redacted]		2	2	3
American Basswood	*Tilia americana*		American Basswood #15 RPM	$ 132.31	[redacted]		2	2	3
Overcup Oak	*Quercus lyrata*		Overcup Oak #15 RPM	$ 132.31	[redacted]		2	2	3
MISCELLANESOU				**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
TREE WRAPS			Tree Wrap - Each	$ 4.99	[redacted]		210	255	375
TREE EXCLOSURES			Tree Exclsoure - Each	$ 63.01	[redacted]		210	255	375
Herbicide			Herbicide Treatment - ACRES	$ 68.75	[redacted]		3	4	5

Temporarily Inundated Forested Wetland Shrubs (TIERS_									
#3 Size RPM (container at 10-1/8" diameter, 7-1/2" depth) density at 50 shrubs per acre									
Common	**Scientific**	**PLANTS**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Per acre		(acres -->)			3.0	4.0	5.0
Common Buttonbush	*Cephalanthus occidentalis*	*10*	IFWS Common Buttonbush - #3 RPM Shru	$ 23.54	[redacted]		30	40	50
Eastern Redbud	*Cercis canadensis*	*10*	TIFWS Easterm Redbud - #3 RPM Shrub	$ 23.54	[redacted]		30	40	50
Red-Osier Dogwood	*Cornus stolonifera*	*10*	IFWS Red - Osier Dogwood - #3 RPM Shru	$ 23.54	[redacted]		30	40	50
Green Hawthorn	*Crataegus viridis*	*10*	TIFWS Green Hawthorn - #3 RPM Shrub	$ 23.54	[redacted]		30	40	50
Elderberry	*Sambucus canadensis*	*10*	TIFWS Elderberry - #3 RPM Shrub	$ 23.54	[redacted]		30	40	50

Understory Seed Mixture									
Seeding rate at 10 pounds per acre.									
Common Name	**Scientific Name**	**PLANTS**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Per acre		(acres -->)			3.0	Yes	Yes
			Understory seed mixture at 10 pounds per acre	$ 171.83	[redacted]		3	4	5
virginia wild rye	*Elymus virginicus*	[redacted]							
canada wild rye	*Elymus canadensis*								
partridge pea	*Chamaechrista fasciculata*								
Buttonbush	*Cephalanthus occidentalis*								
rice cut grass	*Leersia oryzoides*								
cardinal flower	*Lobelia cardinalis*								
sneezeweed	*Helenium autumnale*								

APPENDIX M

"T" Plantings

9/27/12 12:34 PM

Seasonally Inundated Emergent Wetland - EAV EL. 531-534									
Potted Plant density TBD by ERDC									
Tuber/Rhizonme density average 1,500 plants/acre									
Common	**Scientific**	**Tuber/Rhizone**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Per acre		(acres -->)	1.45	1.77			0.28
Sedges	*Carex spp.*	*375*	SIEW - Sedges -Tuber	$ 8.06	544	664			105.00
Bulrush	*Scirpus spp.*	*375*	SIEW - Bulrush -Tuber	$ 7.52	544	664			105.00
Blue Flag Iris	*Iris virginica*	*375*	SIEW - Blueflag Iris -Tuber	$ 8.60	544	664			105.00
Sweet Flag	*Acorus calamus*	*375*	SIEW - Sweet Flag -Tuber	$ 7.52	544	664			105.00
SIEW seed Mix		*10*	Pounds per acre seed SIEW Seed Mix	$ 5,584.00	2.00	2.00			1.00

Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed - EAV (EL. 529 - 532)									
Potted Plant density TBD by ERDC									
Tuber/Rhizonme density average 1,500 plants/acre									
Common	**Scientific**	**Bareroot Stock**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Per acre		(acres -->)	*1.45*	*1.77*			*0.19*
Waterwillow	*Justicia americana*	*375*	IE to SPIAB - Waterwillow -Tuber	$ 8.06	544	664			72.00
Arrowhead	*Sagitarria latifolia*	*375*	IE to SPIAB - Arrowhead - Tuber	$ 8.06	544	664			72.00
Pickerelweed	*Pontederia cordata*	*375*	IE to SPIAB - Pickerelweed - Tuber	$ 8.60	544	664			72.00
Smartweed	*Polygonum spp.*	*375*	IE to SPIAB - Smartweed - Tuber	$ 7.52	544	664			72.00

Permanently Inundated Aquatic Bed - SAV (EL. 526-529; lower dredge shelf)									
Potted Plant density TBD by ERDC									
Tuber/Rhizonme density average 1,500 plants/acre									
Common	**Scientific**	**Bareroot Stock**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
		Per Acre		(acres -->)	2.64	3.22			0.56
Illinois Pondweed	*Potamageton illinoisensis*	*300*	PIAB - Illinois Pondweed - Tuber	$ 9.90	792	966			168
Sago Pondweed	*P. pectinatus*	*300*	PIAB - Sago Pondweed - Tuber	$ 9.14	792	966			168
American Wild Celery	*Vallisneria americana*	*300*	PIAB - American Wild Celery -Tuber	$ 9.25	792	966			168
Coontail	*Ceratophyllum demersum*	*300*	PIAB - Coontail - Tuber	$ 9.14	792	966			168
American Elodea	*Elodea canadensis*	*300*	PIAB - American Elodea - Tuber	$ 9.14	792	966			168

ERDC Plantings									
Potted Plant density TBD by ERDC									
Common	**Scientific**	**UNIT**	**Item**	**Cost Each**	**T1**	**T3**	**F1**	**F3**	**F5**
				(acres -->)	Yes	Yes			Yes
PIAB and others, including testing and analysis		*1*	Lumps Sum	$ 80,000.00	1	1			1

APPENDIX M

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND COMPLEX
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX N

VALUE ENGINEERING

Huron Island Complex Habitat Rehabilitation and Enhancement Project

P2 Number - 134085

VALUE ENGINEERING STUDY REPORT

US Army Corps of Engineers ®

Value Engineering Study
Report Number CEMVR-VE-FY12-01
18-21 June 2012

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Table A-0-1: Brainstorming List 34

1 Executive Summary

1.1 Project Description

The U.S. Army Corps of Engineers, Rock Island District proposes to rehabilitate and enhance the Huron Island Complex through construction measures aimed at increasing the quality of year-round habitat for the fish community, increase diversity of floodplain forest vegetation, and improve the overall structure and function of the complex. The recommended plan for habitat rehabilitation and enhancement of the Huron Island Complex includes Bathymetric Diversity of Goose Lake backwater areas pool 1 and pool 2, forest diversity adjacent to pool 1 and pool 2 up to elevation 537, a closure structure in Garner Chute, chevrons for side channel islands, and forest diversity in non-diverse forested area to elevation 537.

1.2 Value Engineering Study Results

A Value Engineering (VE) Study following the six-phase VE methodology was conducted on 18-21 June 2012 for the Huron Island Complex Project. During the evaluation phase of the study, eight proposals were developed from the 49 generated ideas, and nine comments were developed. Additionally, 13 of the ideas were incorporated into other proposals or comments. All proposals are listed in Table 1-2 including the cost savings and the PDT decision on the proposal. It should be noted that all proposals that have been accepted will be given further consideration by the PDT. If the PDT determines the proposal is not feasible after looking into it further, the PDT will need to document that rationale.

1.3 Project Delivery Team Response Summary

A Value Engineering (VE) Study following the six-phase VE methodology was conducted on 18-21 June 2012 for the Huron Island Project by the St. Paul District. A copy of this report is available for review at the Rock Island District office. During the evaluation phase of the study, eight proposals were developed from the 49 generated ideas, and nine comments were developed. Additionally, 13 of the ideas were incorporated into other proposals or comments. It should be noted that all proposals that have been accepted will be given further consideration by the PDT. If the PDT determines the proposal is not feasible after looking into it further, the PDT will need to document that rationale. A list of proposals and comments are listed below. The survey datum reported in the VE study differed from the datum used in this report. Any incorporation into the final plan must use the appropriate survey datums.

Table 1-10. Value Engineering Proposals and potential incorporation into TSP

Proposal or Comment Number	Idea Number	Description	PDT response to VE Proposals and Comments
P4	4	Eliminate Riprap/Rockfill bedding	The PDT does not concur. Based on geotechnical analysis, the riprap and bedding layer as proposed in the report are appropriate for the uses in this area. More information is available in the report and in the

			geotechnical appendix.
P7	7	Lower riprap El (vanes)	The PDT does not accept this proposal. The quantities to construct this feature were significantly higher than similar bankline protection features, and the size of the structures would likely have an adverse impact on the floodplain analysis.
P8	8	Reduce Dredge depth	The PDT does not accept this proposal. Based on expected sedimentation rates over the project life, an additional 2 feet of dredging is required to maintain optimum dredge depths over 50 years.
P10	10	Change chevron shape from "C" to "Z" to direct flow away from the levee	The PDT does not accept this proposal since floodplain analysis shows adverse impacts.
P17	17	Reduce top width of structure	This proposal may be incorporated into the TSP. In plans and specifications a more detailed closure structure will be designed.
P26	26	Plant on higher ground	The PDT does not accept this proposal since the only area where there is higher ground is a culturally sensitive area.
P32	32	Do more backwater dredging to create forest	This proposal has been incorporated into the TSP. The pad has been moved to incorporate dredged material with the top soil.
P46	46	Only protect toe with riprap	The PDT does not accept this proposal since survey data shows the erosion is not occurring at the toe.
C1	1	Delete forested Area (F5)	The PDT does not accept this comment since this measure helps reestablish a portion of the significant loss of forest diversity that has occurred on Huron Island.
C12	12	LWD - Large Woody Debris	This comment may be incorporated into the TSP during plans and specifications. Incorporation of woody debris will be discussed with ERDC for design and has been added to the cost of the project. Woody debris in the form of locked logs has been added to this project.

C18	18	Introduce flow to dredge area or monitor	This comment has been incorporated into the TSP as part of the adaptive management of the TSP.
C19	19	Rethink the need for shoreline riprap	The PDT does not accept this comment since the sponsor and PDT have noted visible erosion and recommend protection.
C27	27	More naturally shaped forest	The PDT does not accept this comment since the existing shape is a rectangle, although since the VE study was conducted, the location and orientation of the rectangle has changed. The rectangular shape was chosen to maximize areas for benefits, avoid adverse impacts to Indiana bats, and to assist with ease of construction. While it is rectangular in shape, once the site is developed and trees mature, the shape of the proposed site will not be as noticeable from the air, which would be the only way one might note that the shape is rectangular based on the remote interior location of the island. Since there is no habitat benefit to changing the shape, it will remain as shown on Plate 13 (C-104).
C47	47	Validate benefit calculations	This comment has been incorporated into the TSP. The habitat evaluation for topographic diversity was revised and corrected. The CE/ICA was updated as a result.
C48	48	Consider selection criteria	The PDT does not accept this comment since the team used ER1105-2-100 selection criteria for alternative selection.
C49	49	Consider sedimentation behind the structure	The AdH sediment transport modeling results indicate some minor changes in the sedimentation patterns within Garner Chute, however deposition of sediment throughout the 50-yr project life appears to be minimal.
C50	50	Cost Per Habitat Unit	The PDT does not accept this comment since ER1105-2-100 does not dictate a specific cost per habitat unit or

			justification when a $3, 000 thresh hold has been exceeded. However the PDT does concur that being aware of cost per habitat unit is an important part of project selection, since the VE a more refined cost/AAHU around $3K

Table 1-2 Proposals and Comments

Proposal (P) or Comment (C) Number	Idea Number	Description	PDT Recommendation	Potential Cost Savings
P4	4	Eliminate Riprap/Rockfill bedding		$84.6K
P7	7	Lower riprap EL (vanes)		$151K - $332K
P8	8	Reduce Dredge depth		$845K
P10	10	Change chevron shape from "C" to "Z" to direct flow away from the levee		$274K - $874K
P17	17	Reduce top width of structure		$283K
P26	26	Plant on higher ground		$1.23M
P32	32	Do more backwater dredging to create forest		N/A
P46	46	Only protect toe with riprap		$113K
C1	1	Delete forested Area (F5)		N/A
C12	12	LWD - Large Woody Debris		N/A
C18	18	Introduce flow to dredge area or monitor		N/A
C19	19	Rethink the need for shoreline riprap		N/A
C27	27	More naturally shaped forest		N/A
C47	47	Validate benefit calculations		N/A
C48	48	Consider selection criteria		N/A
C49	49	Consider sedimentation behind the structure		N/A
C50	50	Cost Per Habitat Unit		N/A

2 Value Engineering Study

2.1 Study Objectives

Value Engineering (VE) is a process used to study the functions a project is to achieve. VE takes a critical look at how these functions are proposed to be met and it identifies alternative ways to achieve the equivalent function while increasing the value and the benefit ratio of the project. In the end, it is hoped that the project will realize a reduction in cost, but increased value is the focus of the process, rather than simply reducing cost.

2.2 Value Engineering Methodology

The VE methodology was studied using the Corps of Engineering standard VE methodology, consisting of six phases:

Information Phase: During the information phase, the team reviewed the documents and current conditions of the project. During this Phase, the team identifies the goals of the study and answers the following questions: what is the project, what does the project do, what must the project do, and what does the project cost.

Function Analysis Phase: During the function analysis phase, the team defined the project functions using a two-word active verb/measurable noun context to develop a Function Analysis System Technique (FAST) Diagram. The team took a critical look at how these functions are being met, and the team identified alternative ways to achieve the equivalent function while increasing the value of the project.

Creativity Phase: During the creative phase, the team conducts a brainstorming session to generate ideas for alternative designs. All team members contributed ideas. Critical analysis of the ideas was discouraged. A complete list of the ideas generated during the creative phase is included in Appendix A. This list indicates which ideas were developed during later phases of the process.

Evaluation Phase: Evaluation, testing, and critical analysis of all ideas generated during the creative phase, was performed during the evaluation phase to determine potential for savings and possibilities for risk. The team determined which of the ideas generated should be developed into proposals and which should be developed into comments. All other ideas were either being done or were determined by the team not to be feasible. These ideas were discarded from further development.

Development Phase: The VE team members developed the selected ideas from the evaluation phase into proposals and comments during the development phase. Proposal descriptions, along with sketches, technical support documentation, and cost estimates were prepared to support implementation of ideas. Additional comments were included for items of interest that were not developed as proposals.

Presentation Phase: A formal presentation was conducted after the study was complete. A draft VE Study Report was distributed for review and coordination by the Project Delivery Team (PDT) for determination of recommended action for each Proposal. After the recommended action has been supplied to the VE team, the recommended action will be noted with each proposal. An "accepted" recommendation means that the team will give the proposal additional consideration. If the value-added-accepted proposal is not incorporated into the final design, the PDT will need to document that rational in the final product.

2.3 Value Engineering Team

The Value Engineering Team is listed in Table 2-1. The PDT members who briefed the VE team are listed in Table 2-2.

Table 2-1: Value Engineering Study Team Members

Adéle L. Braun, AVS, P.E. USACE-MVP-VEO	Facilitator Structural Engineer	adele.l.braun@usace.army.mil 651-290-5643
Steven J. Clark USACE-MVP-PD-P	Fishery Biologist	steven.j.clark@usace.army.mil 651-290-5278
Ryan Price, P.E. USACE-MVP-ED-C	Geotechnical Engineer	greta.f.schmalle@usace.army.mil 651-290-5651
Jon S. Hendrickson, P.E. USACE-MVP-EC-H	Hydraulic Engineer	jon.s.hendrickson@usace.army.mil 651-290-5634
Jeffrey L. Hansen, P.E. USACE-MVP-EC-D	Cost Engineer	jeffrey.l.hansen@usace.army.mil 651-290-5649

Table 2-2: Product Delivery Team Members who briefed the VE Team

Monique E. Savage USACE-MVP-PD-F	PDT Member Technical Coordinator	monique.e.savage@usace.army.mil 309-794-5342
Kara N. Mitvalsky USACE-MVR-EC-DN	PDT Member, P.E. Project Engineer	kara.n.mitvalsky@usace.army.mil 309-794-5623
Nathan S. Richards USACE-MVR-PD-P	PDT Member Environmental Studies	nathan.s.richards@usace.army.mil 309-794-5286
Lucie M. Sawyer USACE-MVR-EC-HH	PDT Member, P.E. Hydraulic Engineer	lucie.m.sawyer@usace.army.mil 309-794-5836

3 Phase 1 – Information Phase

3.1 Information Phase

During the information phase, the team reviewed the documents and current conditions of the project. It was at this time that the team identified the goals of the study and answered the following questions: what is the project, what does the project do, what must the project do, and what does the project cost.

3.2 Project Description

The U.S. Army Corps of Engineers, Rock Island District proposes to rehabilitate and enhance the Huron Island Complex through construction measures aimed at increasing the quality of year-round habitat for the fish community, increase diversity of floodplain forest vegetation, and improve the overall structure and function of the complex. The recommended plan for habitat rehabilitation and enhancement of the Huron Island Complex includes Bathymetric Diversity of Goose Lake backwater areas pool 1 and pool 2, forest diversity adjacent to pool 1 and pool 2 up to elevation 537, a closure structure in Garner Chute, chevrons for side channel islands, and forest diversity in non-diverse forested area to elevation 537.

3.3 Project Location

As shown in Figure 3-1, the Huron Complex is located along the right descending bank of the Upper Mississippi River in the northern portion of Des Moines County, IA. The project area is in Pool 18 between river miles 421.2 and 423.4, approximately 20 miles upstream of Burlington, Iowa. The elevations near are around the complex varies significantly. The topographic and bathometric map shown in Figure 3-2 was used to distinguish these elevation changes.

3.4 Project Datum

The information that was presented to the Value Engineering team is in NAVD88. All resulting proposals and comments that use elevations are given in NAVD88.

3.5 Cost Breakdown

A cost breakdown for the project was developed during the informational phase so that the Value Engineering team could easily track the cost of the project features. The cost breakdown for the Huron Island Complex Project is shown in Figure 3-3. Based on this cost breakdown, the Value Engineering Team focused on a number of project features including E1 – Bank Stabilization, F5 – Forest area, T1 – Goose Lake Pool 1, T2 – Goose Lake Pool 2, and I2 – Side Channel Island Chevrons. After developing the second cost breakdown, as shown in Figure 3-4, it was clear that the floodplain forest diversity and the aquatic topographic diversity were the items that represented nearly 70 percent of the project cost.

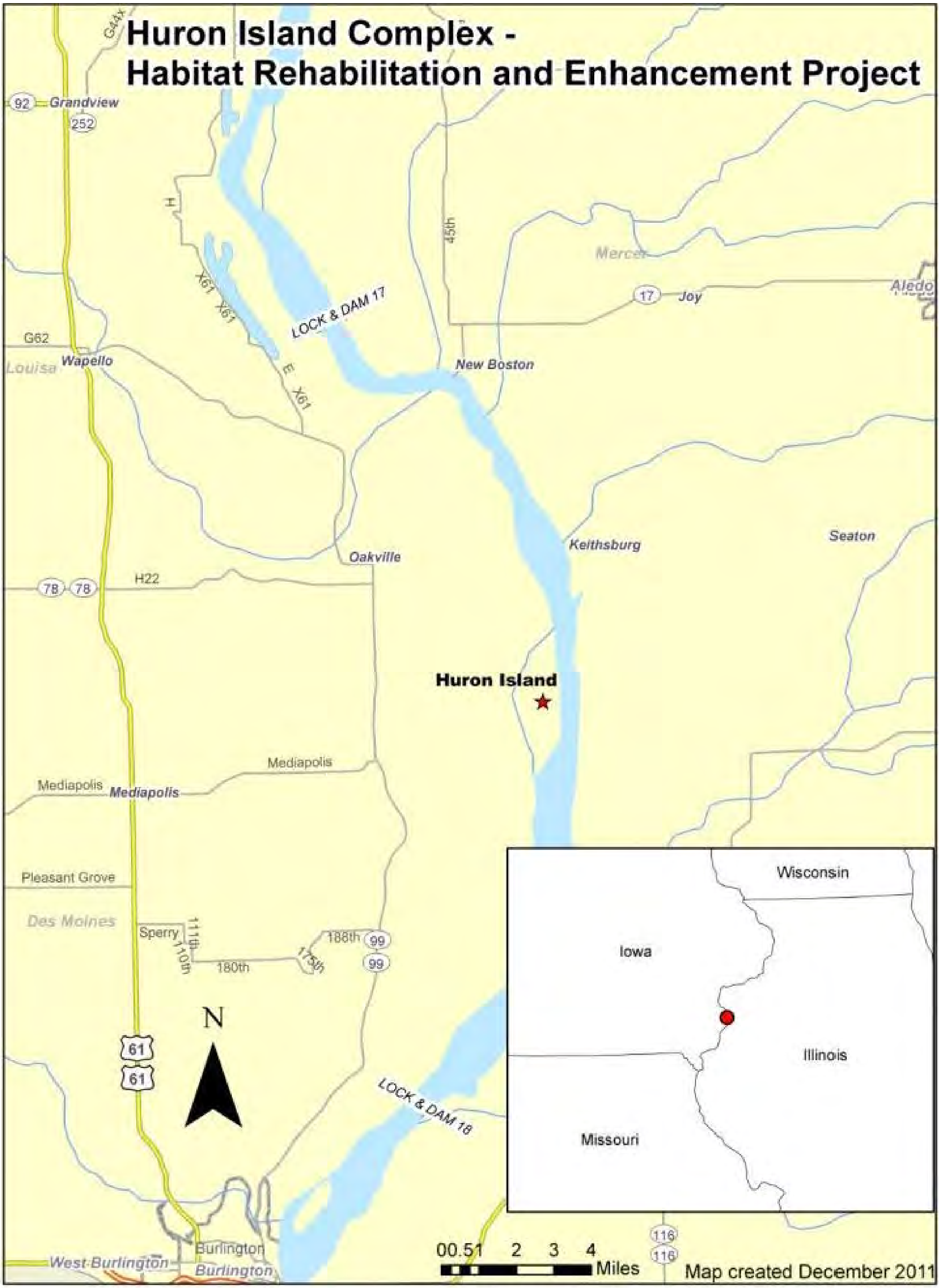

Figure 3-1: Huron Island Complex Location Map

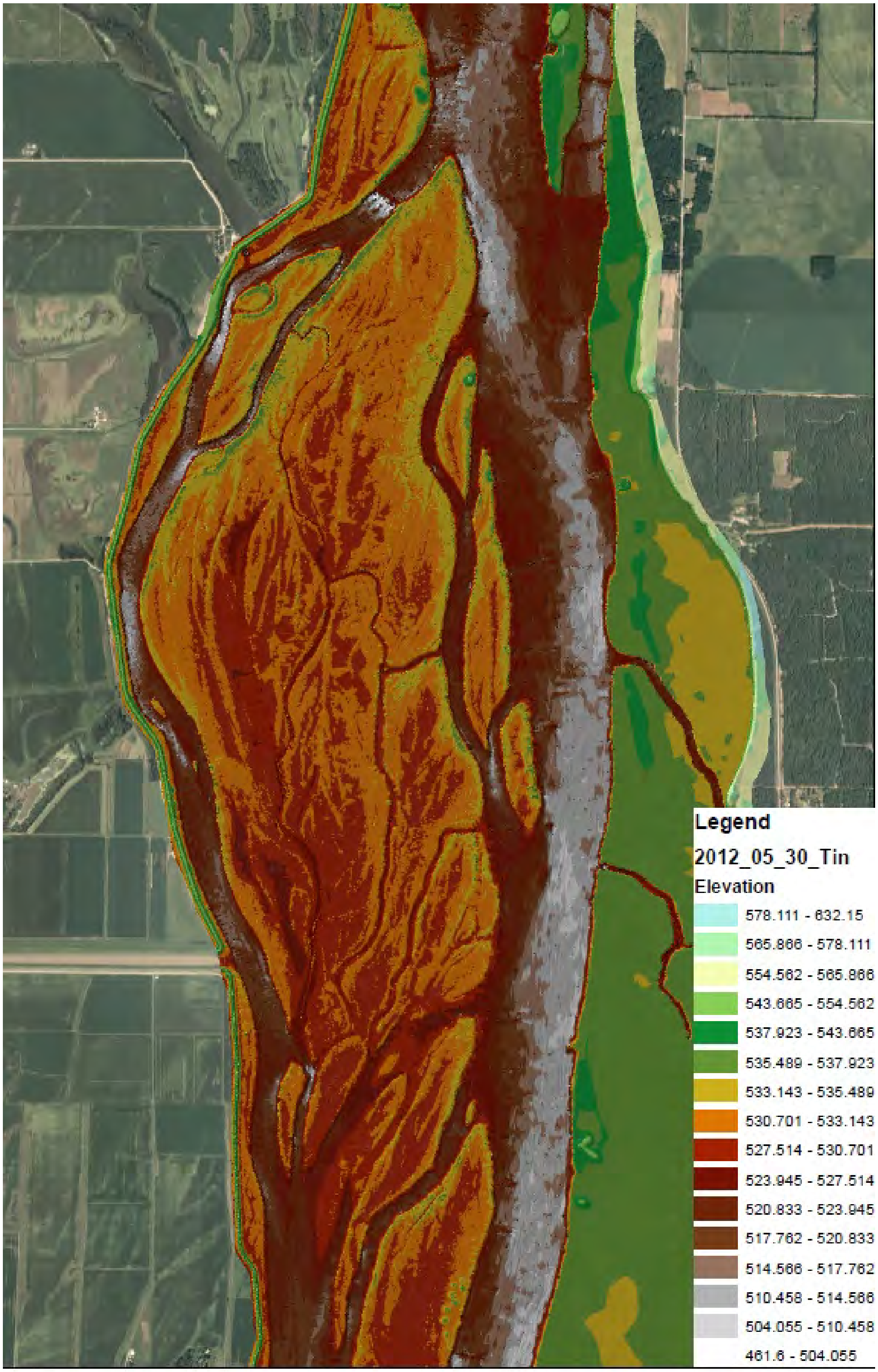

Figure 3-2: Topographic and Bathymetric Map

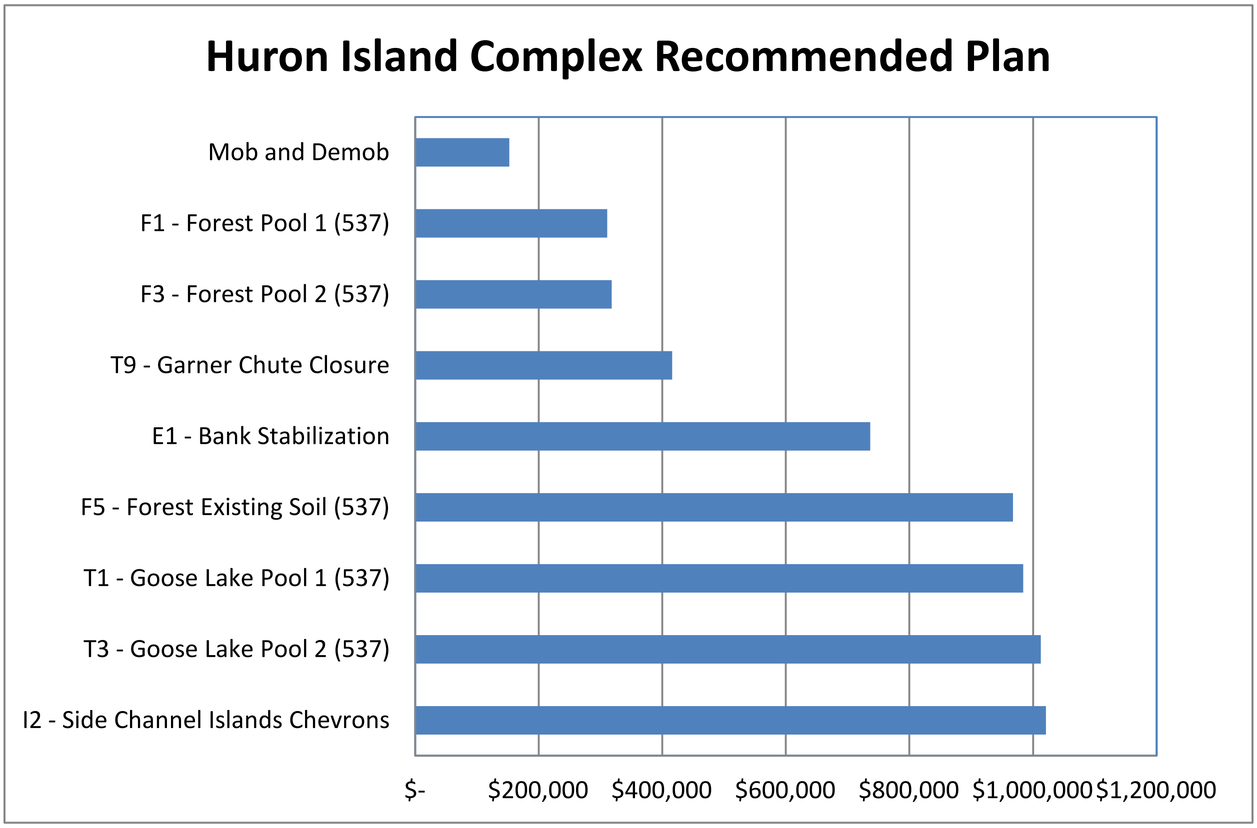

Figure 3-3: Huron Island Complex Cost Breakdown

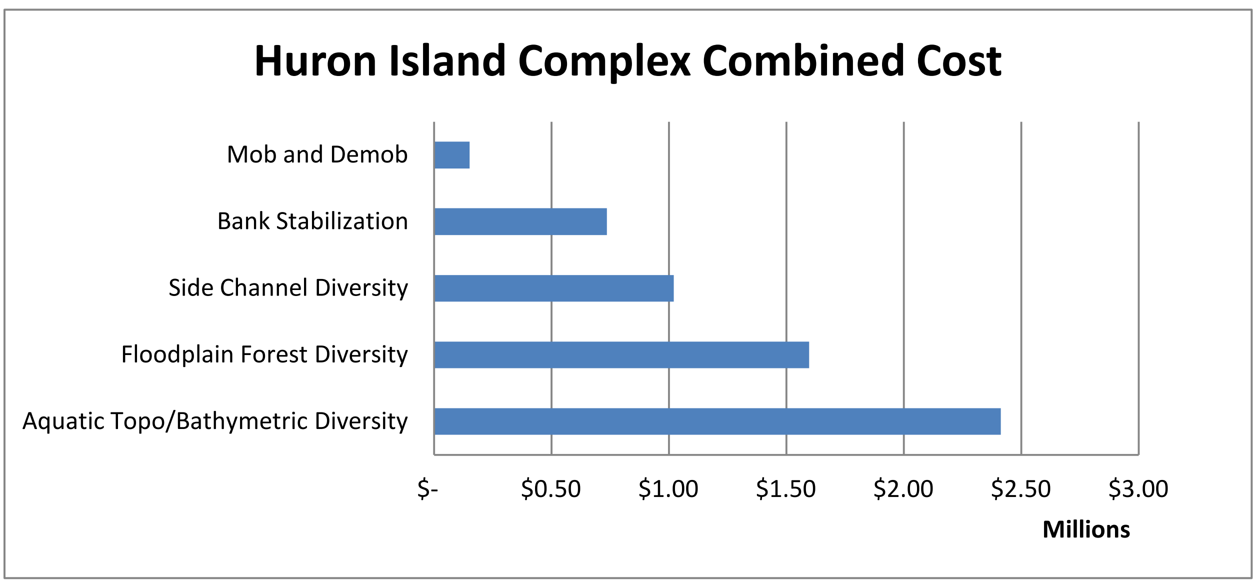

Figure 3-4: Huron Island Complex Combined cost Breakdown

4 Phase 2 – Function Analysis Phase

4.1 FAST Diagram Development

During the function analysis phase, the team defined the project functions using a two-word active verb/measurable noun context. The team took a critical look at the functions of the project features while considering the goals of the project. The Function Analysis System Technique (FAST) Diagram that was developed for the project is included in Figure 4-1. The FAST Diagrams were later referenced during the evaluation of creative ideas to help the VE team members determine if ideas added value to the project by focusing on the function of the project.

4.2 FAST Diagram Discussion

The FAST diagram was developed considering the project purpose and the project features. Upon further consideration, the VE Study Team identified potentially unneeded functions only present in the FAST diagram because they were project features. These functions are shaded red for distinction in the FAST diagram. An example of this is the function "Raise Island" following plant trees. In this case, "Plant Trees" could be the lowest order function defining how to "Diversify Forest"; however, the recommend plan included placing rock, excavating material, and dredging the channel, all lowest order function describing how to "Diversity Forest", so the VE study team retained these functions in the FAST diagram

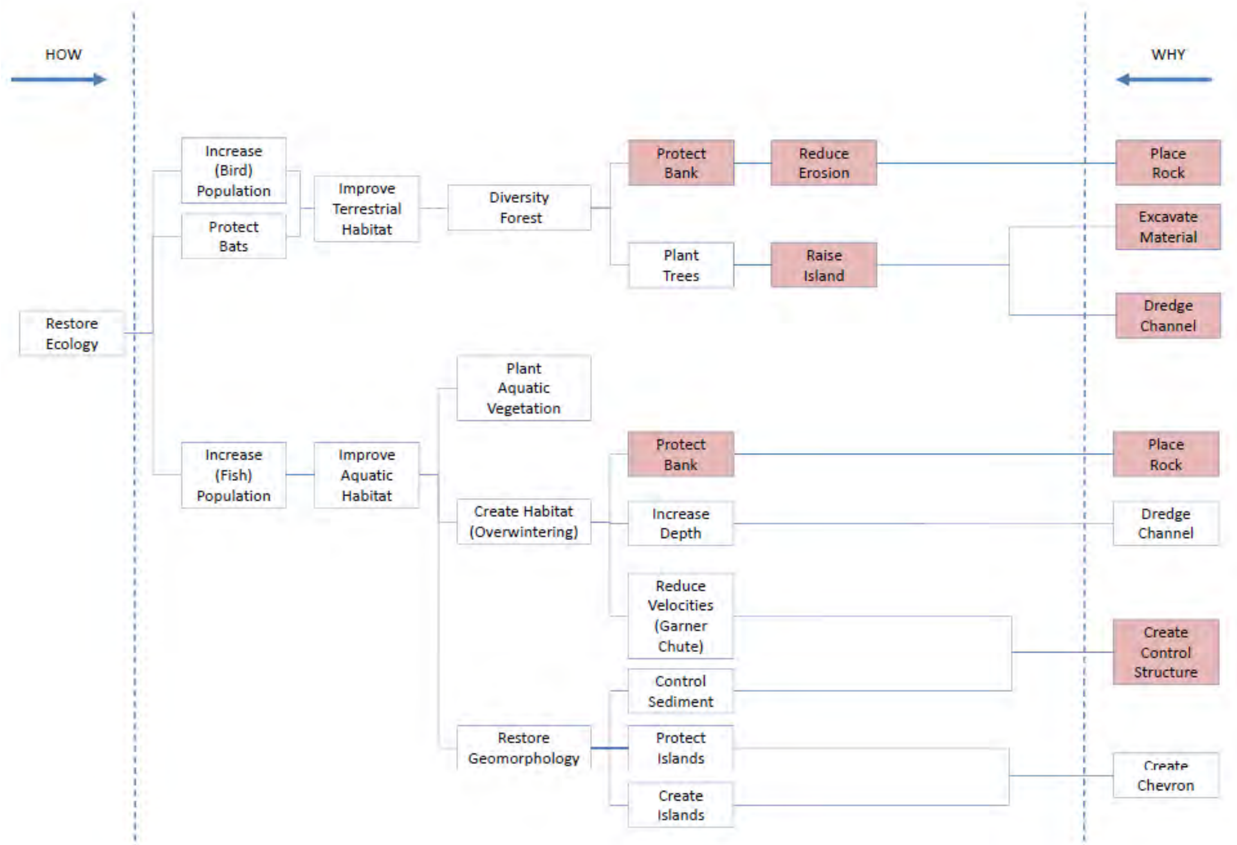

Figure 4-1: FAST Diagram – Huron Island Complex

5 Phase 3 – Creative Phase/Phase 4 – Evaluation Phase

5.1 Creative Phase

During the creative phase, the team conducted a brainstorming session to generate ideas for alternative designs. All team members contributed ideas. Critical analysis of the ideas was discouraged. A complete list of the ideas generated during the creative phase is included in Appendix A. This list indicates which ideas were developed during later phases of the process.

5.2 Evaluation Phase

Evaluation, testing, and critical analysis of all ideas generated during the creative phase, was performed during the evaluation phase to determine potential for savings and possibilities for risk. The team determined which of the ideas generated should be developed into proposals and which should be developed into comments. All other ideas were either being done or were determined by the team not to be feasible. These ideas were discarded from further development.

5.3 Summary of Comments and Proposals

During the evaluation phase of the study, eight proposals were developed from the 49 generated ideas, and nine comments were developed. Additionally, 13 of the ideas were incorporated into other proposals or comments. The study team member developing the specific proposal selected the best alternative and developed that concept. It should be noted that the PDT could reconsider some of the ideas that the study team member did not consider in the final proposal, but was noted in the creativity phase. To keep the comments and proposals referable to the speculation list, the item number used on the speculation list was retained as the comment or proposal number. If multiple speculation items were combined into one comment or proposal, the lowest item number on the speculation list was retained.

6 Phase 5 – Development Phase - Comments

6.1 Comment No. 1 – Reevaluate the Value of F5

The value of F5 appears to be low; therefore, the initiative for diverse forestation should be reevaluated. The cost to perform the work covering about 16.5 acres in F5 is $967,360. Assuming the habitat improvement is from a value of zero to perfect immediately after construction, which is not a reasonable assumptions, the average annual cost per habitat unit would be about $2,729. Additionally, it appears that only about 5 acres would actually be diverse forest habitat, further reducing the benefits. The majority of the construction cost of F5 is earthwork. If the earthwork was eliminated and planting was conducted in areas that are already high, about ten times more forest could be regenerated for the same cost. While it is understood that the F5 was to be a test section of diverse forest, there are ways to use the high ground around the project and still test how various species react at various elevations.

6.1.1 Project Delivery Team Response – Accepted/Rejected

The PDT accepts this comment. F5 is an important measure of the TSP since the measure helps reestablish a portion of the significant loss of forest diversity that has occurred on Huron Island. However, the PDT evaluated the design of F5 and it has been changed to decrease the amount of earthwork and cost associated with this project.

Upper Mississippi River Foresters have collectively been working regionally to gain insight on what specific elevation(s) will support bottomland hard and soft-mast floodplain tree species. Elevation differences of 6" within the floodplain forest, seemingly, is enough of a drastic change to support or not support certain "desirable" tree species. Survivability in relation to elevation will be incorporated within the study design of the forested area. Definitive answer to this question can then be applied regionally to allocate resources towards floodplain forest restoration with the highest survivability at reduced cost.

97% of the entire island complex is located below 535 (2-year flood). Although, the table in Section 2.4 of the existing conditions indicates 17 acres (0.9%) are at or above 536, these areas are diverse forested areas and sporadically located throughout the perimeter of the Complex and fall within culturally sensitive areas. The project footprint does not contain elevations greater than 534.

6.1 Comment No. 12 – Large Woody Debris (LWD)

Large woody debris should be incorporated into the project when opportunities present themselves. For instance, if trees are being cleared as part of reforestation plan, they could be used in various project features. The most likely places where this can be done include the bank stabilization (whether using vanes or using riprap), the Chevrons, and the dredge cut areas. LWD can be placed within the rock structures and anchored in place with rock. LWD or log bundles could be placed in the dredge cuts to provide additional fish habitat.

6.1.1 Project Delivery Team Response – Accepted/Rejected

The PDT concurs with this comment.

Trees will be used as locked logs for the shoreline protection feature associated with Measure T3. This is outlined in Chapter 6 of the report and shown on Plate 23 (Sheet C-304) of the AFB version of the report. Additionally, trees will be incorporated into other areas of the project to provide habitat or used within the channels to provide structure.

6.2 Comment No. 18 – Introduce Flow to Backwaters

After dredging the backwaters to create overwintering habitat, it could be beneficial introduce flow into those backwaters by dredging a connection between the Goose Lake pools and the Huron Chute. Because this project will be an adaptive management project, it is recommended that the habitat created for overwintering be monitored to ensure there is enough flow through these areas. If it is determined additional flow would benefit the habitat, then issue a separate contract to dredge a connecting channel.

6.2.1 Project Delivery Team Response – Accepted/Rejected

The PDT does not concur to make this change to the existing plan, but has incorporated it into the TSP as part of the adaptive management of the TSP.

The overwintering habitat we are trying to create is high temperature, low flow, high DO, and depth. Introducing flow into the backwater could potentially increase flow, decrease temperature, and increase sedimentation during overwintering. However, we are preparing to monitor the backwaters to ensure DO levels do not become a recurring problem in the winter. We do not feel it will become a problem, as there is sufficient circulation from Buffalo Slough and Gun Slough to keep DO levels from becoming lethal.

Hydraulic modeling as outlined in the appendices illustrates the risk of significantly increasing sedimentation in the Goose Lake pools by introducing a direct connection with Huron Chute exists, thereby demonstrating another reason for the PDT's non-concurrence.

6.3 If connectivity becomes an issue and the assumptions made are incorrect, adaptive management would allow for connectivity between pools. Please refer to the adaptive management appendix and Plates 38 (Sheet O-103) and 39 (Sheet O-104) for more details.Comment No. 19 – Shoreline Riprap Considerations

Shoreline protection is included in the project to address scour downstream of the islands in the Huron Chute. The scour has occurred due to the current hydraulic conditions in the chute. If a structure is added to Garner Chute, the PDT should reevaluate their expectation for the scour based on hydraulic modeling. The model may show that scour condition improve or worsen and the shoreline riprap should be placed accordingly. Additionally, the PDT should evaluate the extents, upstream and downstream, of the shoreline protection to ensure propped protection is being applied.

6.3.1 Project Delivery Team Response – Accepted/Reject

The PDT concurs with the need for evaluation using the hydraulic model. Hydraulic modeling was performed both with and without the Garner Chute closure structure alternative to determine impacts to downstream velocities. The closure structure resulted in negligible impacts to the existing velocity magnitudes and vectors near the eroded shoreline further downstream within Huron Chute. Therefore, the Garner Chute closure structure does not alleviate the need for shoreline protection along Huron Chute.

6.4 Comment No. 27 – More Naturally Shaped Forest

The Forest Diversity measure F5 is an unnatural looking rectangular area. It is proposed that the shape be contoured to a more natural looking pattern.

6.4.1 Project Delivery Team Response – Accepted/Reject

The PDT does not concur. The existing shape is a rectangle, although since the VE study was conducted, the location and orientation of the rectangle has changed. The rectangular shape was chosen to maximize areas for benefits, avoid adverse impacts to Indiana bats, and to assist with ease of construction. While it is rectangular in shape, once the site is developed and trees mature, the shape of the proposed site will not be as noticeable from the air, which would be the only way one might note that the shape is rectangular based on the remote interior location of the island. Since there is no habitat benefit to changing the shape, it will remain as shown on Plate 13 (C-104).

6.5 Comment No. 47 – Validate the habitat benefit calculations.

It appears that there may be inconsistencies in the habitat unit calculations. It is understood that the report is an early preliminary draft so this comment is included as a reminder to carefully check habitat unit calculations and provide clear explanations for how they are developed.

6.5.1 Project Delivery Team Response – Accepted/Reject

The PDT accepts this comment. The updated report and habitat evaluation appendix now includes revised areas of influence for each measure. The result is a separate acreage and rationale for each measure under consideration. The habitat unit and AAHU calculations are computational correct.

6.6 Comment No. 48 – Reconsider selection criteria

Section 5.5 of the report states:

> "The PDT inferred from the ICA that there was a discernible breakpoint and this plan maximizes benefits compared to cost. However, it only fulfills three of the four Project

objectives. To meet objective three, maintain and restore side-channel islands, measure I2 (chevrons) is required as a measure in the alternative."

This narrative implies that it is necessary to meet all project objectives regardless of cost/benefit analysis. It is understood that the PDT further reviewed the inclusion I2, but based on the information in Table 5-2, it appears that I2 has an average annual cost per average annual habitat unit (AAC/AAHU) of about $14,000. It does not seem that such a high cost would be incrementally justified. Basing the inclusion of this feature on the existence of an objective alone is highly suspect and could have adverse consequences when planning and/or setting objectives for future projects. It is recommended that the PDT reconsider their approach to plan selection.

6.6.1 Project Delivery Team Response – Accepted/Reject

The PDT does not concur with this comment since ER 1105-2-100 planning criteria wasused to justify the final array of alternatives. The Chevrons were both efficient (cost effective) and effective at meeting all of the project objectives. The team analyzed and determined that the uniqueness and quality of aquatic habitat the chevrons would create was worth cost. Cost per habitat is only one criterion out of many used to make a decision regarding the TSP.

Since the VE has been completed, the chevrons were shown to have a negative impact on flood heights so are no longer part of the TSP.

6.7 Comment No. 49 – Include the cost of E1.

The report makes it unclear as to where the costs of the E1 bank protection are included. Either the costs should be distributed among other features as appropriate, or the habitat unit benefits of constructing E1 need to be calculated and accounted for.

6.7.1 Project Delivery Team Response – Accepted/Reject

The PDT Concurs. Measure E1, at the time of the VE was an independent measure. However, the purpose of E1 is to protect T3, F3, T1 and F1, and was therefore incorporated with the costs of these measures and is no longer listed as a stand alone feature. This is further described in Chapter 6 of the report.

6.8 Comment No. 50 – Include justification for the high AAC/AAHU

While the planning for this project is understood to be in an early phase, the overall average annual cost per average annual habitat unit (AAC/AAHU) seems high at approximately $6,000-$7,000. The actual dollar amount is not explicitly listed or easy to decipher from the report. Typically, in the St. Paul District, anything at $2,000 or under is readily acceptable; however, when costs begin to exceed $3,000, additional justification is required explaining why the expensive increment is special enough to warrant the cost. It is recommended that special justification be included in the report or the AAC/AAHU be reduced.

6.8.1 Project Delivery Team Response – Accepted/Reject

The PDT does not concur. There is no reference in ER1105-2-100 that states an average cost per habitat unit or that additional justification is needed when a threshold is exceeded.

6.9 Comment No. 51– Sediment Transport in Garner Chute

MVP has constructed closure structures similar to the Garner Chute structure to reduce sediment to backwater areas. Our experience has been that, while the sediment load to the backwater is reduced, the channel that the structure is placed in responds geomorphically by getting shallower. This is a concern since one of the habitat benefits associated with constructing this structure is the creation of over-wintering fish habitat. The ADH model that you are proposing to do will help determine if sediment deposition is a problem.

6.9.1 Project Delivery Team Response – Accepted/Reject

PDT concurs with the need for evaluation using the hydraulic model. The AdH sediment transport modeling results indicate some minor changes in the sedimentation patterns within Garner Chute, however deposition of sediment throughout the 50-yr project life appears to be minimal.

7 Phase 5 - Development Phase – Proposals

7.1 Proposal No. 4 – Eliminate Riprap Bedding

7.1.1 Original Design

The original design consists of a bedding layer under the riprap bank protection. A typical section was included on Sheet C-108 and duplicated in Figure 7-1.

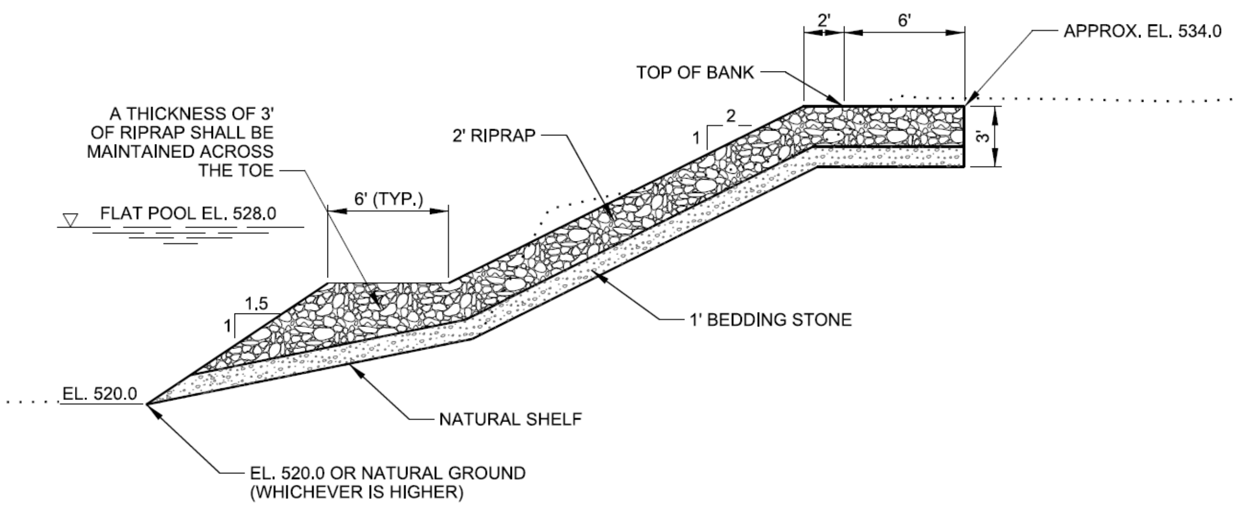

Figure 7-1: Proposal No. 4 Original Design

7.1.3 Proposed Design Change

The proposed design change is to eliminate the bedding layer and to use a rockfill section as the bank protection. The proposed rockfill gradation is as follows based on Percent passing in pounds: 100% 150 – 400 lbs; 50% 80 – 180 lbs; 5% 15 – 65 lbs

7.1.4 Advantages

1. Eliminates the bedding layer
2. Eliminates placement of two separate material layers
3. Reduced measurement of two separate materials
4. A rockfill material may be less expensive than the material cost for the bedding and riprap

7.1.5 Disadvantages

1. A rockfill layer typically is 50% thicker than a riprap layer.
2. The cost of the rockfill could be more expensive than the material cost for the bedding and riprap.

7.1.6 Discussion

Eliminating the bedding under the riprap has been successfully used for EMP projects in the St Paul District by using a rockfill layer. The rockfill layer is generally a thicker layer but it eliminates handling two different types of materials and the quality control issues of the placement of two thinner material layers versus one thicker layer.

7.1.7 Cost Worksheet

The total project savings for this alternative is an approximate cost savings of $84.6K, including mark-up and contingency. The unit cost for the rockfill was obtained as a quote from a local material supplier

DELETIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
MAIN ITEM				**$702,650**	**20.0%**	**$843,180**
Bedding Layer	TN	4700	$49.06	$230,582		
Riprap	TN	9300	$50.76	$472,068		
			Total Deletions:	**$702,650**		**$843,180**

ADDITIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
MAIN ITEM				**$643,932**	**20.0%**	**$772,718**
Rockfill	TN	13950	$46.16	$643,932		
			Total Additions:	**$643,932**		**$772,718**

Net Cost Decrease:	$58,718	$70,462
Mark-ups (20% - Design/Construction):	$11,744	$14,092
Total Cost Decrease:	**$70,462**	**$84,554**

7.1.8 Project Delivery Team Response – Accepted/Rejected

The PDT does not concur. Based on soil characteristics and geotechnical analysis, having a bedding layer as originally proposed is ideal for the uses in this area, as the bedding layer underneath the riprap would as a filter aimed to capture fines that manage to break free from the bank. In addition, there is no assurance that the rockfill material the VE team suggested as an alternative will contain the sufficient amount of small rock in other to obtain the same results. More information is available in the report and in the geotechnical appendix.

7.2 Proposal No. 7 –Rock Vane Alternative

7.2.1 Original Design

The recommend plan includes Measure E1, bank stabilization. The bank stabilization is shown on C-108 and replicated in Figure 7-2.

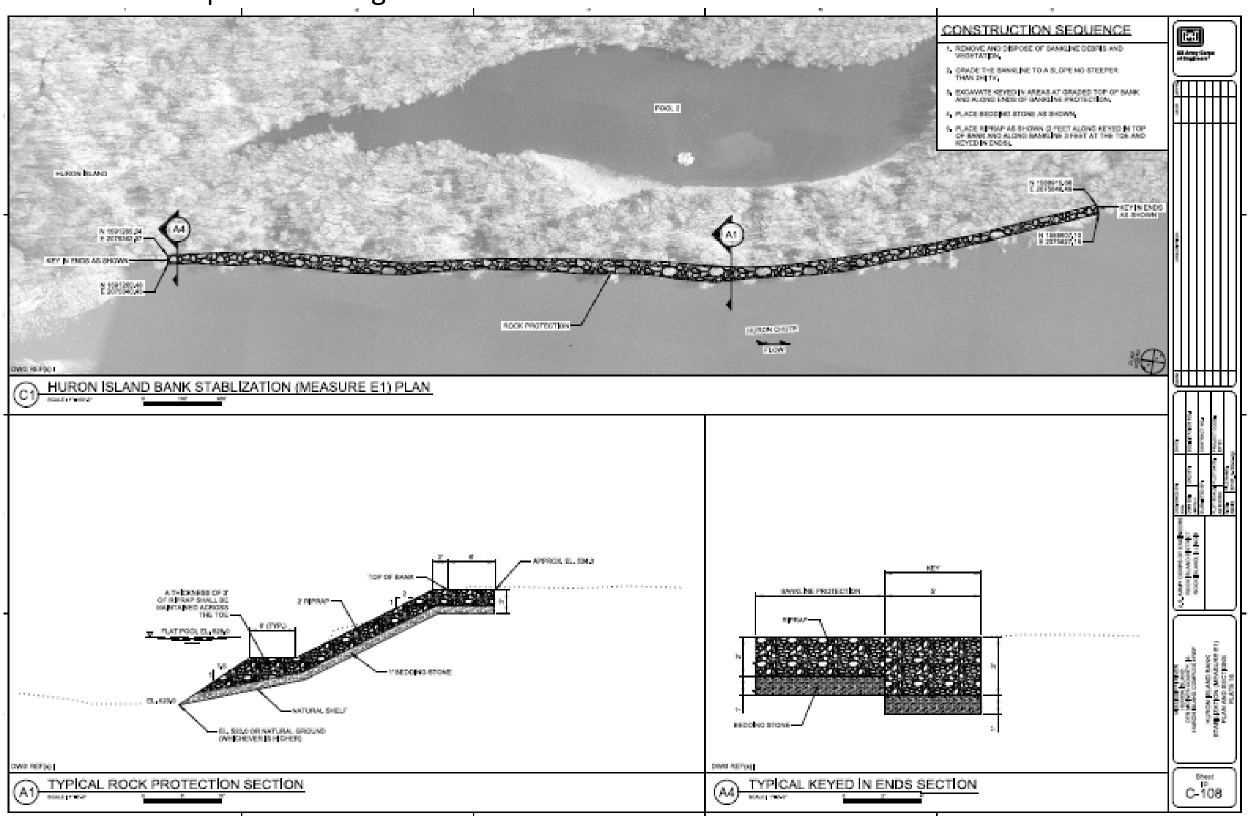

Figure 7-2: Proposal No. 7 – Original Design

7.2.2 Proposed Design Change

The proposed design change has two options. Option 1 involves reevaluating the volume of riprap required for the rock vane alternative. The second is to revise the rock vane alternative alternative, E2, and lowering the top elevation of the vanes to 535' to be consistent with the bank stabilization alternative (E1). In addition to lowering the top elevation, it is proposed to increase the spacing of the vanes to 4 times the vane length or 160 feet.

7.2.3 Advantages

1. Cost savings by reducing the amount of required riprap
2. Rock vanes provide additional habitat

7.2.4 Disadvantage

1. Although vanes have been used with great success on past projects, they do not carry with them the level of certainty that bank revetment does.

7.2.5 Discussion

The original rock vane alterative, which was eliminated from the recommended plan, consists of protecting the forested wetland by providing bank line protection by use of rock vanes. This alternative consisted of 40-foot long vanes spaced at 120 feet that make a 20-degree angle with the shoreline as shown on sheet C-109 and replicated in Figure 7-3. According to the Huron Definite Project Report (DPR), the rock vane alternative E2 was eliminated from further evaluation due to high costs in comparison to the bank revetment alternative. Because rock vanes are typically a less expensive alternative to bank revetment, rock quantities were recalculated during the VE Study. In the cost summary spreadsheet, "Revised Cost Summary of Measures Huron Island 2012-5-29.xlsx", the total riprap required was calculated to be 85,730 tons, which included a 20% contingency. Quantity calculations from the VE study, which are shown in Table 7-1, show that much less riprap may actually be required for this alternative. It is recommended that the Project Delivery Team (PDT) verify the volume of riprap required using Inroads due to the complex geometry. If it is determined that the volume of riprap is less than or close to the volume needed for bank line protection, it is recommended that rock vanes be used instead of the shoreline protection (option 1). Furthermore, it is recommended that the top elevation of the vanes be reduced to 535' and the spacing increased to 4 times the vane length or 160 feet (option 2).

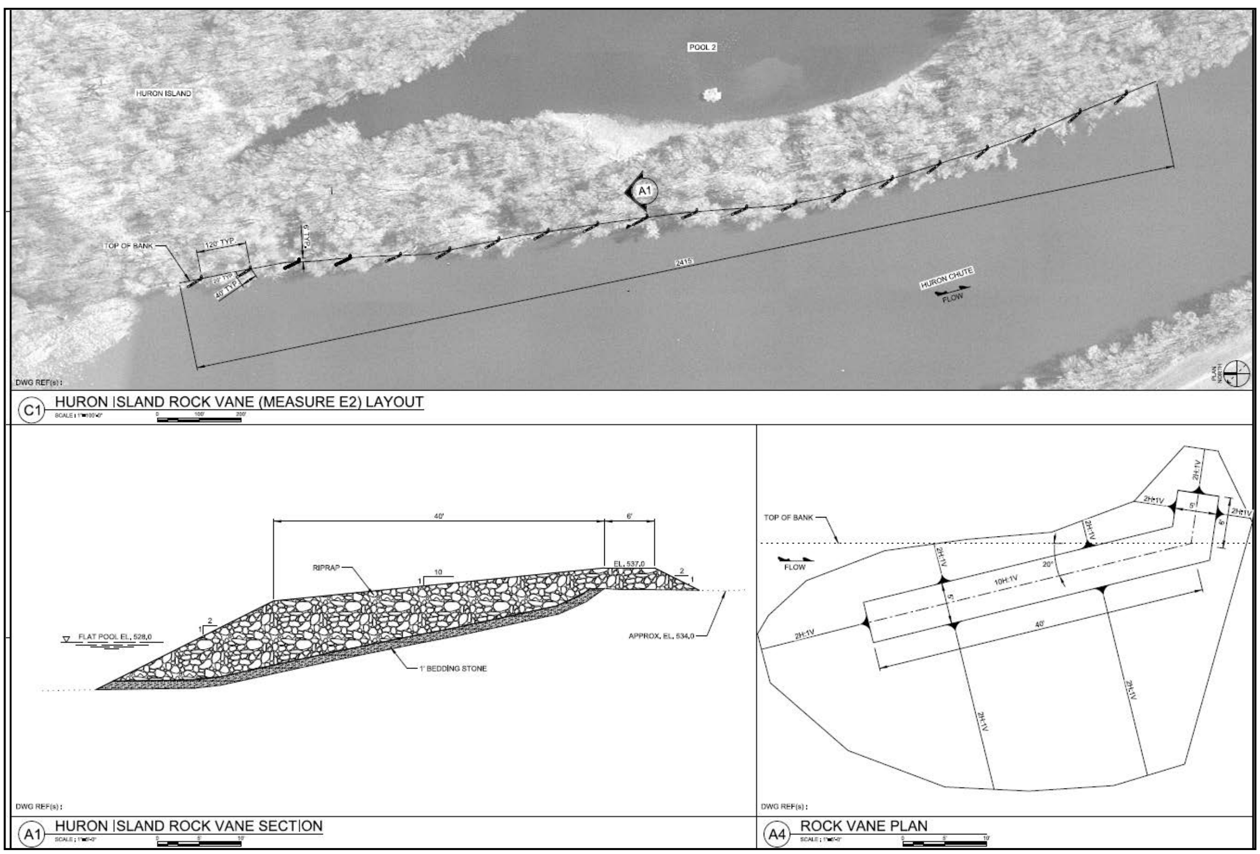

Figure 7-3: Proposal No. 7 – Rock Vane Cross Section

Table 7-1: Proposal No 7 - Quantity Calculations

	Option 1: E2	Option 2: Revised E2 (1)
SF of Section A1, Sheet C-109	331 SF	275 SF
top width	5 FT	5 FT
width of both slopes combined	20 FT	20 FT
Volume (2)	4969 CF	4125 CF
Volume	184 CY	153 DY
Tons	304 TN	252 TN
Contingency	20%	20%
TN per vane w/ Contingency	364 TN	303 TN
# of Vanes	19	14
Total Tons	6923 TN	4235 TN

Notes:
(1) This alternative lowers the riprap elevation to that of Alt. E1 and increases the spacing of the vanes from 3 times the vane length to 4 times.
(2) Divided the slope width by 2 to account for 2H:1V slopes

7.2.6 Cost

The total project savings for this alternative ranges between approximately $151K - $332K including mark-up and contingency. Unit prices and quantities were obtained from the spreadsheet "Revised Cost Summary of Measures Huron Island 2012-5-29.xlsx" with the exception of quantity of the rock vane riprap. Additionally, there were other quantities for bedding and bank shaping that appeared to be high. These were not changed for this proposal, but should be relooked at by the PDT, which would result in additional cost savings for this proposal. The cost worksheet showing the deletions for this proposal, which is the bank stabilization measure E1, is shown in Table 7-2. The cost to include measure E2 into the project is shown in Table 7-3 (Option 1). The cost to include and revise measure E2 is included in Table 7-4 (Option 2).

7.2.7 Project Delivery Team Response – Accepted/Rejected

The PDT does not accept this proposal. The quantities to construct this feature were significantly higher than similar bankline protection features, and the size of the structures would likely have an adverse impact on the floodplain analysis.

Table 7-2: Cost worksheet Proposal No. 7 Deletions

DELETIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
E1 - Bank Stabilization				**$736,613**	**12.78%**	**$830,752**
Riprap	TN	9300	$50.76	$472,068		
Bedding	TN	4700	$49.06	$230,582		
Clearing	AC	2	$6,515.00	$13,030		
Shape & Grade	CY	2087	$10.03	$20,933		
			Total Deletions:	**$736,613**		**$830,752**

Table 7-3: Cost Worksheet Proposal (Option 1)

ADDITIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
E2 - Rock Vanes				**$625,016**	**12.78%**	**$704,893**
Riprap	TN	6923	$49.83	$344,973		
Bedding	TN	5020	$49.02	$246,080		
Clearing	AC	2	$6,515.00	$13,030		
Shape & Grade	CY	2087	$10.03	$20,933		
			Total Additions:	**$625,016**		**$704,893**
			Net Cost Decrease:	$111,597		$125,859
			Mark-ups (20% - Design/Construction):	$22,319		$25,172
			Total Cost Decrease:	**$133,916**		**$151,030**

Table 7-4: Cost Worksheet Proposal No. 7 Additions (Option 2)

ADDITIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
E2 Revised - Rock Vanes				**$491,073**	**12.78%**	**$553,832**
Riprap	TN	4235	$49.83	$211,030		
Bedding	TN	5020	$49.02	$246,080		
Clearing	AC	2	$6,515.00	$13,030		
Shape & Grade	CY	2087	$10.03	$20,933		
			Total Additions:	**$491,073**		**$553,832**
			Net Cost Decrease:	$245,540		$276,920
			Mark-ups (20% - Design/Construction):	$49,108		$55,384
			Total Cost Decrease:	**$294,647**		**$332,303**

7.3 Proposal No. 8 – Reduce dredge depth in T1 and T3 from 8 to 6 feet.

7.3.1 Original Design

The recommended plan includes dredging to a minimum depth of 520 feet MSL, which is approximately eight feet below flat pool. This elevation was chosen to address sedimentation over the project life and to ensure that fish have adequate depths during overwintering and over-summering conditions. This dredging plan, which is Measures T1 and T3, is shown on Sheet C-105 and replicated in Figure 7-4.

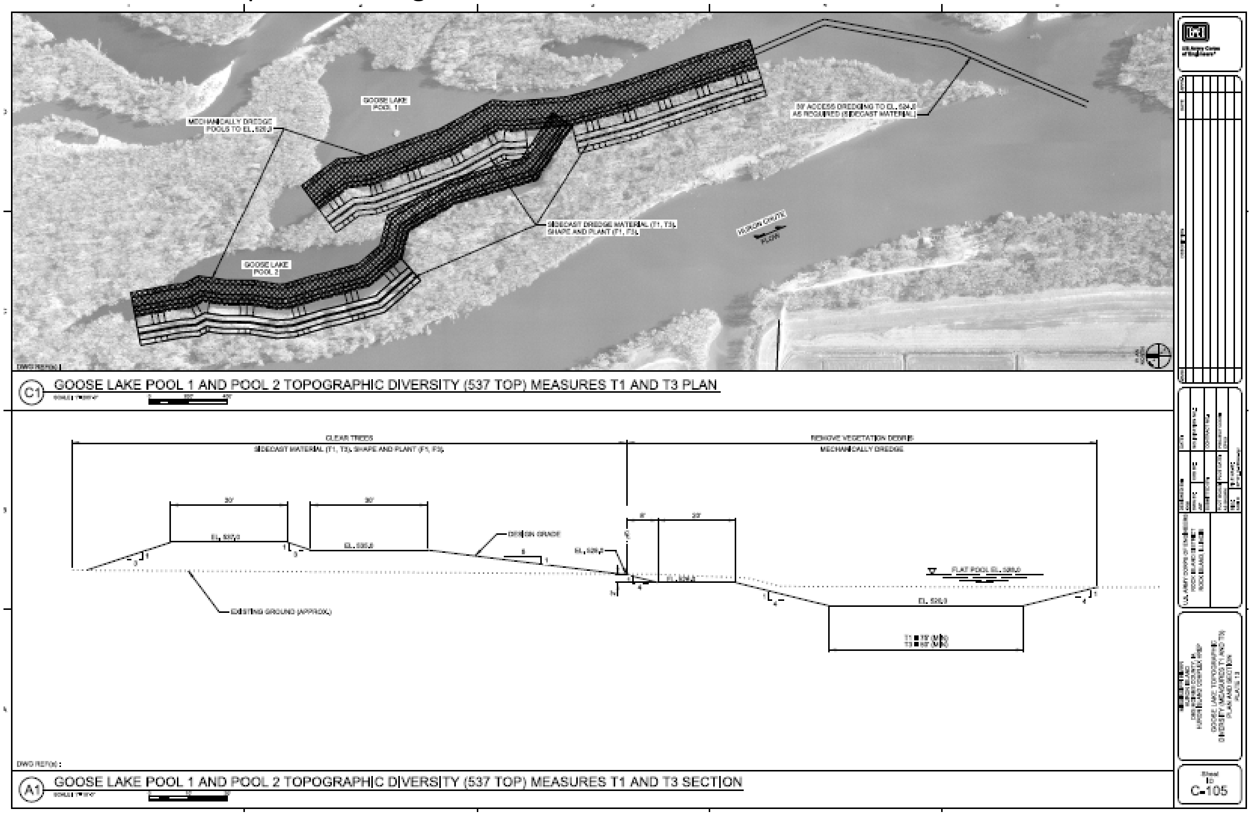

Figure 7-4: Proposal No. 8 – Original Design

7.3.2 Proposed Design Change

The proposed change would be to dredge the same area to a minimum depth of 522 feet MSL, which approximately six feet below flat pool. The proposed typical cross section is shown in Figure 7-5

7.3.3 Advantages

1. Reduced cost while maintain most of the function of the over wintering habitat
2. Cost savings could be applied to enhancing forest on existing high areas

7.3.4 Disadvantages

1. At a depth of six feet, the overwintering habitat would become unsuitable sooner because of sedimentation
2. Less upland forest habitat would be raised due to the decreased quantity of disposed dredge material. However, the

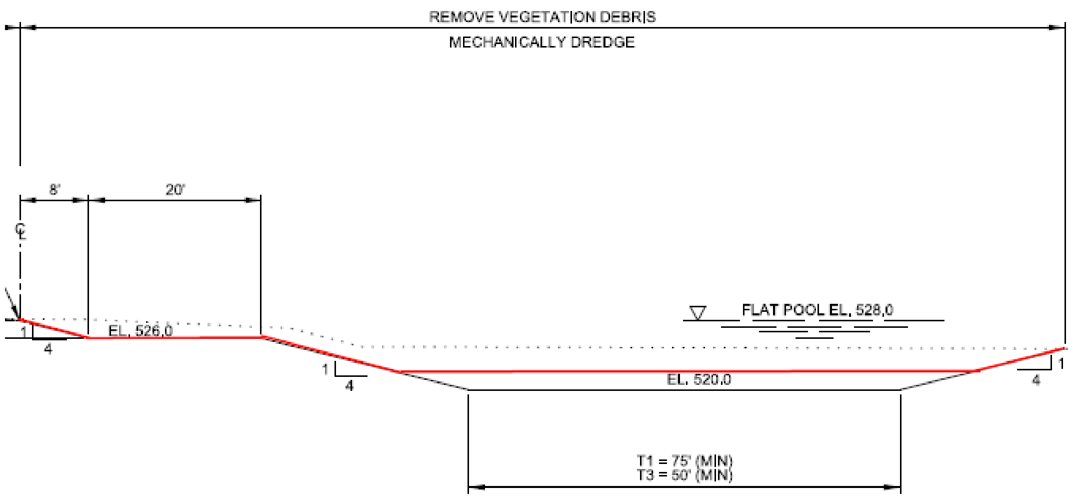

Figure 7-5: Proposal No. 8 – Proposed Design

7.3.5 Discussion

Reducing dredge depths are a clear way to reduce costs. It is generally accepted that backwater depths greater than four feet are adequate to overwinter bluegills. A depth of six feet would meet this requirement while still allowing some room for sedimentation. The major unknown in the development of this proposal is sedimentation rates in these areas. The PDT should consider this cost-saving measure, but in conjunction with site-specific sedimentation information.

7.3.6 Cost Worksheet

The total project savings for this alternative is approximately $845K including mark-up and contingency. Reducing the dredge cut by two feet reduces the quantity of excavated material by over 45,000 CY. The cost worksheet showing the savings is included in Table 7-5.

Table 7-5: Cost worksheet Proposal No. 8

DELETIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
MAIN ITEM				**$586,738**	**20.0%**	**$704,320**
T1 Dredge to 6' deep	CY	21985	$12.96	$284,926		
T3 Dredge to 6' deep	CY	23288	$12.96	$301,812		
			Total Deletions:	**$586,738**		**$704,320**

Net Cost Decrease:	$586,738	$704,320
Mark-ups (20% - Design/Construction):	$117,348	$140,864
Total Cost Decrease:	**$704,086**	**$845,184**

7.3.7 Project Delivery Team Response – Accepted/Rejected

The PDT does not concur. Based on expected sedimentation rates over the project life, an additional 2 feet of dredging is required to maintain optimum dredge depths over 50 years.

Studies of backwater sedimentation rates within the UMR have focused within Pools 4-10, and 13 (Eckblad et al., 1977; McHenry et al., 1984; Korschgen et al., 1987; Rogala and Boma, 1996; Rogala et al., 1997). Sedimentation rates from these studies range from as little as 0.2 cm/yr (Pool 7) to as high as 4 cm/yr (Pools 4-10). A sedimentation rate of 0.8 cm/yr for Pool 13 was reported by Rogala & Boma (1996). Measurements of sedimentation rates within Huron Island were taken by former IA DNR Biologist Bill Aspelmeier. His observations were made at 4 locations within Huron Island over two 5 year periods (1984-1989 and 1989-1994). Observations from the Little Cody Chute indicate consistent aggradation over the 10 year study period. However, observations made in Buffalo Slough suggest that degradation is occurring at that particular location. Sedimentation rates for Huron Island reported by the Aspelmeier study vary as much as (-1.16 cm/yr to +3.47 cm/yr).

The variability seen among these estimated sedimentation rates is caused by a number of different factors including when each measurement was taken with respect to a recent high water event. Variability within estimates for Huron Island itself indicates that there are many different and dynamic processes at work and that sedimentation rates are also dynamic. Sedimentation rates within Huron Island are a function of the discharge magnitude and the rainfall distribution in the contributing watershed, as well as the spatial and temporal variability in vegetation and spatial and temporal variability in natural impoundments such as beaver dams.

In order to obtain another estimate of sedimentation rates within the project area, a sediment transport model has been developed as part of the feasibility study. The purpose of the AdH sediment transport model is to evaluate the design elevation and alignment of project features in terms of their effectiveness in reducing sedimentation and to provide another sedimentation rate value for comparison with previous estimates. Based on the sediment transport modeling results, under existing conditions the average annual sedimentation rate in Goose Lake Pool 1 is 1.2 cm/yr (0.040 ft/yr) and 0.68 cm/yr (0.022 ft/yr) in Goose Lake Pool 2. These rates are comparable to the sedimentation rates cited in the reports discussed above.

7.4 Proposal No. 10 – Chevron Design

7.4.1 Original Design

The original design, shown on sheet C-110 and duplicated in Figure 7-6, consists of two Chevrons placed upstream of two existing islands in Huron Chute. The upstream Chevron is located 125 feet upstream of the island it is protecting, while the downstream chevron is located 170 feet upstream of the island it is protecting. The Chevron cross section has a top width of 10 feet, a top elevation of 534.5, which is 6.5 feet above the flat pool elevation of 528.0 and is equal to the 2-year flood elevation, pg 64, and has side slopes of 1V:2H. The chevron length is 400 feet and 280 feet for the upstream and downstream chevrons, respectively.

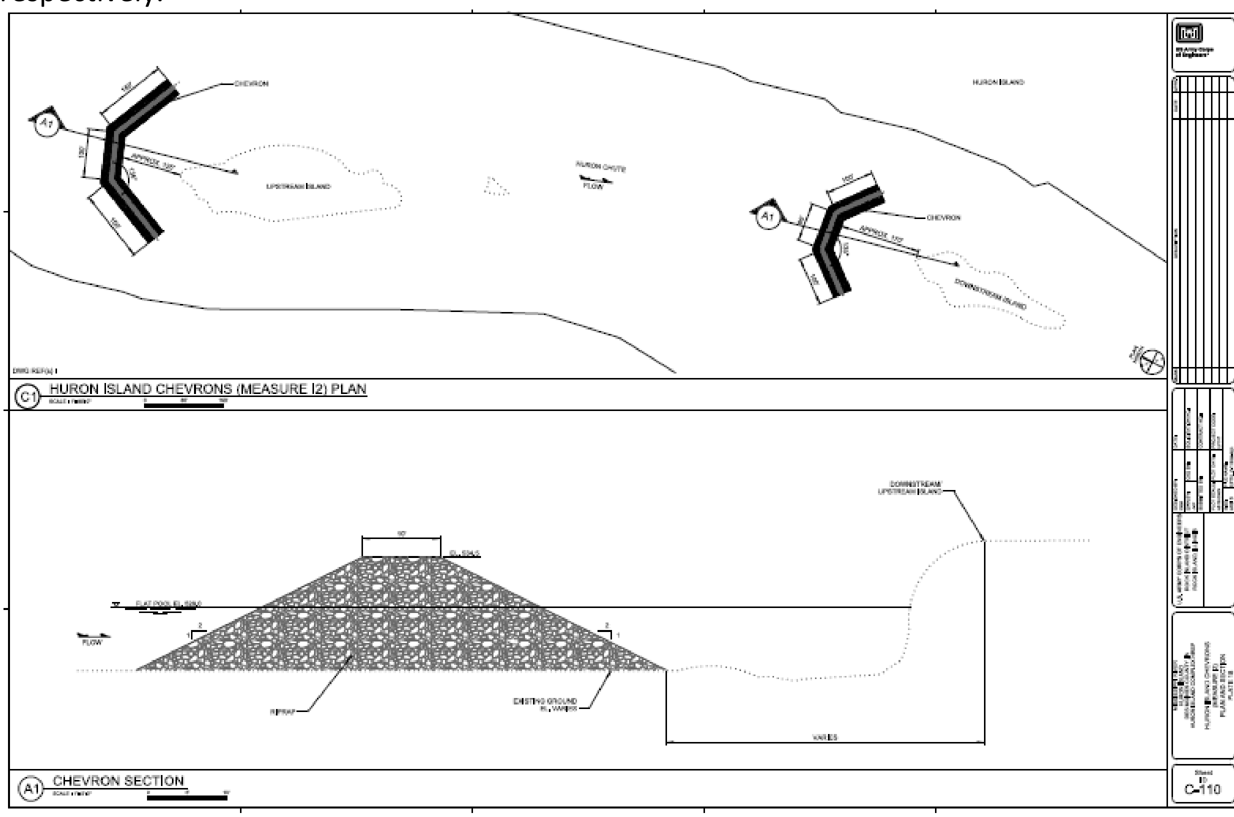

Figure 7-6: Proposal No. 10 – Original Design

7.4.2 Proposed Design Change

Three options within this proposal were considered. Option 1 moves the chevrons closer to the existing islands to take advantage of the shallower water. The heads of the existing two islands would be armored using bank revetment with a top elevation of 534.5, which is the same height as the original Chevrons, a 5-foot top width, and 1V:2H side slopes. The length of revetment on the upper and lower island would be 320' and 230' respectively. Option 2 includes Option 1 but also adds the construction of a Chevron downstream of the upstream island in the area where a small island existed in the 1990s. The outline of this island can be seen on sheet C-110. Option 3 retains the upstream chevron shown in the original design but moves the downstream chevron. This option allows for monitoring of design options.

7.4.3 Advantages

1. Since the rock placement will be in shallower water, it will be less expensive, and probably less prone to degradation due to scour or ice.
2. Less chance of negative effects on Iowa levee, since the footprint of the structures is smaller.
3. Bank revetment has been used many times in the past and has worked very well
4. The smaller, currently unprotected island, could be protected with the additional cost savings
5. Monitoring the effects of both options will help to compare the two options with similar environmental constraints increasing opportunities to learn within an adaptive management framework

7.4.4 Disadvantages

1. Since the footprint of the structures is smaller, the sheltered zone they create will be smaller.
2. The opportunity to learn within an adaptive management framework could be decreased.

7.4.5 Discussion

Typically, rock is placed near the existing island to take advantage of higher ground and reduce the cost of rock placement. While it is realized that locating the chevrons upstream of the existing islands is being done with the hope of growing the islands, it is not certain that this will be accomplished. Because this is an adaptive management project, the protection for one of the islands could be placed upstream of the existing island while the other is placed downstream.

7.4.6 Cost Worksheet

The total project savings for this alternative ranges between approximately \$274K - \$874K including mark-up and contingency. Based on the cost summary in file “Revised Cost Summary of Measures Huron Island 2012-5-29 Proposal 7.xlsx”, the upstream Chevron has 14,100 tons of rock, while the downstream chevron has 6,500 tons of rock, for a total of 20,600 tons. These quantities were obtained by determining the volume of the Chevrons using inroads, converting to tons using a factor of 1.65 tons per cubic yard, and increasing the quantity by 20% to account for settling and bathymetry unknowns. These same values were used to determine quantities for the proposed design change. The cost of the bank revetment and the Chevron depends on the actual depths at the site. A depth of 12.5 feet was to determine quantities for the proposed design change. This depth was determined from the Revised Cost Summary based on a bedding width of 60’. There is a note in the Cost Summary that says no bedding required, and it looks like bedding was not included in the cost estimates. Table 7-6 is the cost worksheet deleting the cost of the originally designed chevron rock while Table 7-7, Table 7-8, and Table 7-9 tabulate the cost of adding the revetment rock and/or the chevron rock back into the cost resulting in the cost savings for option 1, option 2, and option 3, respectively

7.4.7 Project Delivery Team Response – Accepted/Rejected

The PDT does not accept or reject this proposal. This feature was eliminated and is not part of the proposed plan.

Protection and increase in size of the islands via chevrons are important for fish habitat for two reasons: 1) Provides habitat complexity/diversity which does not currently exist in Huron Chute. This includes sand flats, shallow water, flow refuge, and increased forage habitat, 2) scour and protection offered by the chevron produces habitat similar to a backwater but in a riverine environment. Reduced flows, water clarity, depth, and increased forage opportunities have all been documented with the use of chevrons in the Mississippi River. A move in the location of the chevron would be fine if these conditions could still be met.
The hydraulic analysis determined this measure had an adverse impact on floodplain heights and was not retained for further evaluation.

Table 7-6: Proposal No. 10 – Cost worksheet Deletions

DELETIONS						
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL	CONTINGENCY	TOTAL W/ CONTINGENCY
Chevron				**$1,020,730**	**12.8%**	**$1,151,179**
Chevron Rock	TN	20600	$49.55	$1,020,730		
			Total Deletions:	**$1,020,730**		**$1,151,179**

Table 7-7: Proposal No. 10 – Cost worksheet Additions (Option 1)

ADDITIONS						
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL	CONTINGENCY	TOTAL W/ CONTINGENCY
Bank Revetment				**$374,697**	**12.8%**	**$422,583**
U/S Island Revetment	TN	4400	$49.55	$218,020		
D/S Island Revetment	TN	3162	$49.55	$156,677		
			Total Additions:	**$374,697**		**$422,583**
			Net Cost Decrease:	$646,033		$728,596
			Mark-ups (20% - Design/Construction):	$129,207		$145,719
			Total Cost Decrease:	**$775,239**		**$874,315**

Table 7-8: Proposal No. 10 – Cost Worksheet Additions (Option 2)

ADDITIONS						
ITEM	UNITS	QUANTITY	UNIT COST	TOTAL	CONTINGENCY	TOTAL W/ CONTINGENCY
Bank Revetment				**$696,772**	**12.8%**	**$785,820**
U/S Island Revetment	TN	4400	$49.55	$218,020		
D/S Island Revetment	TN	3162	$49.55	$156,677		

Middle Island Revetment	TN	6500	$49.55	$322,075		
			Total Additions:	**$696,772**		**$785,820**

Net Cost Decrease:	$323,958	$365,360
Mark-ups (20% - Design/Construction):	$64,792	$73,072
Total Cost Decrease:	**$388,749**	**$438,432**

Table 7-9: Proposal No. 10 – Cost Worksheet Additions (Option 3)

ADDITIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
Bank Revetment				**$855,332**	**12.8%**	**$964,644**
U/S Chevron	TN	14,100	$49.55	$698,655		
D/S Island Revetment	TN	3162	$49.55	$156,677		
			Total Additions:	**$855,332**		**$964,644**

Net Cost Decrease:	$165,398	$186,536
Mark-ups (20% - Design/Construction):	$33,080	$37,307
Total Cost Decrease:	**$198,477**	**$223,843**

7.5 Proposal No. 17 – Reduce top width of closure structure

7.5.1 Original Design

The original design, shown on sheet C-107 and duplicated in Figure 7-7, consists of a closure structure constructed across Garner Chute near its upstream end. The closure structure is approximately 250' long. The structure cross section has a top width of 15 feet, a top elevation of 532.0, which is 4 feet above the flat pool elevation of 528.0 and corresponds to a discharge that is exceeded 34% of the time, and has side slopes of 1V:2H on the upstream side and 1V:3H on the downstream side. The base width, upstream to downstream dimension, of this structure is close to 100 feet at its widest section. There is also a 3-foot deep key on the upstream side of the structure.

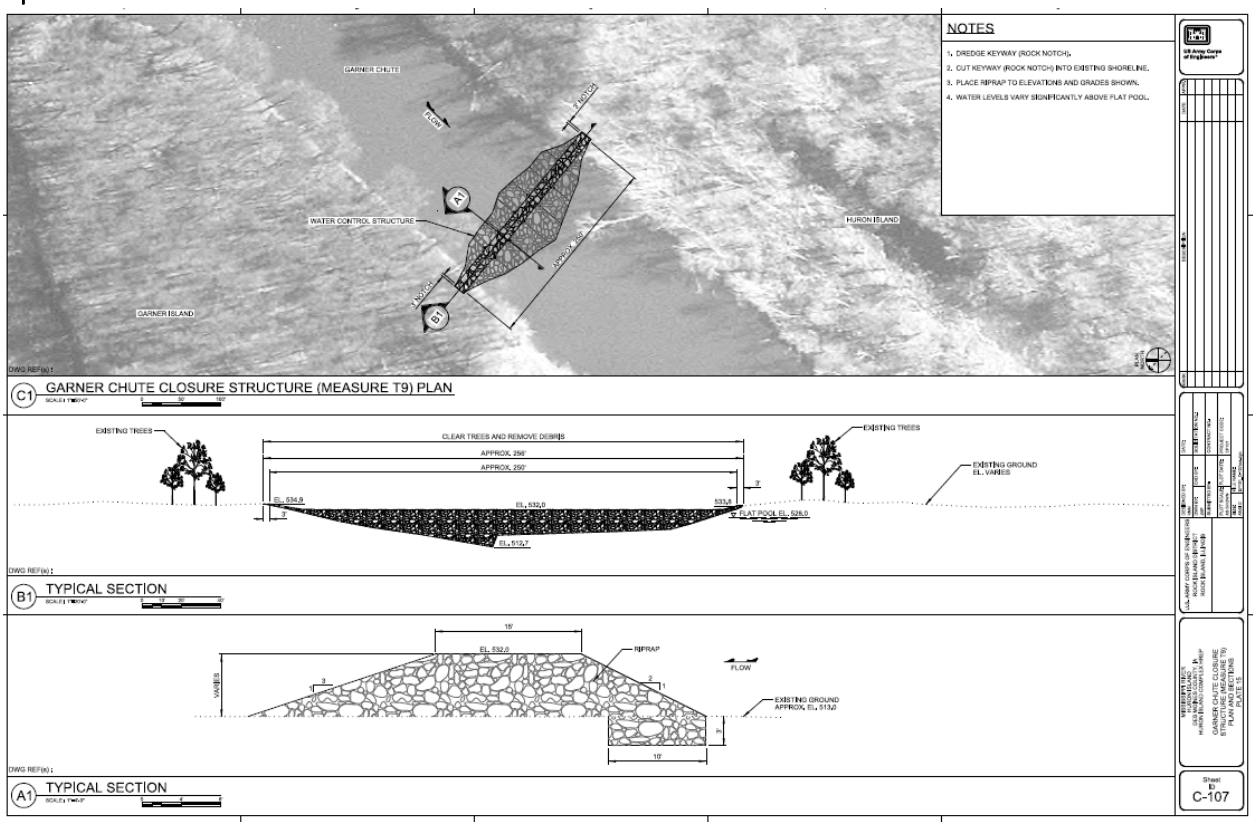

Figure 7-7: Proposal No. 17 – Original Design

7.5.2 Proposed Design Change

The proposed design change includes increasing the downstream side slope to a 1V:2H, decreasing the top width to 7.5', and eliminating the rock key.

7.5.3 Advantages

1. Reduced cost

7.5.4 Disadvantages

1. Decreasing the size of the structure decreases the chance for self-healing in the event that downstream scour, ice, or large woody debris displaces some of the rock.

7.5.5 Discussion

Alterations should be made to the closure structure to optimize the design and effectiveness of that design. While the original design is at the initial states of design, changes are made here to show various options. Any or all of these changes would help to reduce the cost of this feature. However, the design intent of this feature should be modeled to ensure the closure would have a benefit to the project. It is understood that this modeling effort is underway.

7.5.6 Cost Worksheet

The total project savings for this alternative, shown in Table 7-10, is approximately $283K, including mark-up and contingency. The cost of the closure structure depends on the actual depths at the site. An average bottom elevation of 518.0 giving an average structure height of 14 feet was assumed to determine quantities for the proposed design change. The average depth was estimated from the structure width shown in the plan view on sheet C-107. There is a note in the Cost Summary that says the average bottom elevation is 513.0, but this does not match what is shown on sheet C-107. The quantities given in the cost summary in the excel file “Revised Cost Summary of Measures Huron Island 2012-5-29 Proposal 7.xlsx” could not be reproduced, so the quantities were recalculated based on the dimensions discussed above. A factor of 1.65 tons per cubic yard was used, and quantities were increased by 20% to account for settling and bathymetry unknowns.

7.5.7 Project Delivery Team Response – Accepted/Rejected

The PDT concurs that additional changes to the rock closure structure may be made during design. The design provided in the DPR matches closely with other structures constructed in MVR, but additional hydraulic analysis will be performed during plans and specifications to determine if these cost saving changes can occur and maintain a structure that will perform throughout the project life.

Table 7-10: Proposal No. 17 – Cost Worksheet

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL	CONTINGENCY	TOTAL W/ CONTINGENCY
Closure Structure				**$675,556**	**9.5%**	**$739,464**
Closure Structure Rock	tons	13,380	$50.49	$675,556		
			Total Deletions:	**$675,556**		**$739,464**

ADDITIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL	CONTINGENCY	TOTAL W/ CONTINGENCY
Revised Closure Structure				**$459,964**	**9.5%**	**$503,476**
Closure Structure Rock	tons	9110	$50.49	$459,964		

Total Additions:	**$459,964**		**$503,476**
Net Cost Decrease:	$215,592		$235,987
Mark-ups (20% - Design/Construction):	$43,118		$47,197
Total Cost Decrease:	**$258,711**		**$283,185**

7.6 Proposal No. 26 –Move Diverse Forest Plantings to Naturally Higher Ground

7.6.1 Original Design

The original design consists of creating topographic diversity with borrow from adjacent land and planting several species of trees on the higher ground in order to create forest diversity as shown in Figure 7-8. The affected area of Measure F5 is approximately 16.5 acres, and the diversified forested created as a result of Measure F5 is approximately 5 acres.

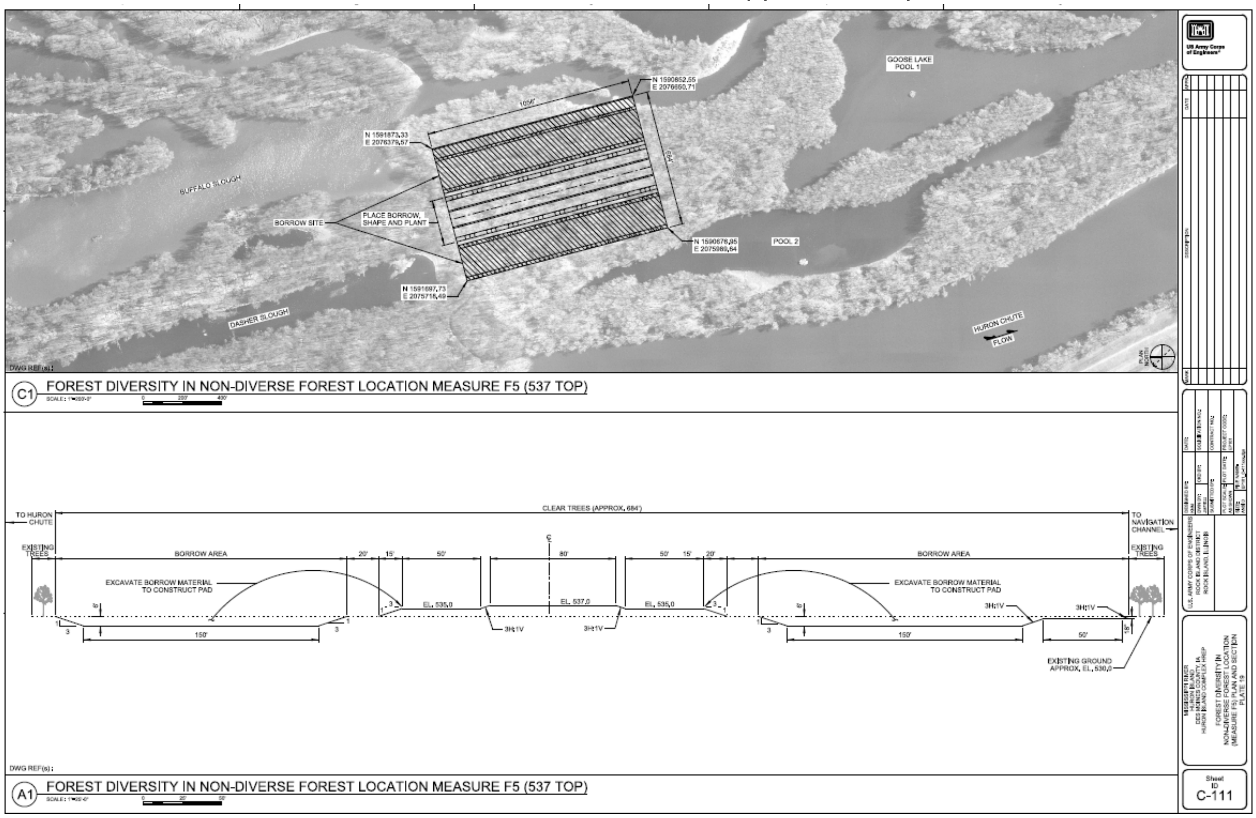

Figure 7-8: Proposal No. 26 – Original Design

7.6.2 Proposed Design Change

The proposed design change is to eliminate Measure F5 and create forest diversity in areas with naturally higher ground. Based on the bathometry map provided, there appears to be areas around the perimeter of Huron Island that are at or near the target elevation of 537. In addition, a large area directly across the main channel from Huron Island also appears to be near elevation 537.

7.6.3 Advantages

1. Cost savings for same amount of habitat units by eliminating the excavation costs.

2. More habitat units could be created for same cost.

7.6.4 Disadvantage

1. More documentation may be required for adaptive management monitoring since the natural ground elevation may be more variable than the flat benches proposed for Measure F5.
2. Isolated ephemeral wetlands will not be created due to deletion of borrow areas.

7.6.5 Discussion

This proposal assumes that these areas of naturally higher ground are high enough and do not currently have diverse forests. In the Definite Project Report on Table 2-2, it is shown that Huron Island Area has approximately 17 acres that are higher than EL 536 feet and 43 acres between EL 535 feet and EL 536 feet. If these naturally higher areas already have diverse forests, it would not make sense to cut them down, and the habitat gain would be smaller relative to cutting down a less diverse area. If these areas are higher but not high enough, some earthwork may be needed to raise them, but the costs of this may be less that doing so in the proposed F5 area.

7.6.6 Cost Worksheet

The total project savings for this alternative, shown in Table 7-11, is approximately $1.23M including mark-up and contingency. The quantities and unit costs were obtained from the spreadsheet “Revised Cost Summary of Measures Huron Island 2012-5-29.xlsx”. A second option to this proposal would be to use the money saved to plant more acres of diverse forest. With the money saved, approximately 40 more acres of diverse forest could be planted in addition to the 4.1 acres that are currently planned.

Table 7-11: Proposal No. 26 – Cost Worksheet

DELETIONS						
ITEM	**UNITS**	**QUANTITY**	**UNIT COST**	**TOTAL**	**CONTINGENCY**	**TOTAL W/ CONTINGENCY**
Fill Borrowed and Placed	CY	51100	$13	$649,992	20.04%	$780,250
Shape to Desired Slopes and Elevations	LS	1	$207,297	$207,297	20.04%	$248,839

Net Cost Decrease:	$857,289	$1,029,090
Mark-ups (20% - Design/Construction):	$171,458	$205,818
Total Cost Decrease:	**$1,028,747**	**$1,234,908**

7.6.7 Project Delivery Team Response – Accepted/Rejected

The PDT does not concur.

97% of the entire island complex is located below 535 (2-year flood). Although, the table in Section 2.4 of the existing conditions indicates 17 acres (0.9%) are at or above 536, these areas are diverse forested areas and sporadically located throughout the perimeter of the Complex. The project footprint does not contain elevations greater than 534.

Most of the areas containing higher ground are located along the NW portion of Huron Chute where sediment deposition overtime has created a natural berm/levee during flood events. This location is a long way to feasibly move mechanically dredged material. These locations are also located in archeological areas which are proposed to be avoided.

7.7 Proposal No. 32 – Increase backwater dredging and upland disposal to restore forest and improve fish habitat

7.7.1 Original Design

The original design includes the restoration of forest habitat through a combination of dredging and upland disposal and grading to improve fish habitat and forest diversity (F1, T1, F3, and T3). Additional forest would be improved by reshaping existing soil without dredging (F5).

7.7.2 Proposed Design Change

The proposed change is to eliminate F5 and increase the dredging/disposal areas to improve aquatic habitat and forest diversity. If the entire cost of F5 is redirected into extending F1, T1, F3, and T3, an additional 6 acres of aquatic and 4.7 acres of upland could be modified. Potential alignments and areas for this change are shown in the figure below. Areas hatched and colored pink in Figure 7-9 would be dredged. Areas lined and colored green in Figure 7-9 would be raised with dredged material and planted.

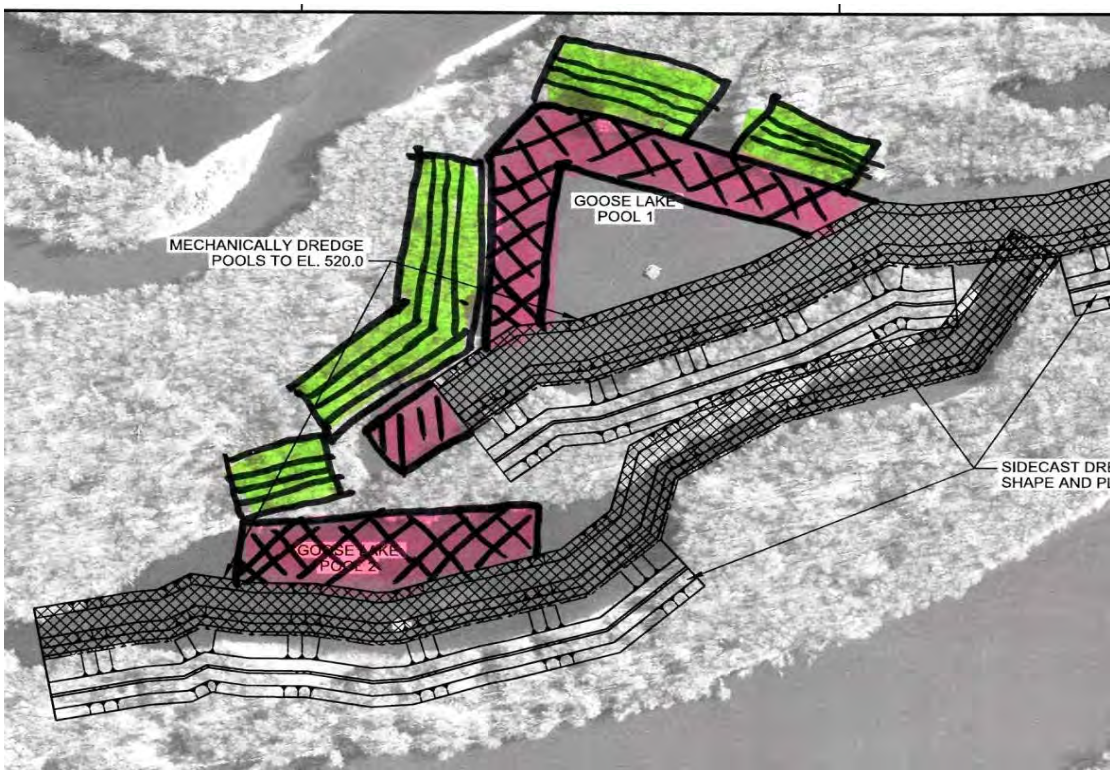

Figure 7-9: Proposal No. 32 – Proposed Design

7.7.3 Advantages

1. Increased aquatic habitat benefits by increasing the overwintering fish habitat
2. Increased diverse forest habitat

7.7.4 Disadvantages

1. The acreage of modified habitat would be reduced from about 16.5 acres in Measure F5 to about 10.7 acres in this proposal.
2. Reduced forested habitat enhanced

3. Another disadvantage may be that the location of new forest may not coincide with the lowest-quality forest in the area (location would be dictated by the dredging locations), however, the area originally proposed for F5 must be relocated anyway due to conflicts with Indiana bat habitat.

7.7.5 Discussion

While it cannot be determined based on the information available at this time, overwintering fish habitat may generally be more valuable per acre than forest habitat, as it would meet a life-history requirement for a fish population over a much larger area, which is apparently lacking in the project area. The PDT should consider this modification while considering the relative value of overwintering habitat, with its ability to influence fish populations over a much larger area.

7.7.6 Cost Worksheet

As this proposal is presented, there would be no cost savings. The amount of additional dredging that could be completed under this proposal was determined by simply calculating the aquatic and upland areas modified per dollar for F1, T1, F3, and T3 features, and increasing that work in other areas in lieu of the cost of F5.

7.7.7 Project Delivery Team Response – Accepted/Rejected

The PDT generally concurs. As indicated on Plate 13 (C-104) and described in Chapter 6 of the report, additional dredging will occur in Pool 1 and Pool 2 to provide dredged material for measure F5. Measure F5 was relocated to avoid Indiana bat habitat which placed it closer to these pools. Some existing soil will still be used for borrow material, but significantly less than that shown in the VE version of the report.

7.8 Proposal No. 46 – Only protect the toe of slope with riprap

7.8.1 Original Design
The original design protects the eroding slope with a full riprap section to the top of the bank.

7.8.2 Proposed Design Change
The proposed design eliminates some of the riprap and bedding by only using riprap and bedding at the toe of the slope.

7.8.3 Advantages
1. Could potentially eliminate 30 to 40% of the riprap and bedding material.

7.8.4 Disadvantages
1. Leaves the top of bank unprotected during higher flood events.
2. Use of vegetative cover in place of riprap at the top of the slope needs to be flood tolerant.

7.8.5 Discussion
If the erosion of the bank is caused by erosive forces eroding the toe of the slope and causing the bank to slough, then the placement riprap at just the toe of the slope may be adequate to prevent further erosion of the bank.

7.8.6 Cost Worksheet
The total cost savings for this proposal, as shown in Table 7-12, is approximately $113K. Assume that only protecting the toe is to bring the riprap up to about the flat pool El. 528. This appears to be about a 30% reduction in the quantity of riprap. Using the cost of planting for measure F5 divided by 7 acres of Understory Seed mix quantity to obtain a unit cost for planting of $132,500/acre, provides a cost for protecting the area at the top of the bank where the riprap erosion protection is eliminated. Assume a 20-foot width by 2,254-foot length for about 1 acre.

7.8.7 Project Delivery Team Response – Accepted/Rejected
The PDT does not concur. The type of erosion observed at the bankline indicates that riprap should be placed to the top of bank, not just along the toe. This is supported by geotechnical explorations, which results show the bank being composed entirely of erodible material, and survey data, which shows the erosion is not occurring at the toe.

Table 7-12: Proposal No. 46 – Cost Worksheet

DELETIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL	CONTINGENCY	TOTAL W/ CONTINGENCY
Only Protect the Toe of Slope with Riprap				**$210,795**	**20.0%**	**$252,954**
Bedding (assume 30% reduction in quantity)	TN	1410	$49.06	$69,175		
Riprap (assume 30% reduction in quantity)	TN	2790	$50.76	$141,620		
			Total Deletions:	**$210,795**		**$252,954**

ADDITIONS

ITEM	UNITS	QUANTITY	UNIT COST	TOTAL	CONTINGENCY	TOTAL W/ CONTINGENCY
Only Protect the Toe of Slpoe with Riprap				**$132,500**	**20.0%**	**$159,000**
Vegetative Cover Replacing Riprap	AC	1	$132,500.00	$132,500		
(Use F5 understory seed mix acreage of 7 acres to derive a unit cost)						
			Total Additions:	**$132,500**		**$159,000**

Net Cost Decrease:	$78,295	$93,954
Mark-ups (20% - Design/Construction):	$15,659	$18,791
Total Cost Decrease:	**$93,954**	**$112,745**

8 Presentation Phase

The PDT was briefed on each comment and proposal that was developed during the study. The PDT was also given a draft copy of the VE report, and they were asked to submit their decision on each proposal for implementation into the report. After the PDT decisions have been incorporated, the final report was given to the PDT to initiate the signature process.

Appendix A – Speculation List

The table below shows the speculation list that was developed during Phase 4. Similar items were combined together during Phase 5, and these are noted in each comment or proposal.

P – Proposal
C – Comment
BD – Being Done
W/# - Combined with number #
X – Removed from further consideration

Table A-0-1: Brainstorming List

Proposal (P) / Comments Number	Action	Idea Number	Description
C1	C	1	Delete forested Area (F5)
	X	2	increase flow down chutes
	X	3	Concrete Mats
P4	P	4	Eliminate Riprap/Rockfill bedding
	X	5	Bioengineer bank stabilization
	X	6	Place navigation dredge material for islands
P7	P	7	Lower riprap EL (vanes)
P8	P	8	Reduce Dredge depth
	X	9	Dredge material with geotextile and rock for control structure and chevron
P10	P	10	Change chevron shape from "C" to "Z" to direct flow away from the levee
	W/10	11	Use a seed Island
C12	C	12	LWD - Large Woody Debris
	X	13	Eliminate Huron Structure
	W/10	14	Change chevron shape from "C" to a more curved "C"
	W/10	15	Change chevron shape for a "C" to a line
	W/10	16	Reduce chevron top width to about 4'
P17	P	17	Reduce top width of structure
C18	C	18	Introduce flow to dredge area or monitor
C19	C	19	Rethink the need for shoreline riprap
	W/7	20	Consider a different vane (45 degrees)
	W/7	21	Use redesigned vanes not slope protection
	X	22	Overwinter dredge behind garner structure D/S
	X	23	O&M Dredge for garner structure

Proposal (P) / Comments Number	Action	Idea Number	Description
	X	24	Eliminate connections which provide turbid water to interior
	X	25	Water level management - draw down
P26	P	26	Plant on higher ground
C27	C	27	More naturally shaped forest
	X	28	Plant smaller trees
	X	29	Revise islands near main channel and use O&M dredge material
	W/19	30	Reassess riprap extents
	W/10	31	Eliminate Chevrons
P32	P	32	Do more backwater dredging to create forest
	W/32	33	Extend pool use to raise forested area
	X	34	Use Johnson for overwintering habitat
	X	35	Increase flow by opening up an area by garner slough
	X	36	Dredge Buffalo for overwintering access between islands
	X	37	Buy agricultural fields and plant
	X	38	Tear out levees
	W/26	39	Plant naturally high areas
	W/26	40	Plant high areas on opposite bank
	W/10	41	Add more chevrons
	BD	42	Build (Dredge) Isolated Floodplain lake
	X	43	Consider Benton Bay
	X	44	Minimize tree expense by using smaller trees or reduced species
	X	45	Turf reinforcement
P46	P	46	Only protect toe with riprap
C47	C	47	Validate benefit calculations
C48	C	48	Consider selection criteria
C49	C	49	Consider sedimentation behind the structure
C50	C	50	Cost Per Habitat unit seems high

Appendix B – References

Below is a list of the documents that the VE team was given with which to perform the study.

1. U.S. Army Corp of Engineers. June 2012. Upper Mississippi River System Environmental Management Program Definite Project Reort with Integrated Environmental Assessment **Huron Island Complex Habitat Rehabilitation and Enhancement Project**. U. S. Army Corps of Engineers, Rock Island District. Rock island, IL.

2. U.S. Army Corp of Engineers. June 2012. Mississippi River Huron Island, Des Moines County, IA Huron Island Complex Plan Set. U. S. Army Corps of Engineers, Rock Island District. Rock island, IL.

INDEX		
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SURVEY		
PLATE 4	V-101	SURVEY CONTROL DIAGRAM
PLATE 5	V-102	XXXX
GEOTECHNICAL		
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PLATE 20	C-112	FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION (MEASURE F6) PLAN AND SECTION
PLATE 21	C-113	OBSERVED ISLAND EROSION
PLATE 22	C-114	GOOSE LAKE (MEASURE T1) PLAN AND PROFILE STA. 00+00 TO STA. 14+00
PLATE 23	C-115	GOOSE LAKE (MEASURE T1) PLAN AND PROFILE STA. 14+00 TO STA. 24+36
PLATE 24	C-116	GOOSE LAKE (MEASURE T2) PLAN AND PROFILE STA. 00+00 TO STA. 14+00
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Appendix C – Statement of Acceptance

VALUE ENGINEERING STUDY REPORT - STATEMENT OF ACCEPTANCE

The St. Paul District completed the Value Engineering (VE) Study Report (Report No. CEMVR-VE-FY12-01) for the Huron Island Complex Project in accordance with ER 11-1-321. Notice is hereby given that the VE Study Report was reviewed and accepted by the Project Delivery Team (PDT). At this time, the proposals noted in the VE Study Report as accepted should be given further consideration by the PDT and implemented where reasonable. Acceptance for each proposal is noted in the Executive Summary of VE Study Report. The rational for acceptance or rejection is included after the description of each proposal.

Adéle L. Braun, AVS. P.E.
VE Study Team Lead, CEMVP-VEO

Monique E. Savage
Technical Coordinator, CEMVP-PM-F

CERTIFICATION OF APPROVAL

The proposals and PDT concurrence presented in the Value Engineering Study Report No CEMVP-VE-FY12-04 are acceptable and should be given additional consideration by the PDT for implementation.

Denny A. Lundberg, P.E.
Chief, Engineering & Construction, CEMVR-EC

Gary R. Meden, P.E.
Deputy for Programs and Project Management, CEMVR-DPM

Appendix D – PM Certification

VALUE ENGINEERING STUDY – PROJECT MANAGEMENT CERTIFICATION

I, Monique Savage, certify that this procurement action, Huron Island Complex Project, has completed the Value Engineering process as required by ER 11-1-321, Army Programs Value Engineering. Specifically, I certify compliance with Public Law 99-662 (33 USC 2288) and OMB Circular A-131. A VE study was conducted between 18-21 June 2012 by the appropriate authority. All VE proposals indicating potential savings over $1,000,000 have been resolved with approval of MSC/Engineering Center Commander.

Monique E. Savage Technical Coordinator, CEMVP-PM-F	Jack McDaniel Value Engineering Officer, CEMVR-VEO

VALUE ENGINEERING STUDY – PROJECT MANAGEMENT CERTIFICATION REFERENCE

In order to ensure compliance with applicable statutory requirements, ER 11-1-321 Change 1 dated 01 January 2011 requires that each project/contract, prior to award contain the Project Management (PM) Certification as follows:

a. Civil Works Decision Documents: All feasibility reports, post authorization change reports, general reevaluation reports, reauthorization letter reports, and the equivalent shall contain a review and approval statement from the PM indicating that required VE action has been completed, as appropriate, for that phase of the project. This statement will indicate that appropriate studies have been performed and that all proposals indicating savings greater than $1 Million, impacting plan formulation, have been resolved.

b. Biddibility, Constructability, Operability, and Environmental (BCOE): The statement that appropriate VE actions have been completed shall accompany the BCOE document for all procurement actions with a current working estimate over $1 Million.

Supporting Data of VE Study for CVS Certification

Project Title
Huron Island Complex Project

Project Description
The U.S. Army Corps of Engineers, Rock Island District proposes to rehabilitate and enhance the Huron Island Complex through construction measures aimed at increasing the quality of year-round habitat for the fish community, increase diversity of floodplain forest vegetation, and improve the overall structure and function of the complex. The recommended plan for habitat rehabilitation and enhancement of the Huron Island Complex includes Bathymetric Diversity of Goose Lake backwater areas pool 1 and pool 2, forest diversity adjacent to pool 1 and pool 2 up to elevation 537, a closure structure in Garner Chute, chevrons for side channel islands, and forest diversity in non-diverse forested area to elevation 537.

Dates of VE Study and Related VM Team Meetings

Activity	Dates	Hours	CPs
VE Study Workshop	18-22 June 2012	36	3.6
VE Presentation/Discussion	29 June 2012	4	0.4
		Total CPs	**4.0**

Project Team Roster

Adéle L. Braun, AVS, P.E. USACE-MVP-VEO	Facilitator Structural Engineer
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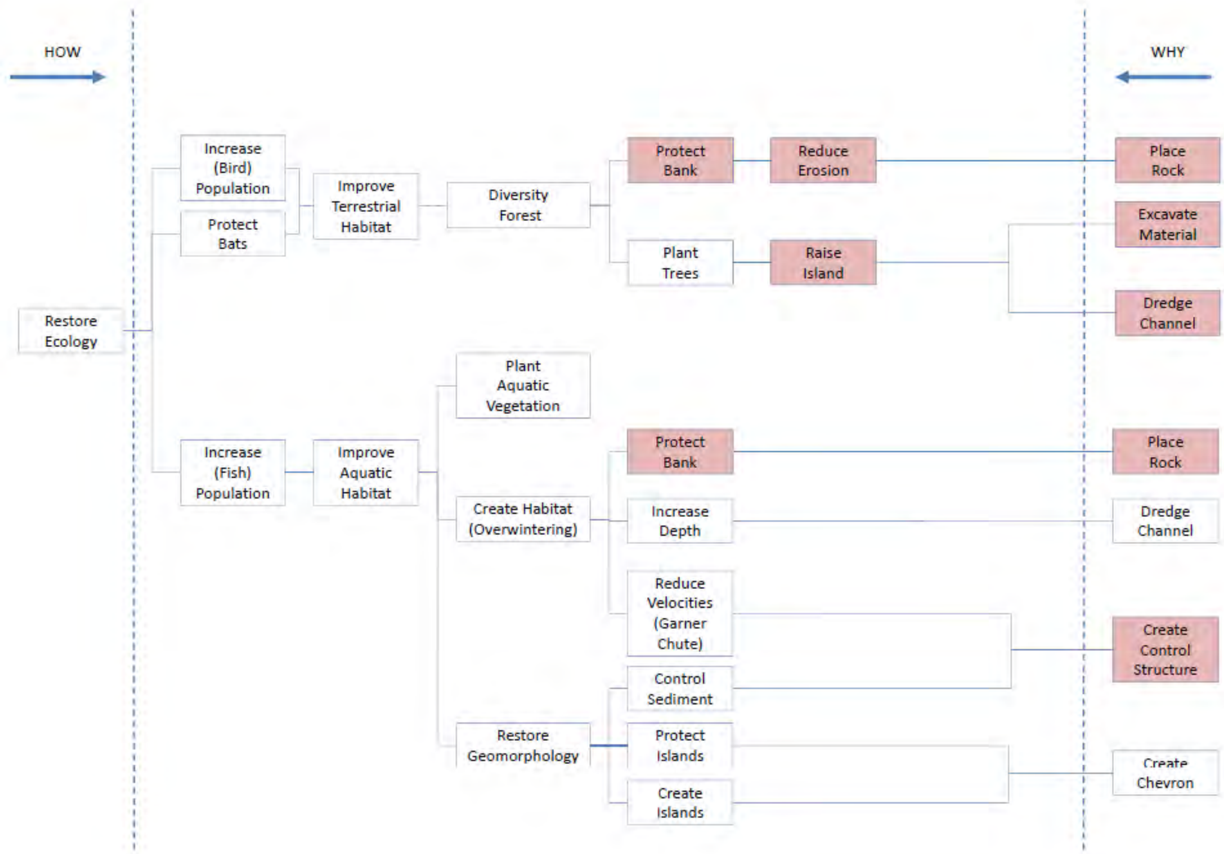
Jeffrey L. Hansen, P.E. USACE-MVP-EC-D	Cost Engineer

Evidence of Unfettered Creativity
During the evaluation phase of the study, eight proposals were developed from the 49 generated ideas, and nine comments were developed. Additionally, 13 of the ideas were incorporated into other proposals or comments

FAST Diagram



UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX O

DISTRIBUTION LIST

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UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

HURON ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX P

PLATES

MISSISSIPPI RIVER

HURON ISLAND

DES MOINES COUNTY, IA

HURON ISLAND COMPLEX HREP

DEFINITE PROJECT REPORT

US Army Corps of Engineers

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: KNM
DWN BY: LLH
CKD BY:
SUBMITTED BY:
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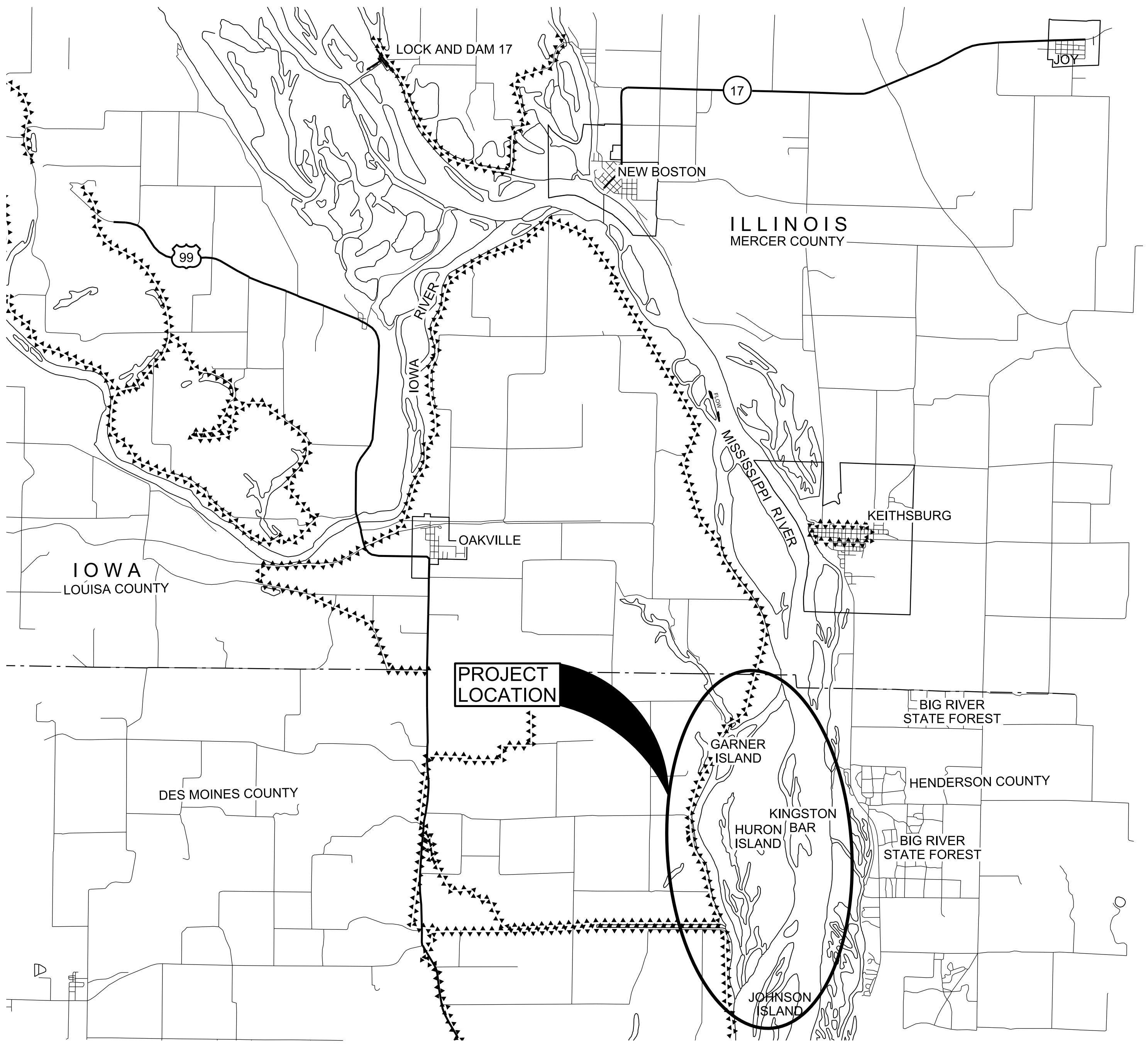
PLOT DATE:
SIZE: ANSI D
FILE NAME: EP101_G-001xxx.dgn
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: EP101

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT

COVER SHEET

PLATE

Sheet ID
G-001



DWG REF(s) :

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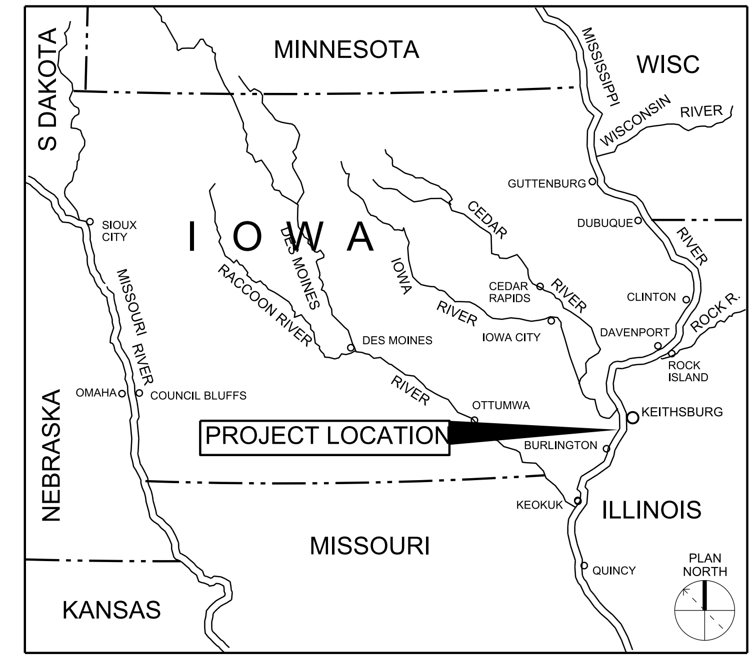

DWG REF(s) :

A4 VICINITY MAP

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT

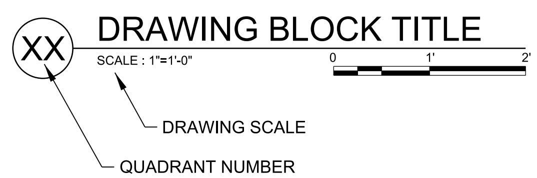
LOCATION PLAN
AND VICINITY MAP

PLATE 1

Sheet ID
G-002

DRAWING ANNOTATIONS

DWG REF(s) :



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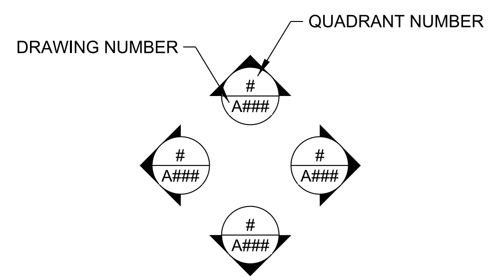
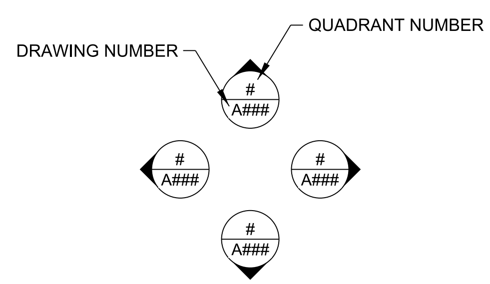


ELEVATION MARKER



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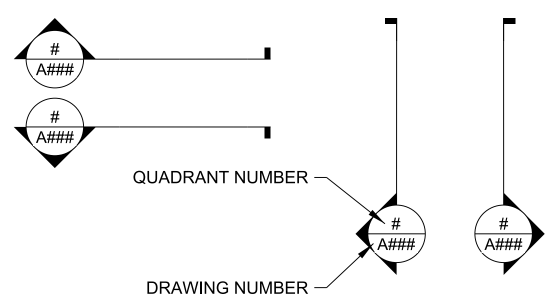

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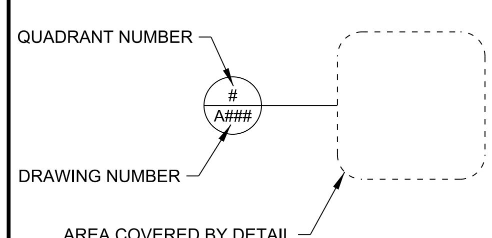
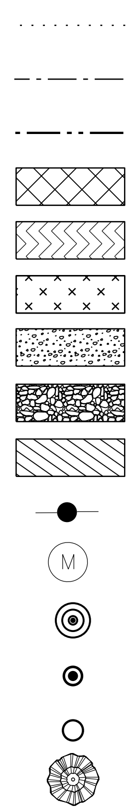


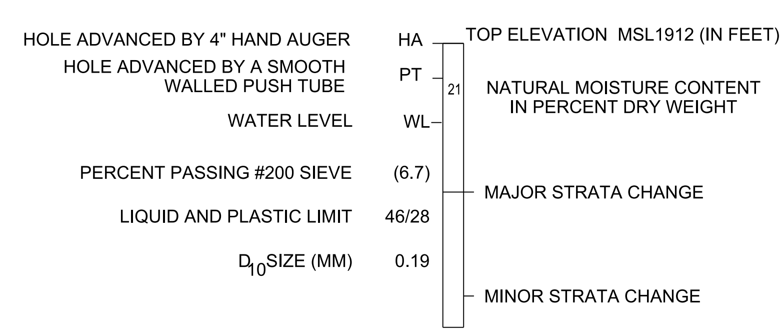
DETAIL CALLOUT

LEGEND



- EXISTING GROUND
- CENTERLINE
- COMMERCIAL FISHERIES
- DREDGE CUTS
- ENVIRONMENTALLY SENSITIVE ZONE
- SEDIMENT DEFLECTION BERM
- BEDDING STONE
- RIPRAP
- BORROW SITE
- RIVERMILE
- EXISTING MONITORING
- WATER INLET
- BORING LOCATION
- BENCHMARK
- TREE PLANTING

BORING NUMBER



DATE OF DRILLING
LOCATION OF BORING
(STATE PLANE COORDINATES NAD 83)
(IL WEST IN FEET)

BORING LEGEND

ABBREVIATIONS

A	
AC	ACRE
APPROX.	APPROXIMATE
AVE	AVENUE
B	
BM	BENCHMARK
E	
EL.	ELEVATION
F	
FT	FEET
H	
H	HORIZONTAL
M	
MAX	MAXIMUM
MSL	MEAN SEA LEVEL
MIN	MINIMUM
R	
RD	ROAD
RM	RIVERMILE
RR	RAILROAD
S	
ST	STREET
STA.	STATION
T	
TYP.	TYPICAL
V	
V	VERTICAL

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT

LEGEND AND ABBREVIATIONS

PLATE 2

Sheet ID
G-003

July 2013 Draft

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DWG REF(s) :

A1 INDEX

GENERAL NOTES

1. THE HURON ISLAND COMPLEX AREA IS LOCATED IN POOL 18 ALONG THE RIGHT DESCENDING BANK OF THE UPPER MISSISSIPPI RIVER (RM 421.4 TO 425.4) IN THE NORTHEAST PORTION OF DES MOINES COUNTY, IA.
2. THE PROJECT AREA IS IN POOL 18 BETWEEN RIVER MILES 421.2 AND 425.4 APPROXIMATELY 20 MILES UPSTREAM OF BURLINGTON, IOWA. THE IOWA RIVER ENTERS THE MISSISSIPPI RIVER ROUGHLY 12 MILES UPSTREAM OF THE ISLAND SYSTEM.
3. AREAS CONSIDERED AS PART OF THIS 2,000 ACRE COMPLEX INCLUDE BUFFALO SLOUGH, GUN SLOUGH, CODY CHUTE, BEAVER CHUTE, HURON CHUTE, AND AREAS ASSOCIATED WITH GARNER ISLAND.
4. THE PROJECT LANDS ARE FEDERALLY OWNED BY THE US ARMY CORPS OF ENGINEERS, AND ARE PART OF THE NATIONAL WILDLIFE SYSTEM. THE US FISH AND WILDLIFE SERVICE HAS GRANTED MANAGEMENT OF THE PROJECT AREA TO THE IA DEPARTMENT OF NATURAL RESOURCES.
5. SEDIMENTATION IN THE AREA HAS NEGATIVELY IMPACTED THE FISH AND WILDLIFE COMPLEX BY DECREASING WATER DEPTH IN THE COMPLEX.
6. HORIZONTAL DATUM IS STATE PLANE COORDINATE SYSTEM, IL WEST, NAD 83, US SURVEY FOOT. VERTICAL DATUM IS MSL 1912.
7. ORTHO PHOTOGRAPHY FROM MARCH 2005.
8. FLAT POOL IS AT EL. 528.0
9. THE HIGHEST ELEVATION A WETLAND CAN BE EXPECTED TO OCCUR AT HURON CHUTE IS EL. 537.06.
10. AQUATIC HABITAT BENEFITS CAN BE OBSERVED AT OR BELOW WATER SURFACE ELEVATIONS 529.8 FT MSL (AT RM 425.4) AND 529.3 FT MSL (AT RM 421.2). FLOODPLAIN HABITAT BENEFITS CAN BE OBSERVED ABOVE THESE WATER SURFACE ELEVATIONS. THE RIVER SLOPES UNIFORMLY BETWEEN THESE RIVER MILES.
11. AT RIVER MILE 422.4, ACCORDING TO THE KEITHSBURG GAGE, THE FOLLOWING ELEVATIONS (IN FT MSL 1912) ARE RELATED TO THE FOLLOWING FLOOD FREQUENCIES:
    A. 2 YEAR FLOOD: EL. 534.7
    B. 5 YEAR FLOOD: EL. 537.3
    C. 10 YEAR FLOOD: EL. 538.9
12. NO CLEARING OF TREES GREATER THAN 4 INCHES IN DIAMETER WITH LOOSE PEELING BARK SHALL BE ALLOWED BETWEEN APRIL 1 AND SEPTEMBER 30, INCLUSIVE (DURING THE INDIANA BAT BREEDING AND REARING SEASON). COORDINATION WITH THE US FISH AND WILDLIFE SERVICE AND IOWA DEPARTMENT OF NATURAL RESOURCES PRIOR TO ANY TREE CUTTING MAY BE REQUIRED.
13. NO CLEARING OF TREES SHALL BE ALLOWED WHERE ROOSTING OR ACTIVE NESTING BY BALD EAGLES OR RED SHOULDERED HAWKS ARE OBSERVED. ALTHOUGH THERE ARE KNOWN NEST SITES IN THE WILDLIFE MANAGEMENT AREAS (WMA), CURRENTLY, NONE ARE KNOWN TO EXIST WITHIN 660 FEET OF THE PROJECT SITE. IF ANY NESTING ACTIVITY IS OBSERVED, NO CONSTRUCTION ACTIVITIES WITHIN 660 FEET OF THE NEST SHALL BE ALLOWED. COORDINATION WITH THE US FISH AND WILDLIFE SERVICE AND IOWA DEPARTMENT OF NATURAL RESOURCES PRIOR TO ANY TREE CUTTING MAY BE REQUIRED.
14. COPPERBELLY AND DIAMONDBACK WATER SNAKES EMERGE FROM HIBERNATION IN EARLY SPRING (APRIL) WHEN TEMPERATURES REACH 64 TO 72 DEGREES F. U.S. FISH AND WILDLIFE SERVICE AND IOWA DEPARTMENT OF NATURAL RESOURCES PERSONNEL SHALL SURVEY AREAS UNDER CONSTRUCTION FOR SNAKE ACTIVITY DURING THIS PERIOD AS A PRECAUTION TO KEEP THESE SNAKES FROM BEING DESTROYED WHILE THEY ARE STILL LETHARGIC. CONSTRUCTION ACTIVITIES WITHIN THESE AREAS OF SUITABLE SNAKE HABITAT SHALL BE RESTRICTED IF SUCH ACTIVITIES ARE IDENTIFIED. HEAVY EQUIPMENT SHALL BE RESTRICTED FROM THIS HABITAT AND NORMALLY BE LIFTED WITHIN 7 TO 10 DAYS WHEN THE SNAKES ARE ACTIVE ENOUGH TO ESCAPE THE DISTURBANCE.
15. COORDINATION WITH THE IOWA DEPARTMENT OF NATURAL RESOURCES 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.
16. PLACEMENT OF DREDGED MATERIALS AND FINAL PREPARATION OF THE DREDGED MATERIAL PLACEMENT AREA SHALL BE COMPLETED BEFORE SEEDING AND PLANTING OF TREES WILL BE ALLOWED.
17. TREES SHALL BE PLANTED BETWEEN OCTOBER 25 AND DECEMBER 10. ACTUAL PLANTING SHALL BE PERFORMED DURING THE ABOVE PERIOD ONLY WHEN WEATHER AND SOIL CONDITIONS ARE SUITABLE AND IN ACCORDANCE WITH LOCALLY ACCEPTED PRACTICE, AS APPROVED BY THE CONTRACTING OFFICER. PLANTING OPERATIONS SHALL BE SUSPENDED DURING PERIODS WHEN AIR TEMPERATURE IS BELOW FREEZING OR ABOVE 80 DEGREES F. IN THE EVENT THAT PLANTING OPERATIONS SPECIFIED FOR A SEASON CANNOT BE COMPLETED DUE TO FLOODING OR LIKELIHOOD OF FLOODING, THE PLANTING OR REMAINING PORTION OF PLANTING SHALL BE DEFERRED UNTIL THE NEXT PLANTING PERIOD.
18. CONSTRUCTION SCHEDULE IS SHOWN IN CHAPTER 7 OF THE MAIN REPORT.

CONSTRUCTION SEQUENCE (COMPLETE TABLE IS SHOWN IN CHAPTER 6 OF THE MAIN REPORT):
1. ROCK PLACEMENT
2. CLEAR, GRUB, STRIP
3. DREDGING - USE EXCAVATED MATERIAL TO PROVIDE BORROW FOR MEASURES F1, F3 AND F5
4. PAD CONSTRUCTION - USE EXISTING SOIL MATERIAL FOR MEASURE F5
5. PLACEMENT SITE SHAPING - SHAPE SITES F1, F3 AND F5
6. PLANT AQUATIC VEGETATION
7. PLANT SHRUBS AND TREES

PROJECT GOALS:

1. MANAGE FOR A DIVERSE AND DYNAMIC PATTERN OF HABITATS TO SUPPORT NATIVE BIOTA.
2. MANAGE FOR VIABLE POPULATIONS OF NATIVE SPECIES WITHIN DIVERSE PLANT AND ANIMAL COMMUNITIES.
3. MANAGE FOR PROCESSES THAT SHAPE A PHYSICALLY DIVERSE AND DYNAMIC RIVER-FLOODPLAIN SYSTEM.

PROJECT OBJECTIVES:

1. INCREASE THE AREAL COVERAGE, AS MEASURED IN ACRES, OF EMERGENT AND SUBMERSED AQUATIC VEGETATION IN BACKWATER AREAS DURING THE GROWING SEASON.
2. MAINTAIN AND INCREASE DIVERSIFICATION OF YEAR ROUND FLOODPLAIN FOREST AND SCRUB-SHRUB HABITAT ON HURON ISLAND, AS MEASURED IN ACRES.
3. MAINTAIN AND INCREASE YEAR-ROUND AQUATIC HABITAT DIVERSITY, AS MEASURED IN ABUNDANCE AND DIVERSITY OF NATIVE FISH, IN THE PROJECT AREA.
4. MAINTAIN AND RESTORE SIDE CHANNEL ISLANDS TO RESTORE RIVERINE HYDRODYNAMIC, SEDIMENT TRANSPORT AND GEOMORPHIC CONDITIONS IN HURON CHUTE.

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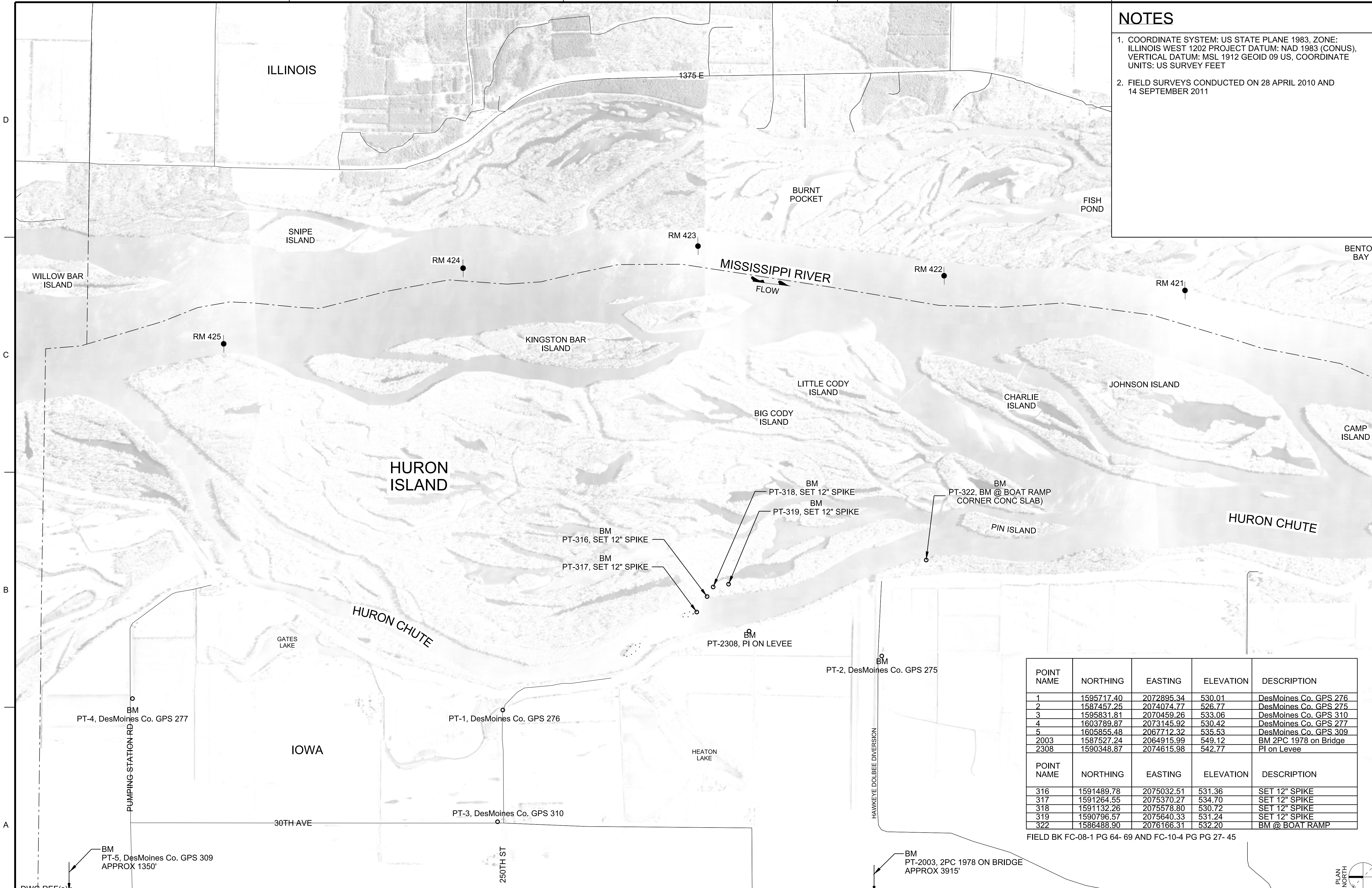
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
INDEX AND GENERAL NOTES
PLATE 3

Sheet ID G-004

NOTES

1. COORDINATE SYSTEM: US STATE PLANE 1983, ZONE: ILLINOIS WEST 1202 PROJECT DATUM: NAD 1983 (CONUS), VERTICAL DATUM: MSL 1912 GEOID 09 US, COORDINATE UNITS: US SURVEY FEET
2. FIELD SURVEYS CONDUCTED ON 28 APRIL 2010 AND 14 SEPTEMBER 2011



POINT NAME	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	1595717.40	2072895.34	530.01	DesMoines Co. GPS 276
2	1587457.25	2074074.77	526.77	DesMoines Co. GPS 275
3	1595831.81	2070459.26	533.06	DesMoines Co. GPS 310
4	1603789.87	2073145.92	530.42	DesMoines Co. GPS 277
5	1605855.48	2067712.32	535.53	DesMoines Co. GPS 309
2003	1587527.24	2064915.99	549.12	BM 2PC 1978 on Bridge
2308	1590348.87	2074615.98	542.77	PI on Levee
POINT NAME	NORTHING	EASTING	ELEVATION	DESCRIPTION
316	1591489.78	2075032.51	531.36	SET 12" SPIKE
317	1591264.55	2075370.27	534.70	SET 12" SPIKE
318	1591132.26	2075578.80	530.72	SET 12" SPIKE
319	1590796.57	2075640.33	531.24	SET 12" SPIKE
322	1586488.90	2076166.31	532.20	BM @ BOAT RAMP

FIELD BK FC-08-1 PG 64- 69 AND FC-10-4 PG PG 27- 45

DWG REF(s):

A1 SURVEY CONTROL DIAGRAM

SCALE : 1"=1000'-0"

0 1000' 2000'

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ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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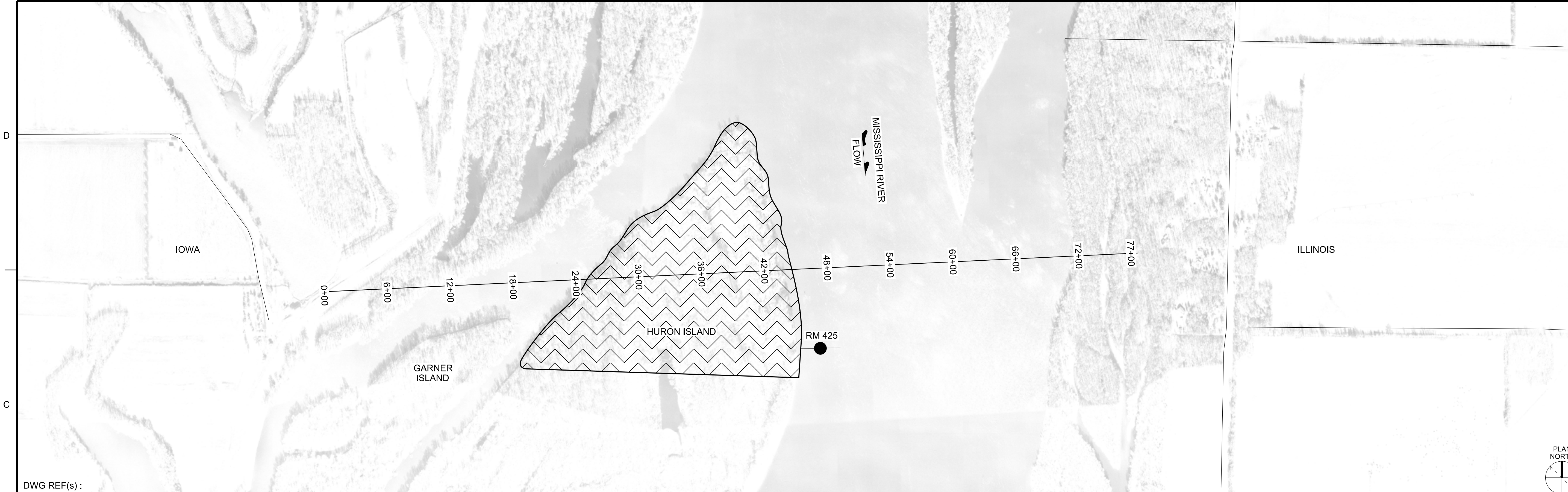
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT

SURVEY
CONTROL DIAGRAM

PLATE 4

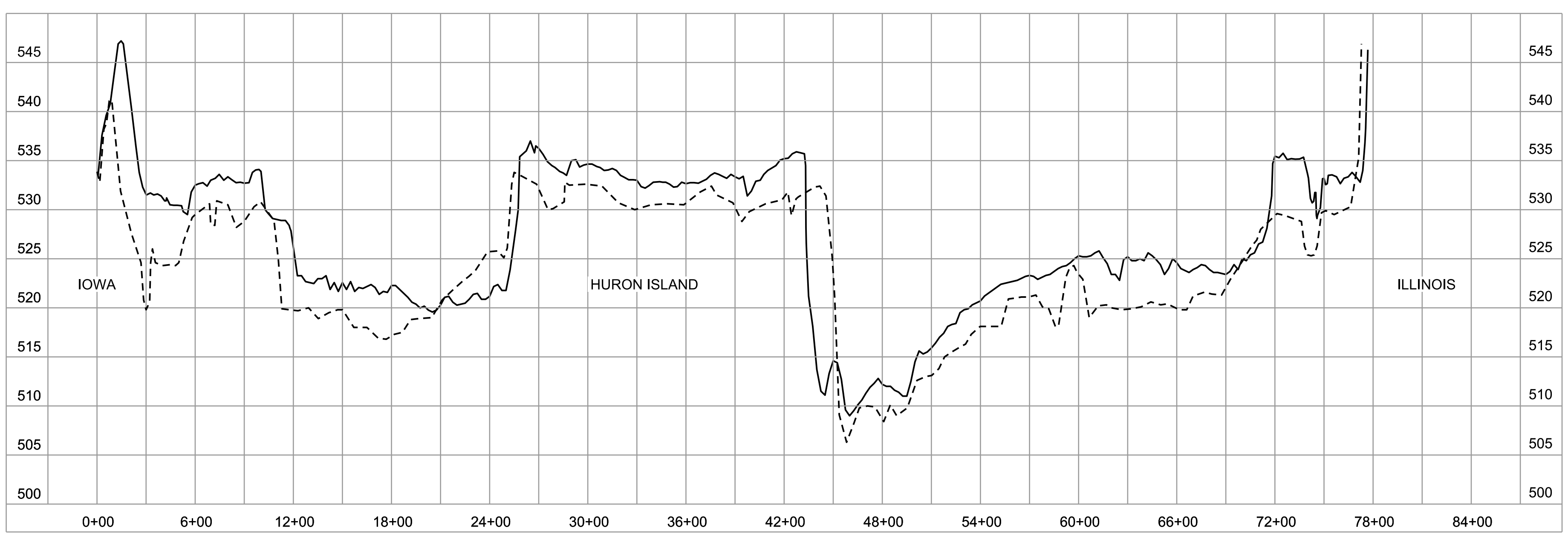
Sheet ID
V-101



DWG REF(s) :

C1 SEDIMENT RANGE

SCALE : 1"=500'-0"   0   500'   1000'



- 2005 SEDIMENT
- 1938 SEDIMENT

DWG REF(s) :

A1 SEDIMENT RANGE

SCALE : 1"=500'-0"   0   500'   1000'

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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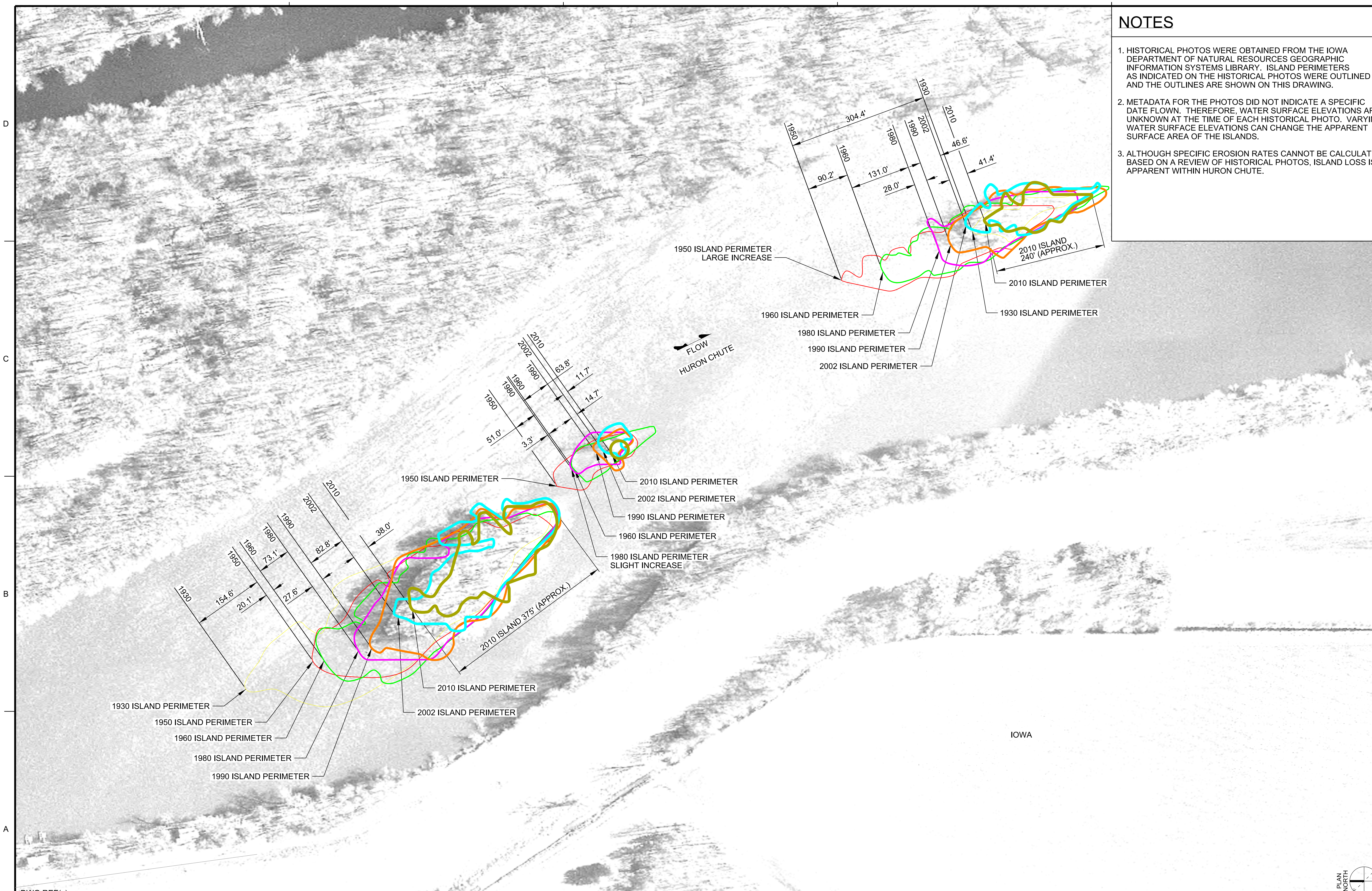
SUBMITTED BY: | CONTRACT NO.:
PLOT SCALE: AS SHOWN | PLOT DATE: | PROJECT CODE: EP101
SIZE: ANSI D | FILE NAME: EP101_V-102xxx.dgn

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT

SEDIMENT RANGE
PLAN AND PROFILE

PLATE 5

Sheet ID
V-102



NOTES

1. HISTORICAL PHOTOS WERE OBTAINED FROM THE IOWA DEPARTMENT OF NATURAL RESOURCES GEOGRAPHIC INFORMATION SYSTEMS LIBRARY. ISLAND PERIMETERS AS INDICATED ON THE HISTORICAL PHOTOS WERE OUTLINED AND THE OUTLINES ARE SHOWN ON THIS DRAWING.
2. METADATA FOR THE PHOTOS DID NOT INDICATE A SPECIFIC DATE FLOWN. THEREFORE, WATER SURFACE ELEVATIONS ARE UNKNOWN AT THE TIME OF EACH HISTORICAL PHOTO. VARYING WATER SURFACE ELEVATIONS CAN CHANGE THE APPARENT SURFACE AREA OF THE ISLANDS.
3. ALTHOUGH SPECIFIC EROSION RATES CANNOT BE CALCULATED, BASED ON A REVIEW OF HISTORICAL PHOTOS, ISLAND LOSS IS APPARENT WITHIN HURON CHUTE.

DWG REF(s) :

A1 OBSERVED ISLAND EROSION

SCALE : 1"=100'-0" 0 100' 200'

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ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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PLOT SCALE: AS SHOWN
PLOT DATE:
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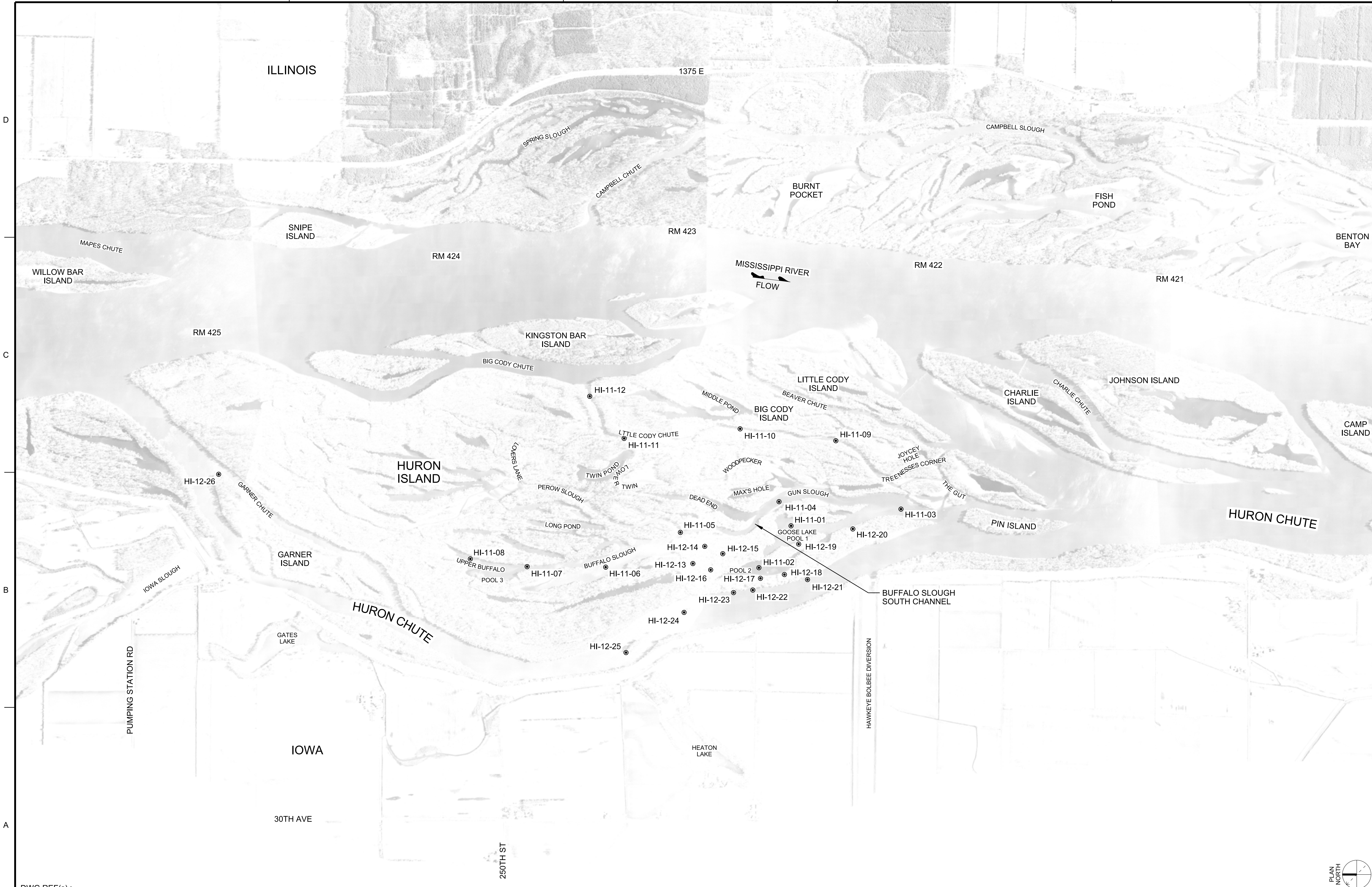
FILE NAME: EP101_V-103xxx.dgn
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: EP101

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
OBSERVED ISLAND EROSION

PLATE 6

Sheet ID
V-103

July 2013 Draft



DWG REF(s) :

A1 BORING LOCATION PLAN

SCALE : 1"=1000'-0" 0 1000' 2000'

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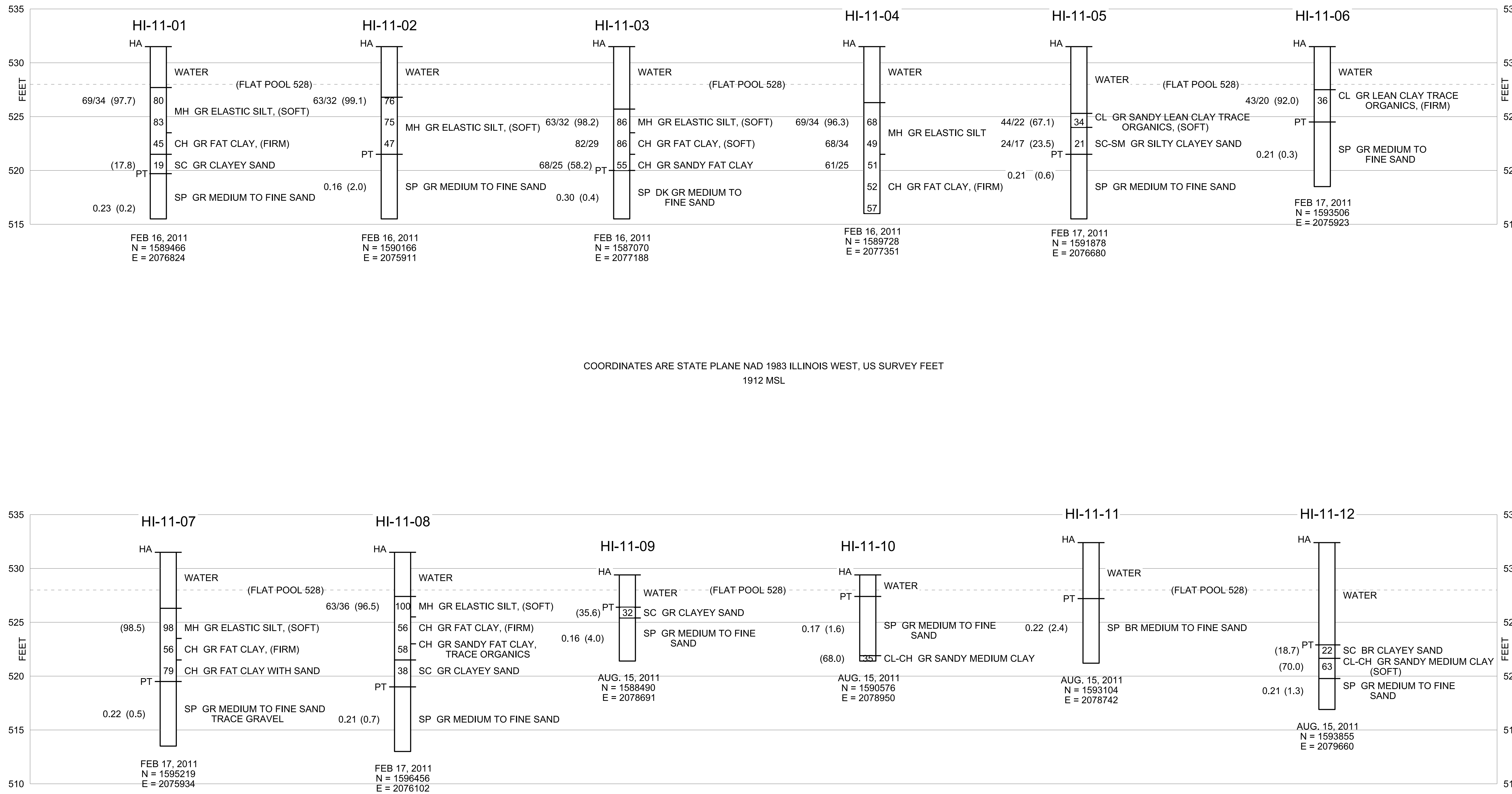
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
BORING LOCATION PLAN

PLATE 7

Sheet ID
B-101



COORDINATES ARE STATE PLANE NAD 1983 ILLINOIS WEST, US SURVEY FEET
1912 MSL

DWG REF(s) :

A1 BORING LOGS

SCALE : 1"=5'-0"

US Army Corps of Engineers

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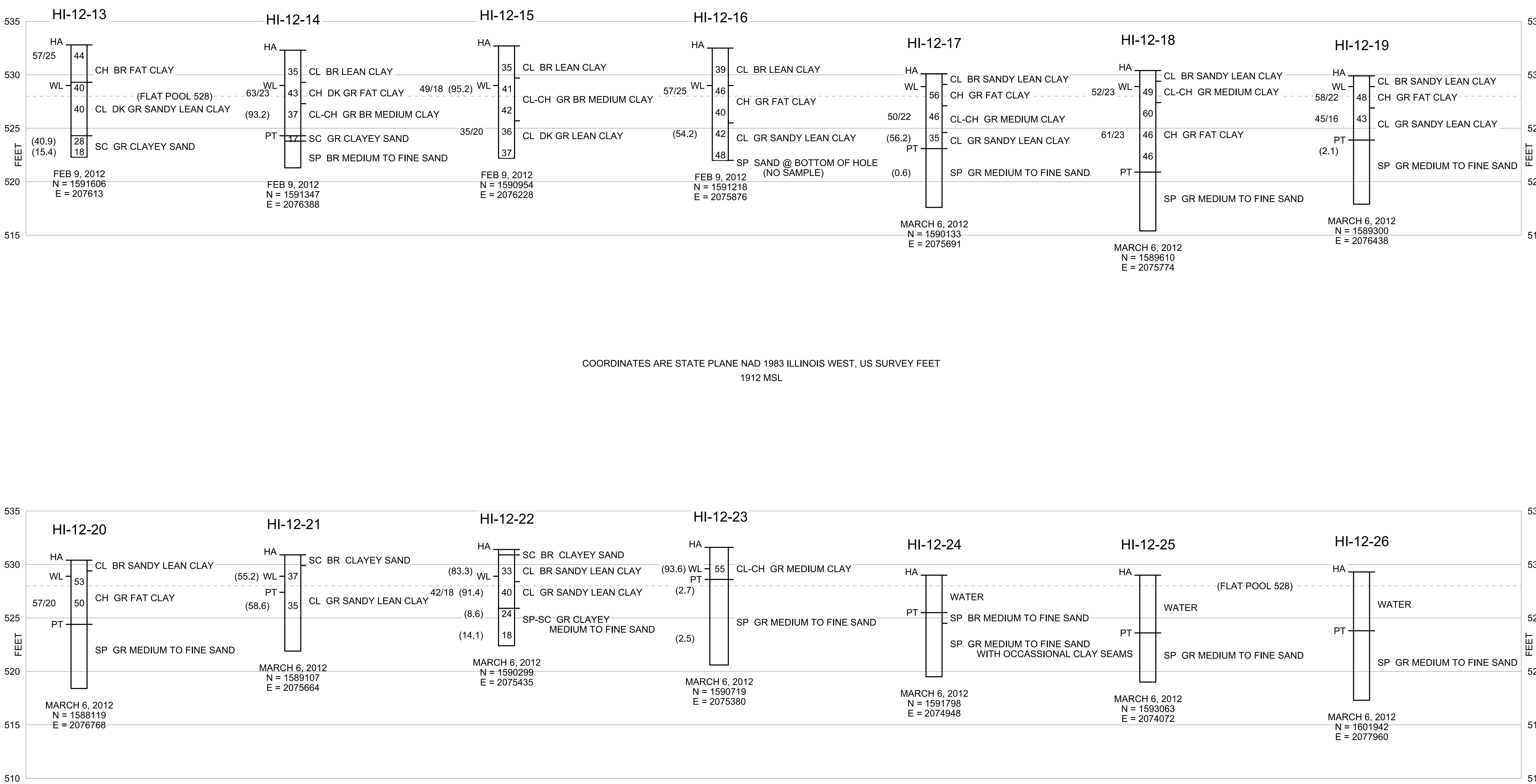
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
BORING LOGS

PLATE 8

Sheet ID
B-301



COORDINATES ARE STATE PLANE NAD 1983 ILLINOIS WEST, US SURVEY FEET
1912 MSL

DWG REF(s) :

A1 BORING LOGS

SCALE : 1"=5'-0"

US Army Corps of Engineers

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
BORING LOGS

PLATE 9

Sheet ID
B-302

NOTES

1. PLATE SHOWS EXISTING CONDITIONS.
2. SPAWNING HABITAT HAS BEEN OBSERVED THROUGHOUT THE HURON ISLAND COMPLEX.
3. NO MUSSEL BEDS AND NO ROOKERIES WERE IDENTIFIED IN THE HURON ISLAND COMPLEX PER THE SCIENTIFIC ASSESSMENT AND STRATEGY TEAM OF THE USGS FROM 1995.
4. WATER INLETS WERE OBSERVED IN THE FIELD AND INDICATE LOWER ELEVATIONS ON THE ISLAND WHICH HAVE WATER PASSAGE FROM THE MAIN CHANNEL, HURON CHUTE, GARNER CHUTE OR BIG CODY CHUTE AT HIGHER RIVER ELEVATIONS.

DWG REF(s) :

A1 SITE PLAN

SCALE : 1"=1000'-0"

0 1000' 2000'

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: KNM	DWN BY: LLHUMF	CKD BY:	SUBMITTED BY:	
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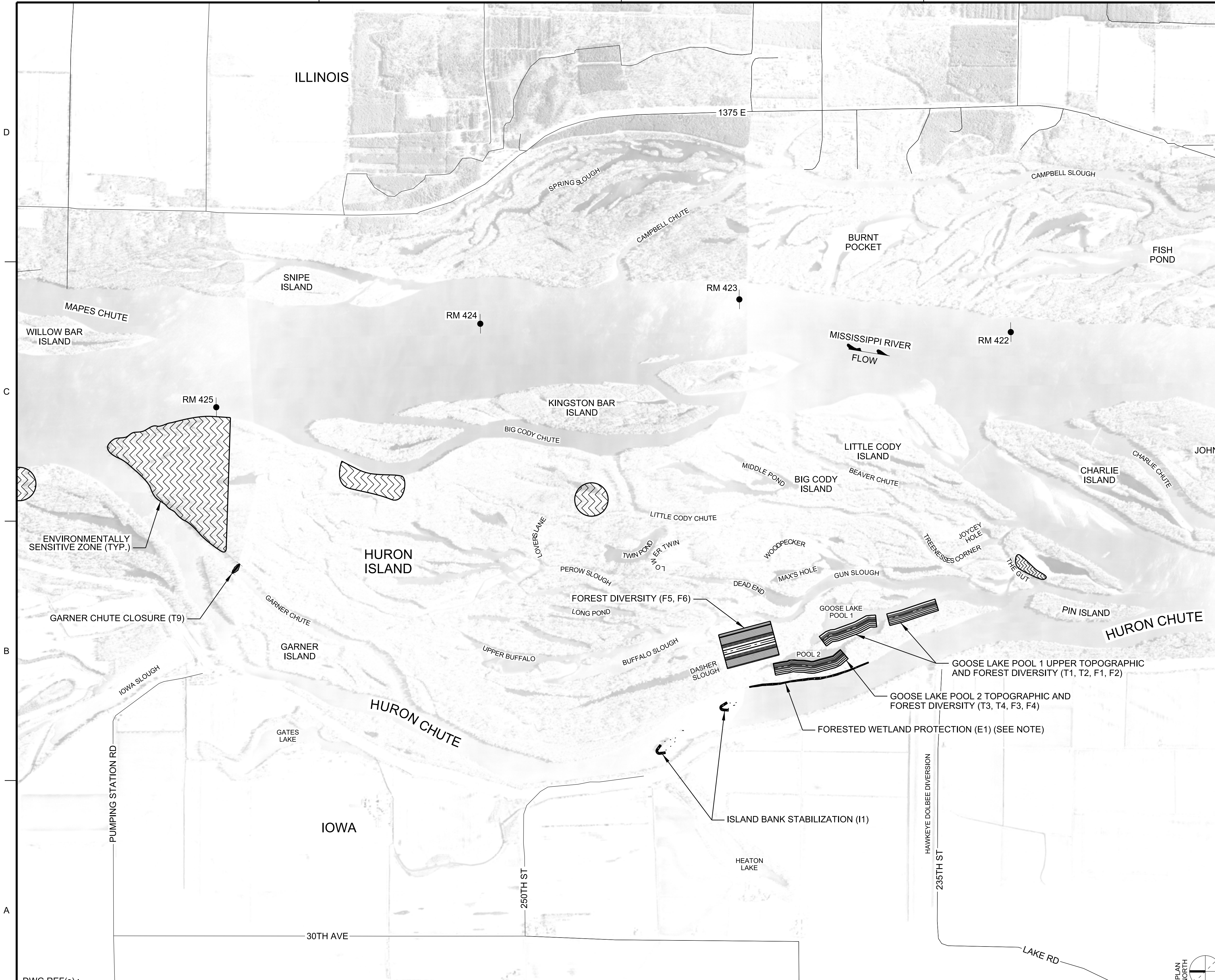
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
SITE PLAN

PLATE 10

Sheet ID
C-101



DWG REF(s) :

A1 PROJECT ENHANCEMENT FEATURES EVALUATED

SCALE : 1"=1000'-0" 0 1000' 2000'

NOTE

1. E1 WAS COMBINED WITH MEASURE T3 AND T4 AND IS NOT SHOWN AS AN INDIVIDUAL MEASURE IN THE INCREMENTAL COST ANALYSIS.

TOPOGRAPHIC DIVERSITY AND OVERWINTERING	
T0	NO ACTION
T1	GOOSE LAKE POOL 1 TOPOGRAPHIC DIVERSITY (537 TOP)
T2	GOOSE LAKE POOL 1 TOPOGRAPHIC DIVERSITY (539 TOP)
T3	GOOSE LAKE POOL 2 TOPOGRAPHIC DIVERSITY (537 TOP)
T4	GOOSE LAKE POOL 2 TOPOGRAPHIC DIVERSITY (539 TOP)
T9	GARNER CHUTE CLOSURE STRUCTURE
FORESTED WETLAND PROTECTION (HURON ISLAND)	
E0	NO ACTION
E1	BANK STABILIZATION (SEE NOTE)
HURON CHUTE DIVERSITY	
I0	NO ACTION
I1	ISLAND BANK STABILIZATION
FLOODPLAIN FOREST DIVERSITY	
F0	NO ACTION
F1	FOREST DIVERSITY ADJACENT TO POOL 1 (537 TOP)
F2	FOREST DIVERSITY ADJACENT TO POOL 1 (539 TOP)
F3	FOREST DIVERSITY ADJACENT TO POOL 2 (537 TOP)
F4	FOREST DIVERSITY ADJACENT TO POOL 2 (539 TOP)
F5	FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION USING EXISTING SOIL (537 TOP)
F6	FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION USING EXISTING SOIL (539 TOP)

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ROCK ISLAND, ILLINOIS

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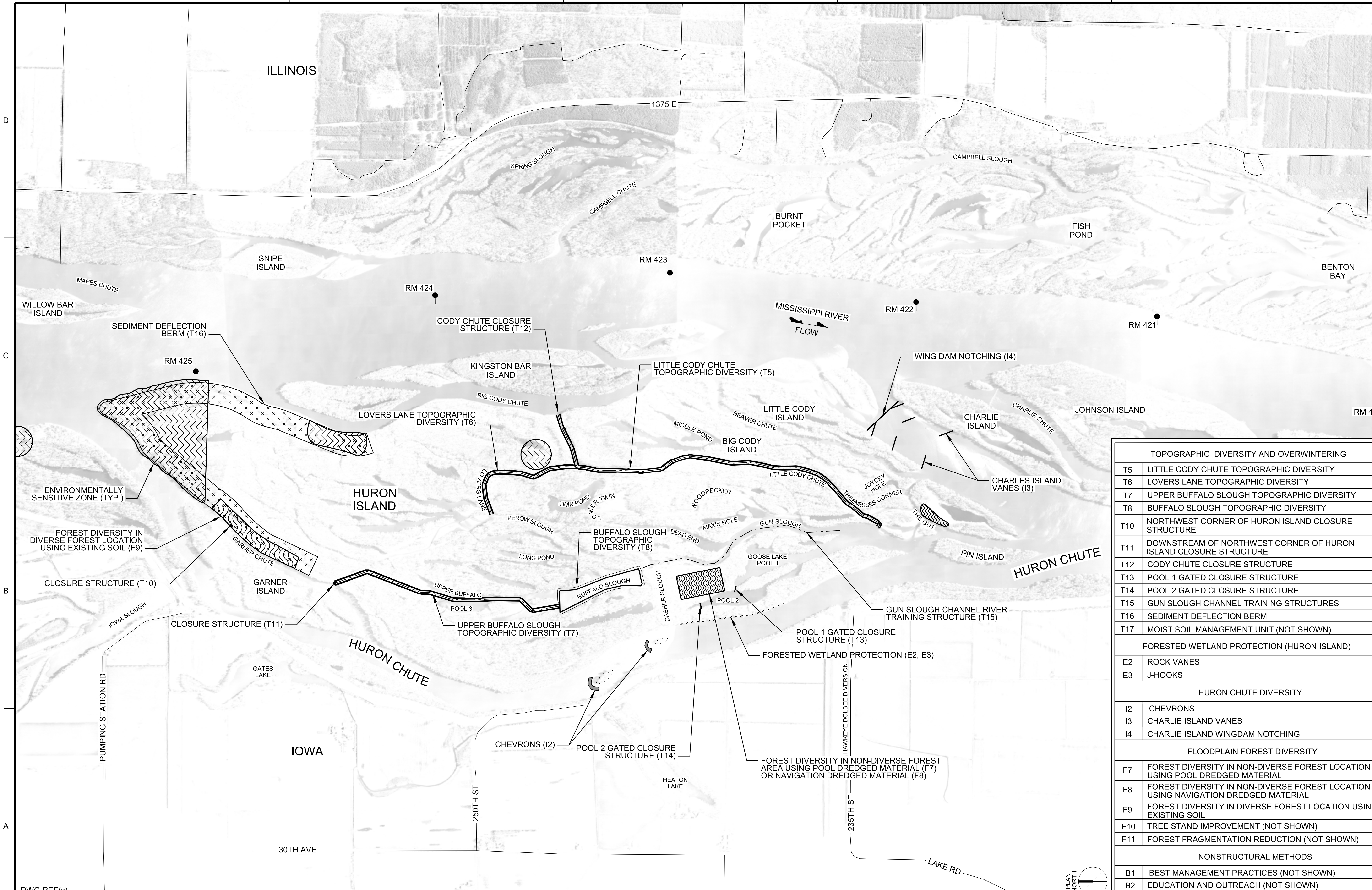
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
PROJECT ENHANCEMENT FEATURES EVALUATED

PLATE 11

Sheet ID
C-102



TOPOGRAPHIC DIVERSITY AND OVERWINTERING	
T5	LITTLE CODY CHUTE TOPOGRAPHIC DIVERSITY
T6	LOVERS LANE TOPOGRAPHIC DIVERSITY
T7	UPPER BUFFALO SLOUGH TOPOGRAPHIC DIVERSITY
T8	BUFFALO SLOUGH TOPOGRAPHIC DIVERSITY
T10	NORTHWEST CORNER OF HURON ISLAND CLOSURE STRUCTURE
T11	DOWNSTREAM OF NORTHWEST CORNER OF HURON ISLAND CLOSURE STRUCTURE
T12	CODY CHUTE CLOSURE STRUCTURE
T13	POOL 1 GATED CLOSURE STRUCTURE
T14	POOL 2 GATED CLOSURE STRUCTURE
T15	GUN SLOUGH CHANNEL TRAINING STRUCTURES
T16	SEDIMENT DEFLECTION BERM
T17	MOIST SOIL MANAGEMENT UNIT (NOT SHOWN)
FORESTED WETLAND PROTECTION (HURON ISLAND)	
E2	ROCK VANES
E3	J-HOOKS
HURON CHUTE DIVERSITY	
I2	CHEVRONS
I3	CHARLIE ISLAND VANES
I4	CHARLIE ISLAND WINGDAM NOTCHING
FLOODPLAIN FOREST DIVERSITY	
F7	FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION USING POOL DREDGED MATERIAL
F8	FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION USING NAVIGATION DREDGED MATERIAL
F9	FOREST DIVERSITY IN DIVERSE FOREST LOCATION USING EXISTING SOIL
F10	TREE STAND IMPROVEMENT (NOT SHOWN)
F11	FOREST FRAGMENTATION REDUCTION (NOT SHOWN)
NONSTRUCTURAL METHODS	
B1	BEST MANAGEMENT PRACTICES (NOT SHOWN)
B2	EDUCATION AND OUTREACH (NOT SHOWN)
CONSTRUCTED SOIL UNITS	
P1	EPHEMERAL WETLAND (NOT SHOWN)
P2	SEASONALY FLOODED PERCHED WETLAND (NOT SHOWN)

DWG REF(s) :

A1 PROJECT ENHANCEMENT FEATURES NOT EVALUATED

SCALE : 1"=1000'-0"

0 1000' 2000'

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ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
PROJECT ENHANCEMENT
FEATURES NOT EVALUATED

PLATE 12

Sheet ID
C-103

NOTE

1. FORESTED WETLAND PROTECTION BANK STABILIZATION IS COMBINED WITH MEASURE T3.

	TOPOGRAPHIC DIVERSITY AND OVERWINTERING
T1	GOOSE LAKE POOL 1 TOPOGRAPHIC DIVERSITY (537 TOP)
T3	GOOSE LAKE POOL 2 TOPOGRAPHIC DIVERSITY (537 TOP)
T9	GARNER CHUTE CLOSURE STRUCTURE
	HURON CHUTE DIVERSITY
I1	ISLAND BANK STABILIZATION
	FLOODPLAIN FOREST DIVERSITY
F1	FOREST DIVERSITY ADJACENT TO POOL 1 (537 TOP)
F3	FOREST DIVERSITY ADJACENT TO POOL 2 (537 TOP)
F5	FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION USING EXISTING SOIL (537 TOP)

DWG REF(s) :

A1 RECOMMENDED PLAN

SCALE : 1"=1000'-0" 0 1000' 2000'

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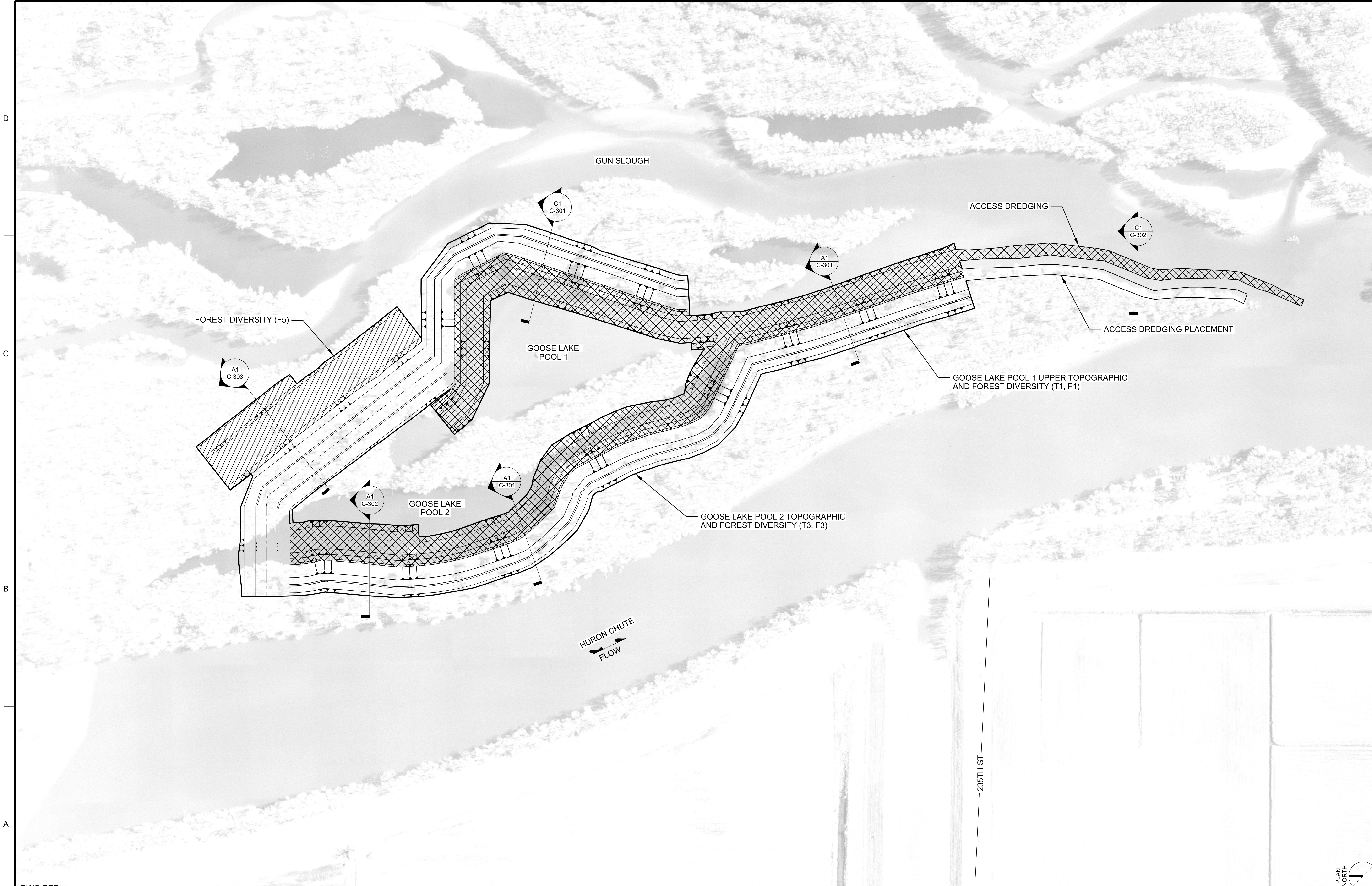
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
RECOMMENDED PLAN

PLATE 13

Sheet ID
C-104



DWG REF(s) :

A1 DREDGING AND EXCAVATION (MEASURES T1, T3, F1, F3, F5) PLAN

SCALE : 1"=200'-0"   0   200'   400'

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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PLOT SCALE: AS SHOWN
PLOT DATE:
PROJECT CODE: EP101
SIZE: ANSI D
FILE NAME: EP101_C-105xxx.dgn

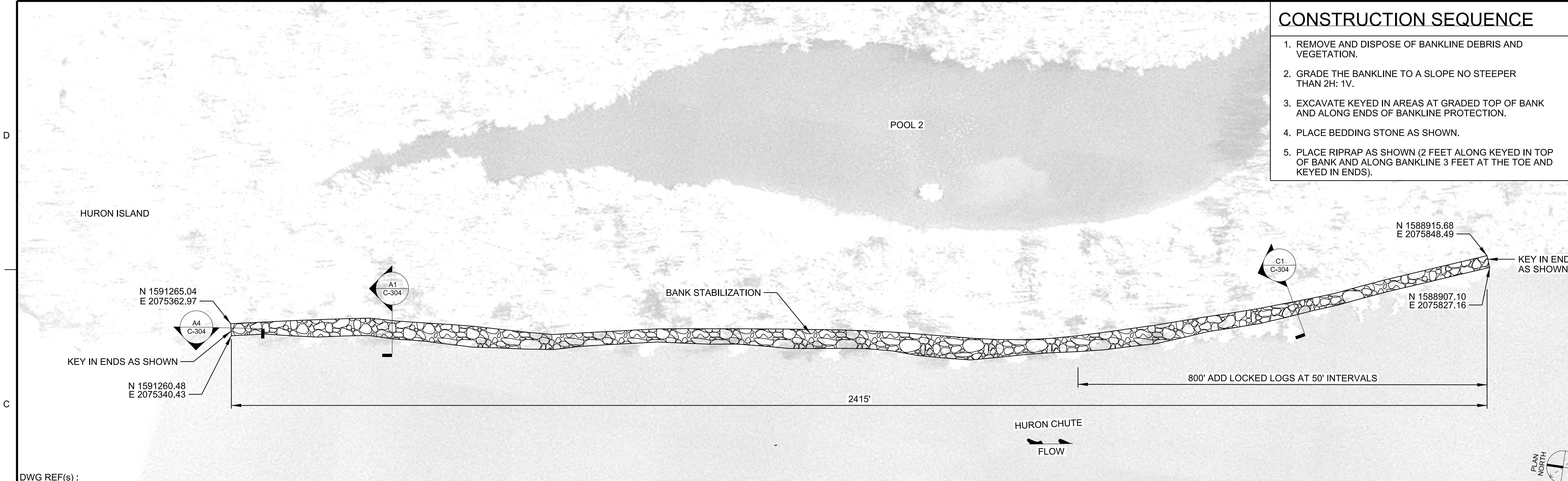
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
DREDGING AND EXCAVATION
(MEASURES T1, T3, F1, F3, F5) PLAN

PLATE 14

Sheet ID
C-105

CONSTRUCTION SEQUENCE

1. REMOVE AND DISPOSE OF BANKLINE DEBRIS AND VEGETATION.
2. GRADE THE BANKLINE TO A SLOPE NO STEEPER THAN 2H: 1V.
3. EXCAVATE KEYED IN AREAS AT GRADED TOP OF BANK AND ALONG ENDS OF BANKLINE PROTECTION.
4. PLACE BEDDING STONE AS SHOWN.
5. PLACE RIPRAP AS SHOWN (2 FEET ALONG KEYED IN TOP OF BANK AND ALONG BANKLINE 3 FEET AT THE TOE AND KEYED IN ENDS).



DWG REF(s) :

C1 HURON ISLAND FORESTED WETLAND PROTECTION BANK STABLIZATION PLAN

SCALE : 1"=100'-0" 0 100' 200'

DWG REF(s) :

A1 HURON ISLAND BANK STABILIZATION (MEASURE I1) PLAN

SCALE : 1"=100'-0" 0 100' 200'

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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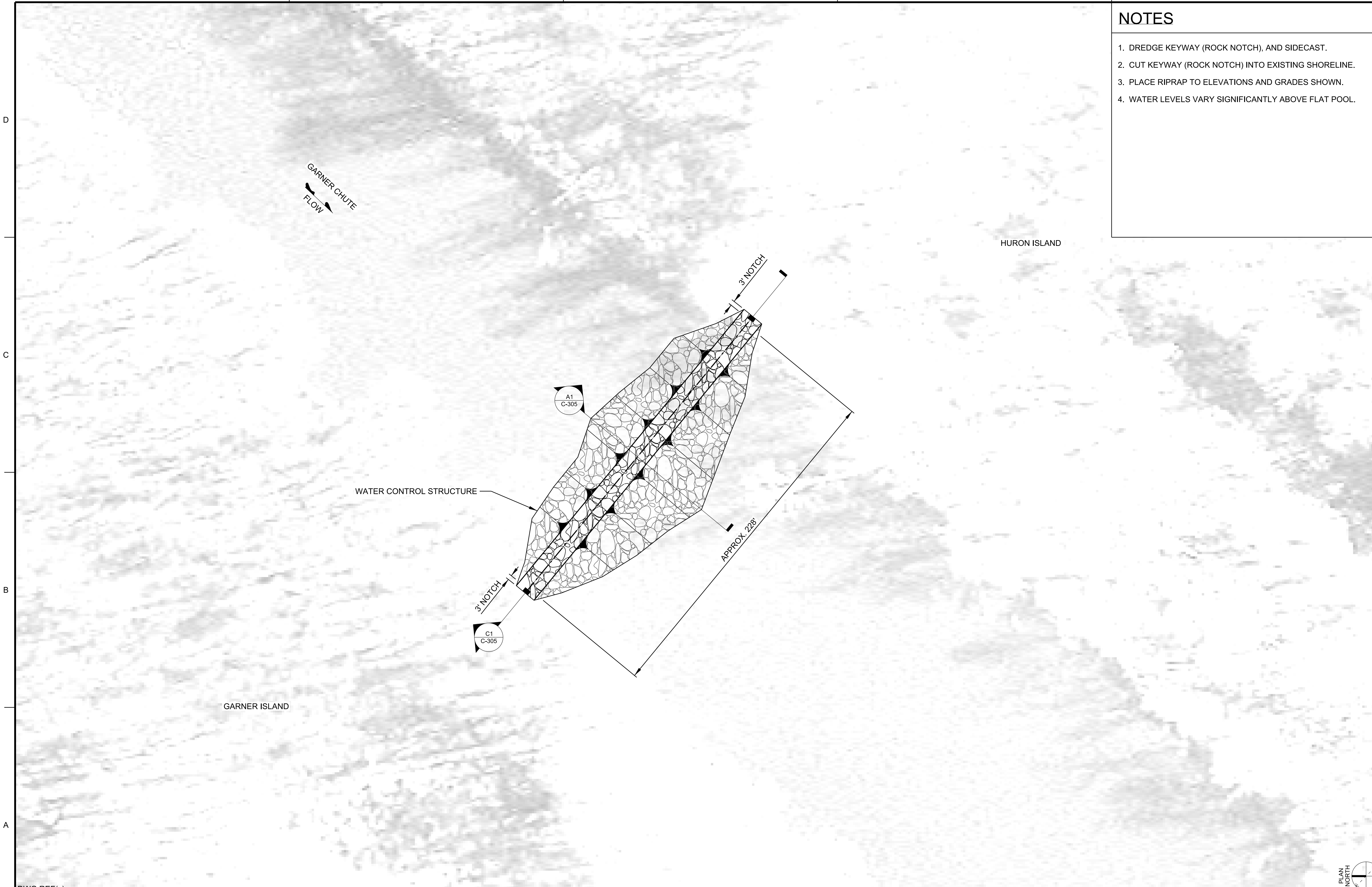
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
BANK STABILIZATION PLANS

PLATE 15

Sheet ID
C-106

July 2013 Draft



NOTES

1. DREDGE KEYWAY (ROCK NOTCH), AND SIDECAST.
2. CUT KEYWAY (ROCK NOTCH) INTO EXISTING SHORELINE.
3. PLACE RIPRAP TO ELEVATIONS AND GRADES SHOWN.
4. WATER LEVELS VARY SIGNIFICANTLY ABOVE FLAT POOL.

DWG REF(s) :

A1 GARNER CHUTE CLOSURE STRUCTURE (MEASURE T9) PLAN

SCALE : 1"=30'-0" 0 30' 60'

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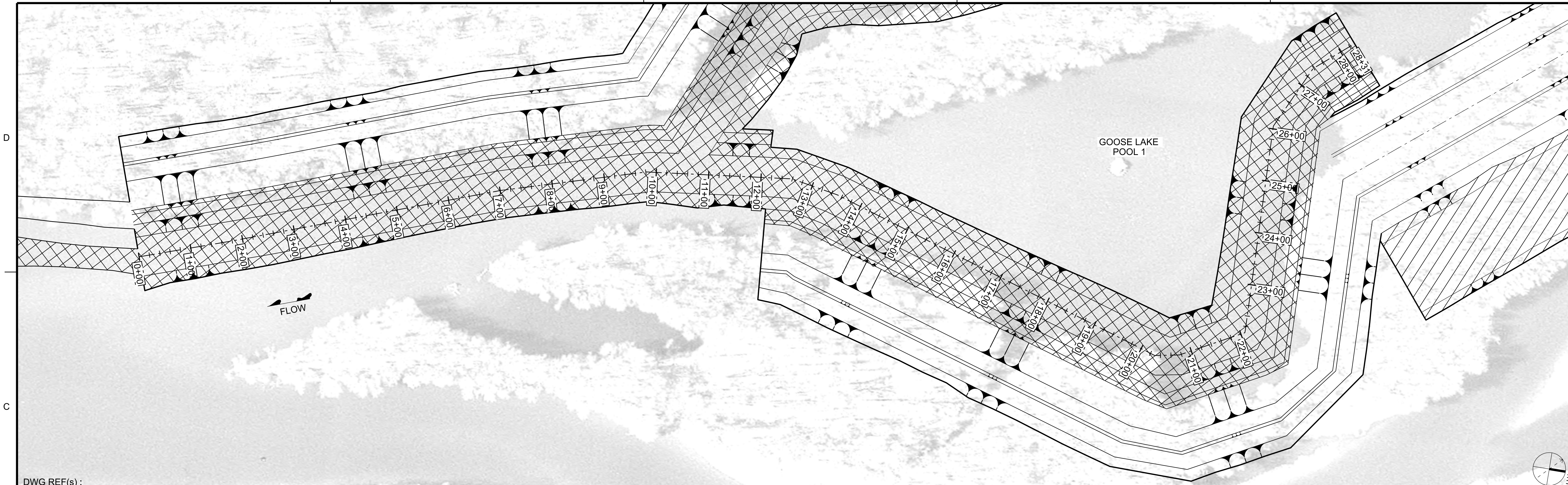
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: EP101_C-107xxx.dgn

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
GARNER CHUTE CLOSURE
STRUCTURE (MEASURE T9) PLAN

PLATE 16

Sheet ID
C-107



DWG REF(s) :

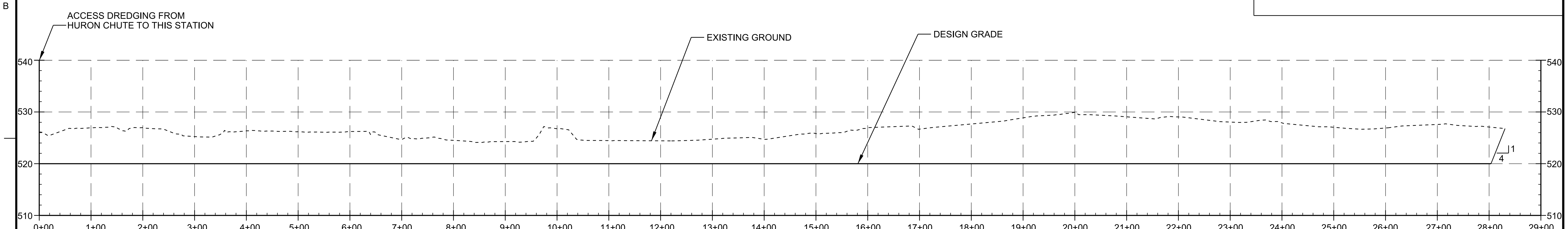
C1 GOOSE LAKE (MEASURE T1) PLAN

SCALE : 1"=100'-0"

0 100' 200'

NOTE

1. DREDGE PLAN AND PROFILE SHOWN WILL BE PLACED AT MEASURES F1 AND F5. ACCURATE LENGTHS FOR EACH MEASURE ARE SHOWN IN THE MAIN REPORT.



DWG REF(s) :

A1 GOOSE LAKE (MEASURE T1) PROFILE

SCALE : 1"=80'-0"

0 100' 200'

US Army Corps of Engineers®

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ROCK ISLAND, ILLINOIS

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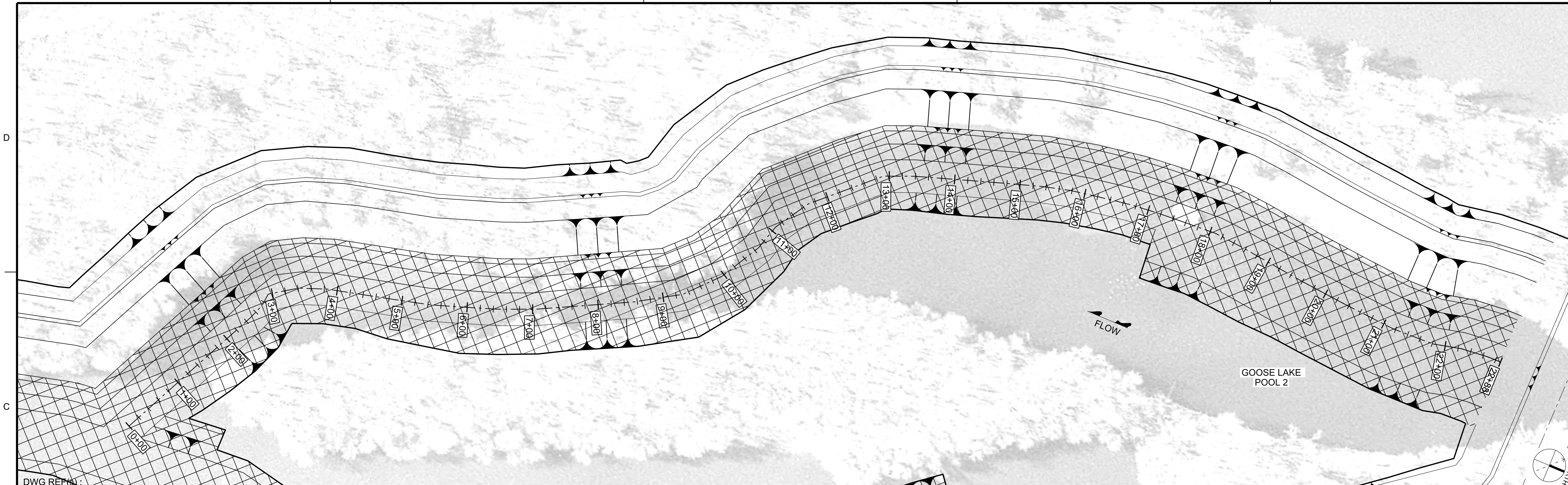
SIZE: ANSI D | FILE NAME: EP101_C-108xxx.dgn

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
GOOSE LAKE (MEASURE T1)
PLAN AND PROFILE

PLATE 17

Sheet ID
C-108

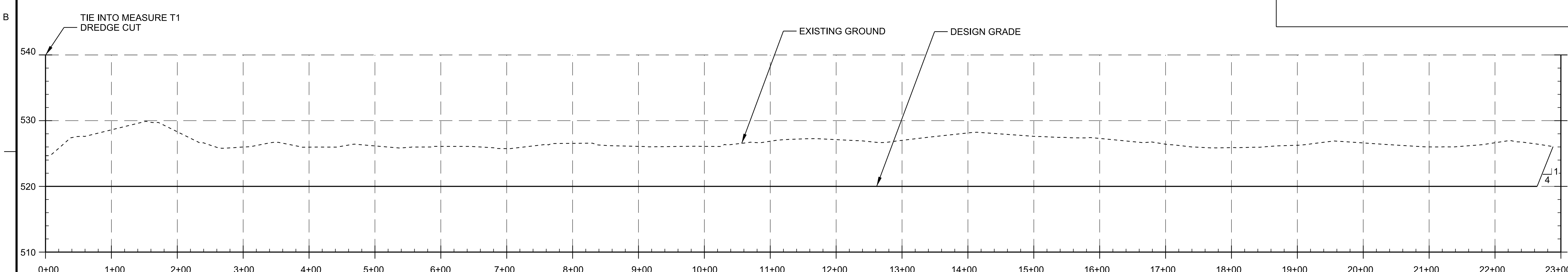


C1 GOOSE LAKE (MEASURE T3) PLAN

SCALE : 1"=80'-0"   0   80'   160'

NOTE

1. DREDGE PLAN AND PROFILE SHOWN WILL BE PLACED AT MEASURES F1 AND F5. ACCURATE LENGTHS FOR EACH MEASURE ARE SHOWN IN THE MAIN REPORT.



DWG REF(s) :

A1 GOOSE LAKE (MEASURE T3) PROFILE

SCALE : 1"=80'-0"   0   80'   160'

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
GOOSE LAKE (MEASURE T3)
PLAN AND PROFILE

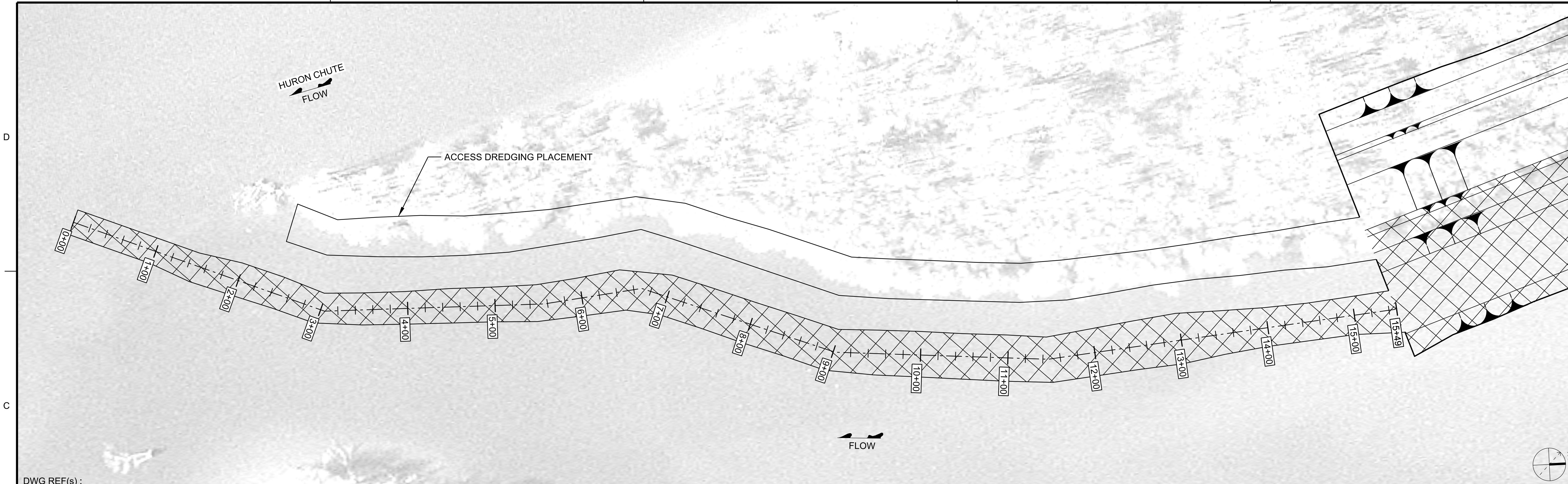
PLATE 18

Sheet ID
C-109

1 2 3 4 5

D

C

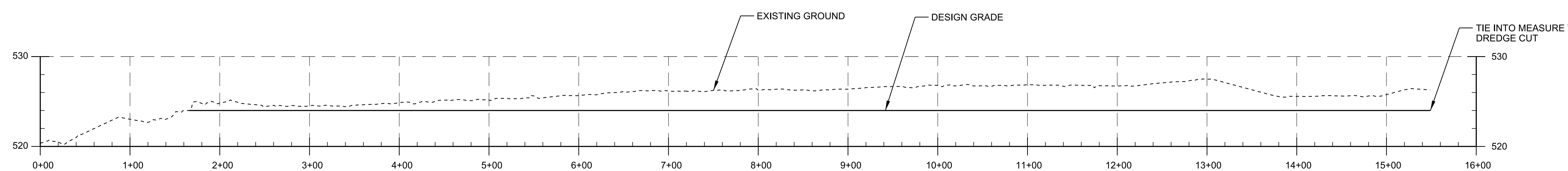


DWG REF(s) :

C1 GOOSE LAKE (MEASURE T1) ACCESS DREDGE CUT PLAN

SCALE : 1"=60'-0"   0 60' 120'

B



A

DWG REF(s) :

A1 GOOSE LAKE (MEASURE T1) ACCESS DREDGE CUT PROFILE

SCALE : 1"=60'-0"   0 60' 120'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: KNM
DATE:
DWN BY: EJJ
CKD BY:
SOLICITATION NO.:
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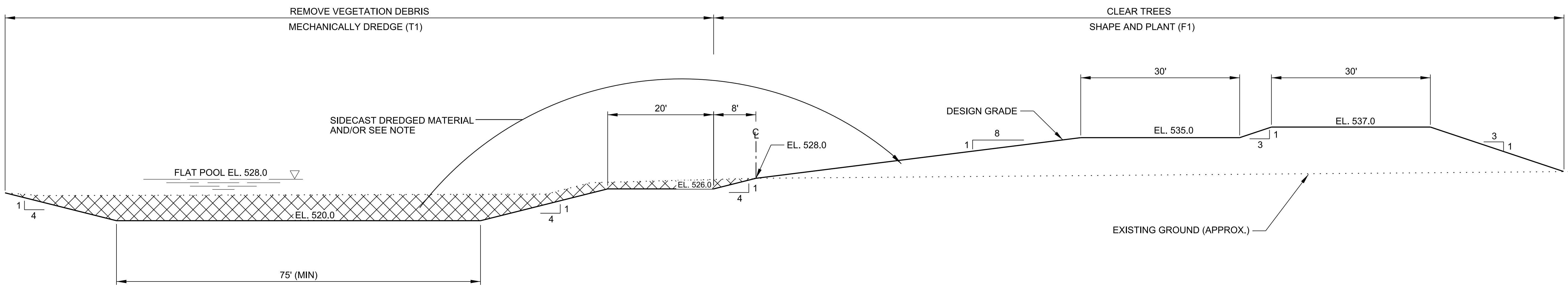
CONTRACT NO.:
PLOT SCALE: AS SHOWN
PLOT DATE:
PROJECT CODE: EP101
SIZE: ANSI D
FILE NAME: EP101_C-110xxx.dgn

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
GOOSE LAKE (MEASURE T1)
ACCESS DREDGE CUT
PLAN AND PROFILE
PLATE 19

Sheet ID
C-110

NOTE

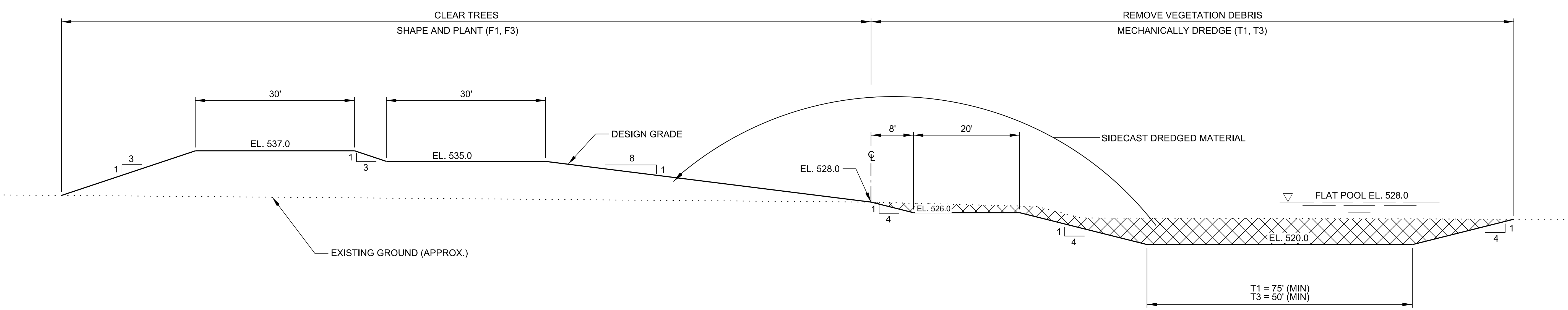
1. EXCESS MATERIAL DREDGED FROM MEASURE T1 WILL BE USED TO CONSTRUCT MEASURE F5.



DWG REF(s) :

C1 GOOSE LAKE POOL 1 TOPOGRAPHIC DIVERSITY (537 TOP) MEASURES T1/F1 SECTION

SCALE : 1"=10'-0"



DWG REF(s) :

A1 GOOSE LAKE POOL 1 AND POOL 2 TOPOGRAPHIC DIVERSITY (537 TOP) MEASURES T1/F1 AND T3/F3 SECTION

SCALE : 1"=10'-0"

US Army Corps of Engineers

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DWN BY: JMF
CKD BY:
SUBMITTED BY:
DATE:
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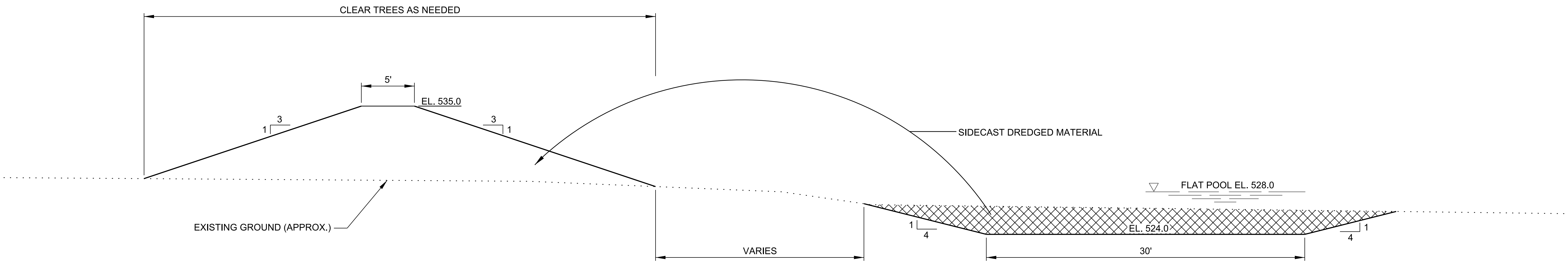
CONTRACT NO.:
PLOT SCALE: AS SHOWN
PLOT DATE:
PROJECT CODE: EP101
SIZE: ANSI D
FILE NAME: EP101_C-301xxx.dgn

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
GOOSE LAKE
TOPOGRAPHIC DIVERSITY
(MEASURES T1/F1, T3/F3) SECTIONS
PLATE 20

Sheet ID
C-301



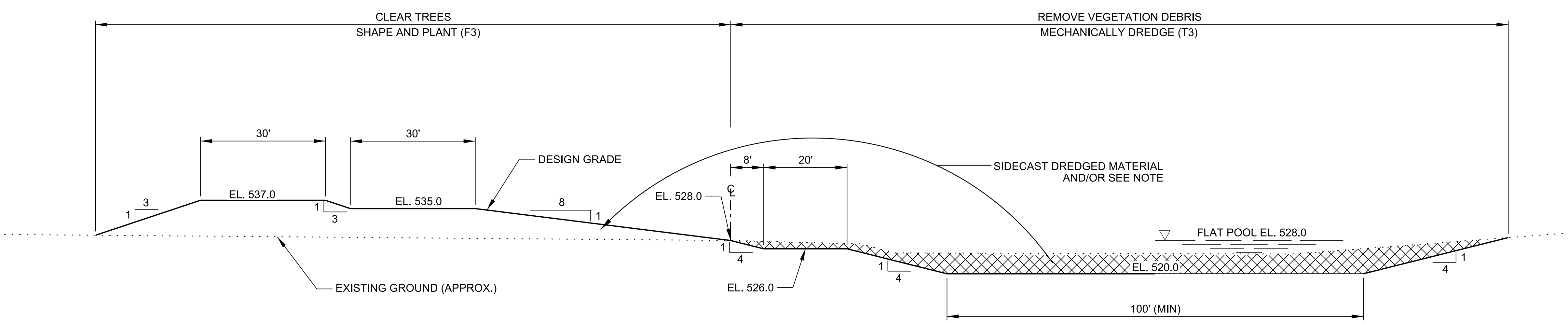
DWG REF(s) :

C1 GOOSE LAKE POOL 1 ACCESS DREDGE SECTION

SCALE : 1"=5'-0"

NOTE

1. EXCESS MATERIAL DREDGED FROM MEASURE T3 WILL BE USED TO CONSTRUCT MEASURE F5.



DWG REF(s) :

A1 GOOSE LAKE POOL 2 TOPOGRAPHIC DIVERSITY (537 TOP) MEASURE T3/F3 SECTION

SCALE : 1"=15'-0"

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

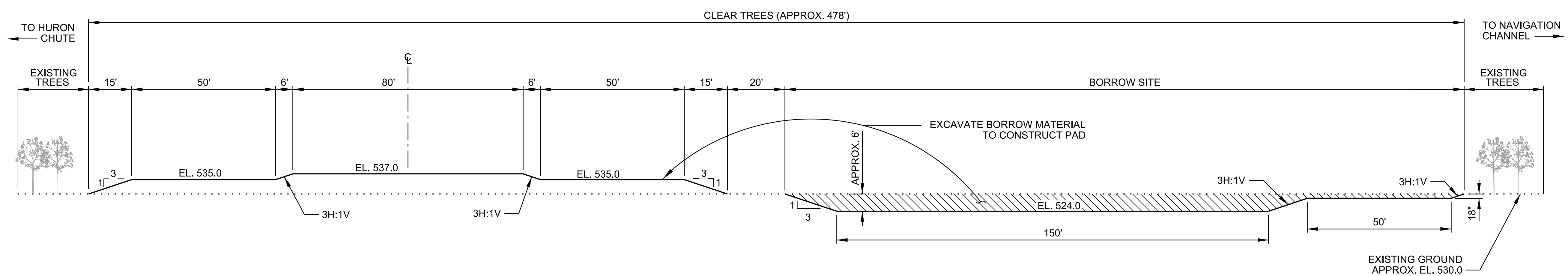
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
GOOSE LAKE
TOPOGRAPHIC DIVERSITY
(MEASURES T1/F1, T3/F3) SECTIONS
PLATE 21

Sheet ID
C-302

July 2013 Draft

NOTE

1. BORROW WILL COME FROM THE BORROW SITE SHOWN AND FROM GOOSE LAKE POOL 1 (T1) AND GOOSE LAKE POOL 2 (T3).



DWG REF(s) :

A1 FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION MEASURE F5 (537 TOP)

SCALE : 1"=20'-0"

US Army Corps of Engineers

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ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
FOREST DIVERSITY IN
NON-DIVERSE FOREST LOCATION
(MEASURE F5) SECTION
PLATE 22

Sheet ID
C-303

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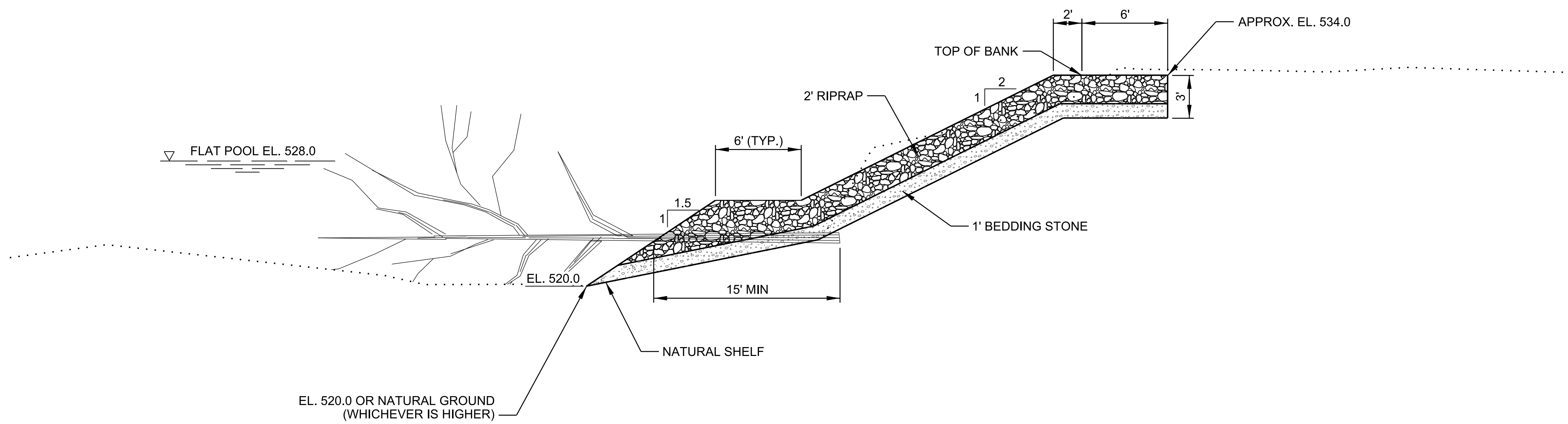
NOTES

1. LOCKED LOGS TO BE APPLIED AT MEASURE E1 FOR THE DOWNSTREAM 800 FEET OF THE PROTECTION AREA.

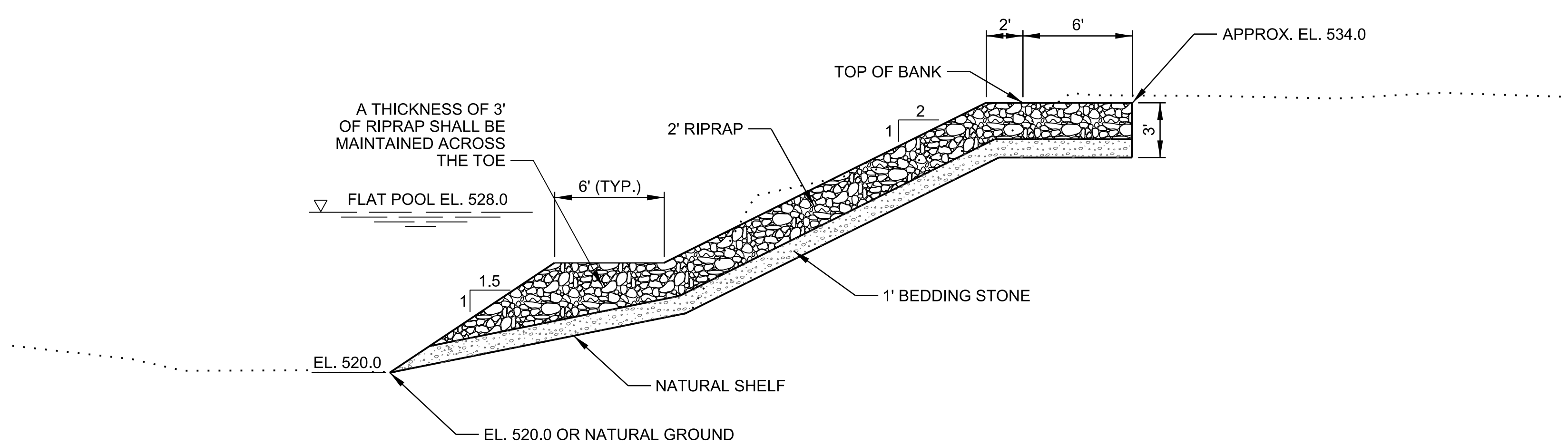


DWG REF(s) :

C1 LOCKED LOG SECTION

SCALE : 1"=100'-0"

0 100' 200'

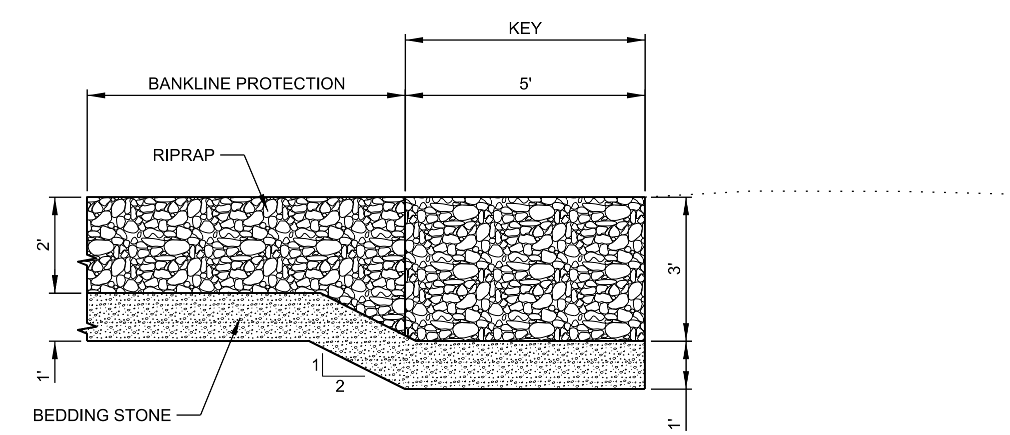


DWG REF(s) :

A1 TYPICAL ROCK PROTECTION SECTION

SCALE : 1"=5'-0"

0 5' 10'



DWG REF(s) :

A4 TYPICAL KEYED IN ENDS SECTION

SCALE : 1"=2'-0"

0 2' 4'

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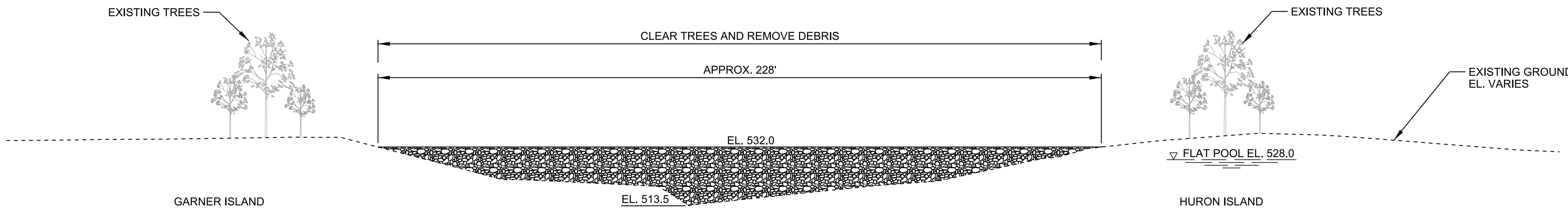
SUBMITTED BY: | PROJECT CODE: EP101
PLOT SCALE: AS SHOWN | PLOT DATE: | SIZE: ANSI D | FILE NAME: EP101_C-304xxx.dgn

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
BANK STABILIZATION SECTIONS

PLATE 23

Sheet ID
C-304

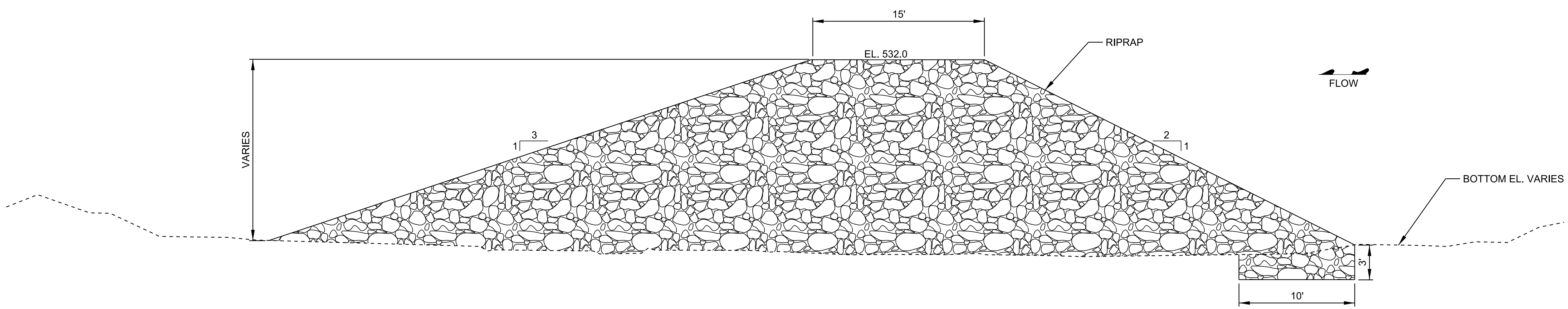
DWG REF(s) :



C1 TYPICAL SECTION

SCALE : 1"=20'-0" 0 20' 40'

DWG REF(s) :



A1 TYPICAL SECTION

SCALE : 1"=5'-0" 0 5' 10'

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PLOT DATE:
PROJECT CODE: EP101
SIZE: ANSI D
FILE NAME: EP101_C-305xxx.dgn

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
GARNER CHUTE CLOSURE
STRUCTURE (MEASURE T9) SECTIONS

PLATE 24

Sheet ID
C-305

NOTES

1. LARGE AREAS INDICATING POTENTIAL CLEARING ARE SHOWN ON THIS DRAWING TO ENSURE THAT THE ENTIRE AREA IS SURVEYED FOR INDIANA BATS.
2. CLEARING WILL LIKELY ONLY BE REQUIRED FOR THE FOLLOWING ACREAGES:
   A. MEASURE T1/F1: 13 AC
   B. MEASURE T3/F3: 10 AC
   C. MEASURE T9: 1 AC
   D. MEASURE F5: 15 AC
   E. MEASURE I1: 1 AC
   F. BANK STABILIZATION: 2 AC

DWG REF(s) :

A1 TREE CLEARING

SCALE : 1"=1000'-0"

0 1000' 2000'

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DWN BY: LLH | CKD BY: | SUBMITTED BY: | PLOT DATE: | PLOT SCALE: AS SHOWN | SIZE: ANSI D | FILE NAME: EP101_L-101xxx.dgn

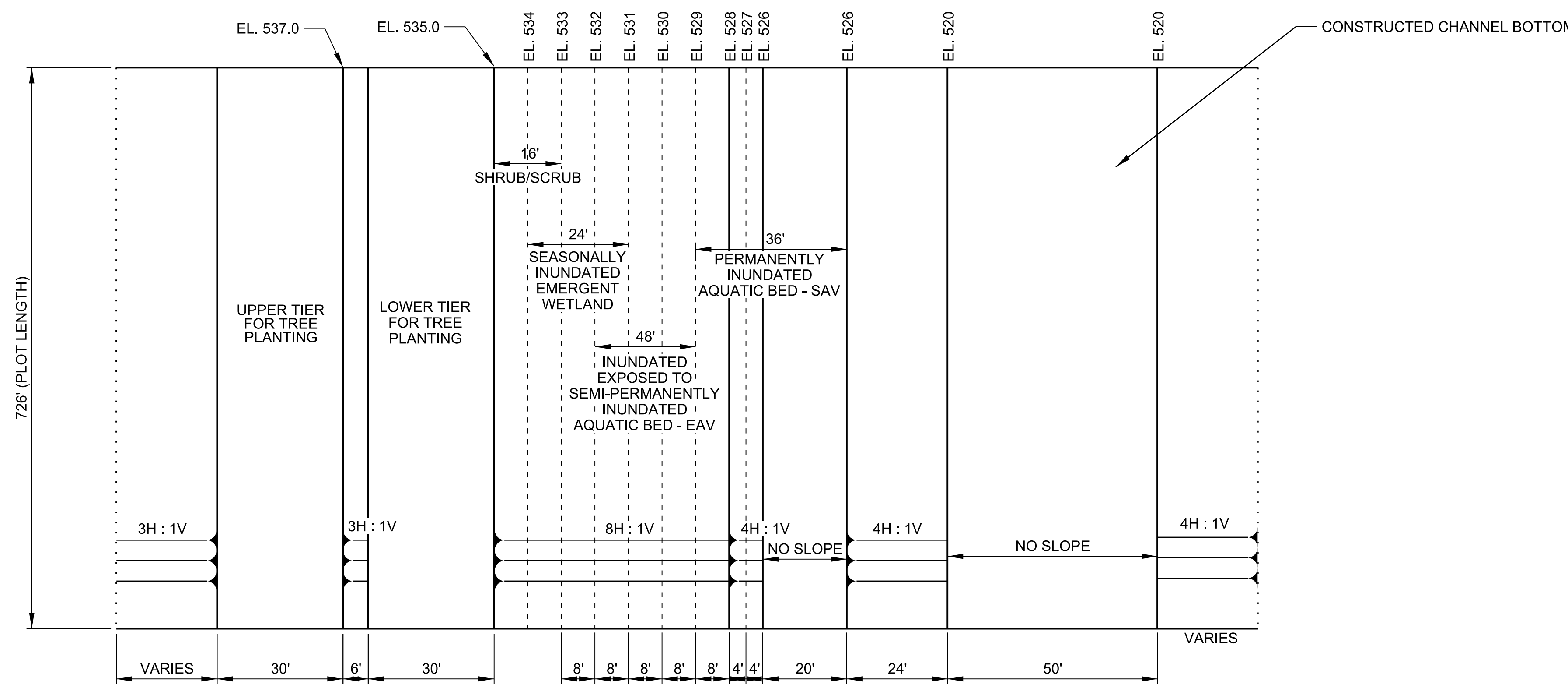
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
TREE CLEARING

PLATE 25

Sheet ID
L-101

NOTES

1. TREE PLANTING PLOTS FOR UPPER TIER AND LOWER TIER TREE PLANTINGS ARE SHOWN ON SHEETS L-103 AND L-104.



DWG REF(s) :

A1 VEGETATION PLANTING PLAN (MEASURES T1, T3, F1 AND F3)

SCALE : 1"=20'-0" 0 20' 40'

US Army Corps of Engineers

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
VEGETATION PLANTING PLAN
(MEASURES T1, T3, F1, F3)

PLATE 26

Sheet ID
L-102

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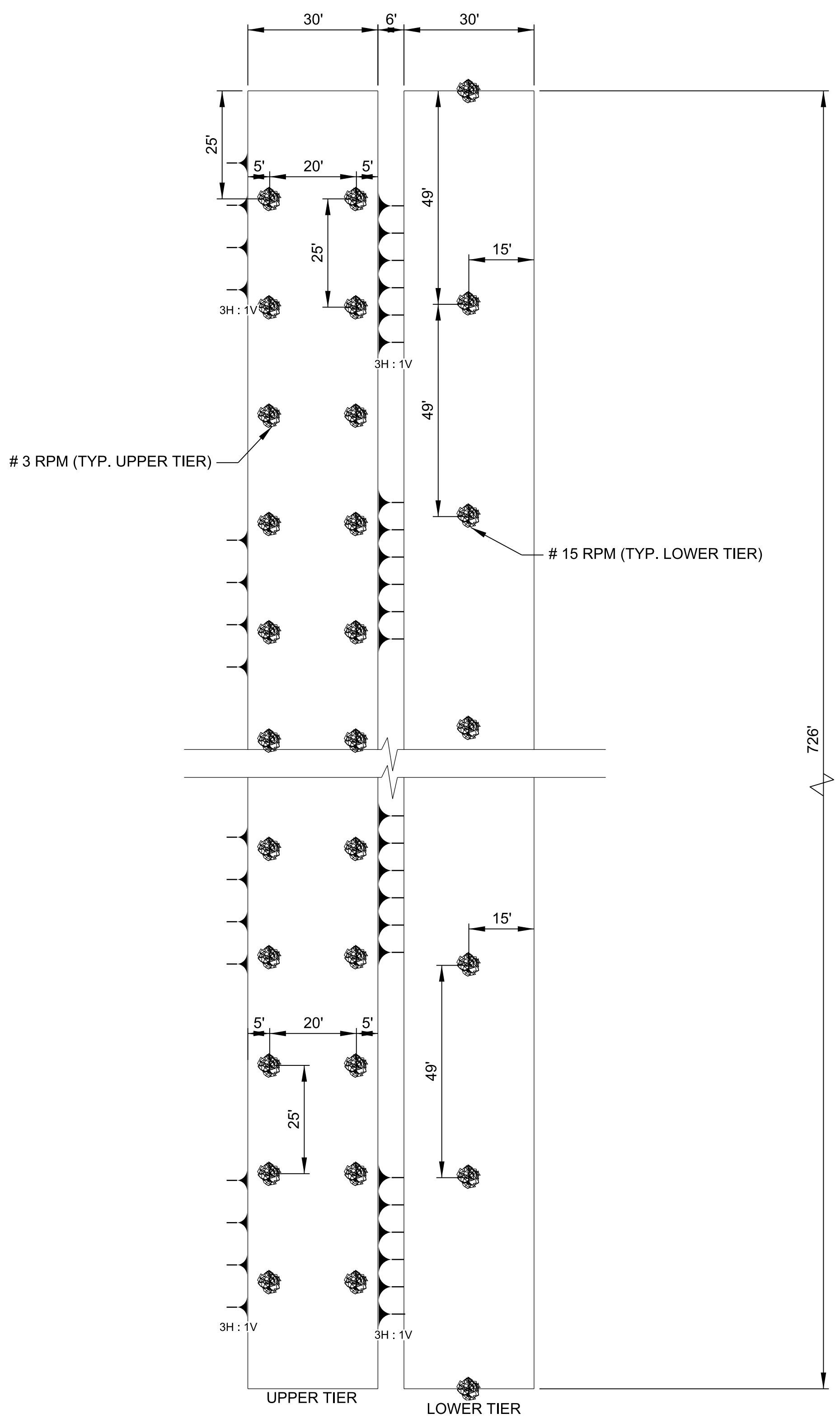
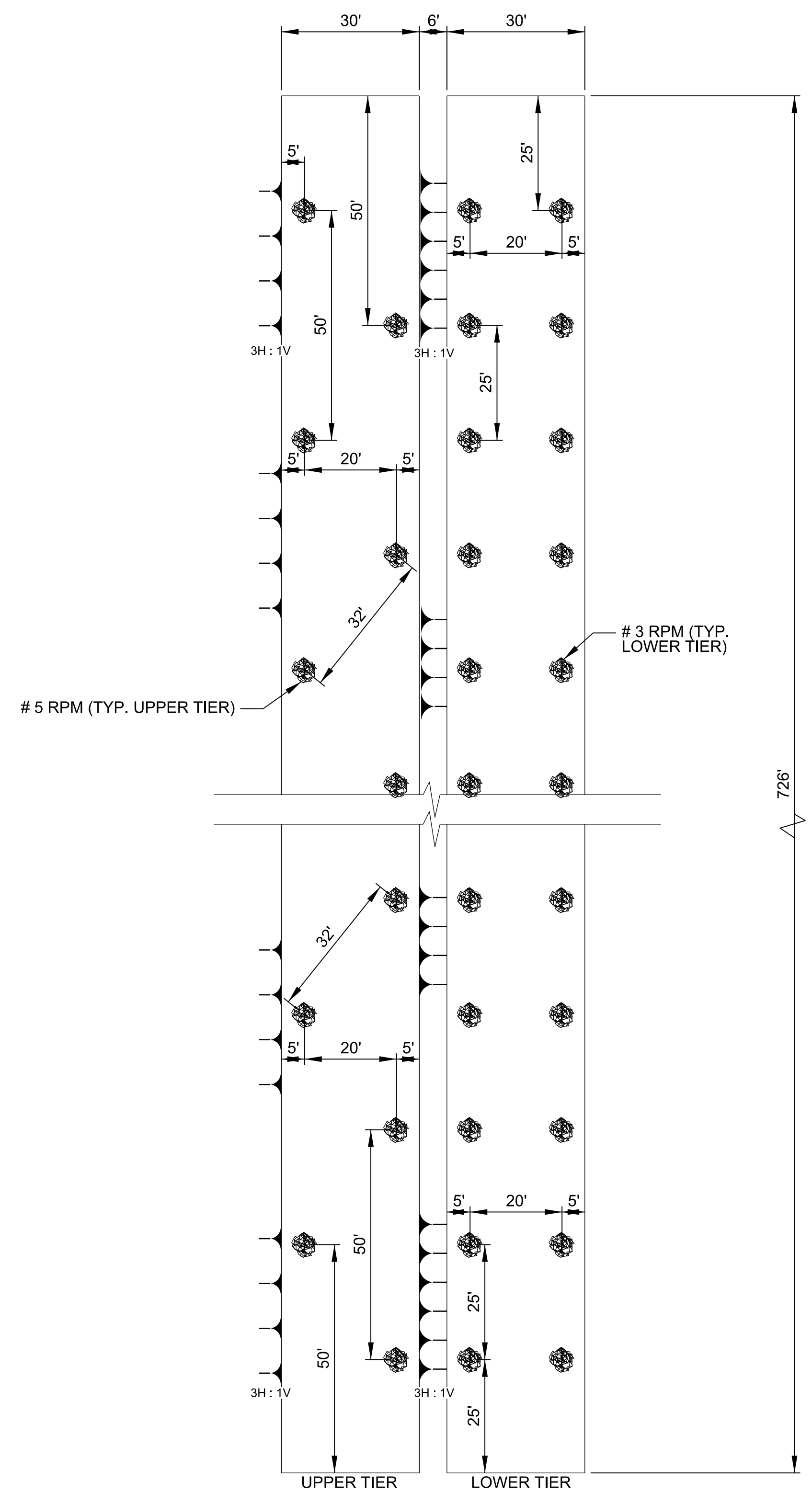
July 2013 Draft



DWG REF(s) :

(A1) TREE PLANTING PLANS - PLOT 1 (MEASURES F1 AND F3)

SCALE : 1"=20'-0"



DWG REF(s) :

(A3) TREE PLANTING PLANS - PLOT 2 (MEASURES F1 AND F3)

SCALE : 1"=20'-0"

NOTES

1. TREE PLANTING RATES ARE AS FOLLOW:
   a. SIXTY #3 RPM SIZE TREES PER HALF ACRE PLOT,
   b. THIRTY #5 RPM TREES PER HALF ACRE PLOT, OR
   c. FIFTEEN #15 RPM SIZE TREES PER HALF ACRE PLOT.
2. TREE SPECIES AND PLANTING RATES ARE PROVIDED IN THE TREE PLANTING SCHEDULE.
3. TREES SHALL BE PLANTED TO ENSURE THAT THE SPECIES ARE INTERMIXED WITHIN EACH PLOT.
4. EACH TREE PLANTING AREA WILL BE SEEDED WITH THE SEED MIX SHOWN ON THE TREE PLOT SEEDING SCHEDULE. SEEDING RATE SHALL BE 10 POUNDS PER ACRE.
5. TEMPORARILY INUNDATED FORESTED WETLAND SHRUBS SHALL BE INTERPLANTED INTO EACH TREE PLOT TO PROVIDE SHADE COVERAGE/WEED COMPETITION WHILE THE LARGE GROWTH TREES MATURE.

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
TREE PLANTING PLANS
PLOT 1 AND PLOT 2

PLATE 27

Sheet ID
L-103

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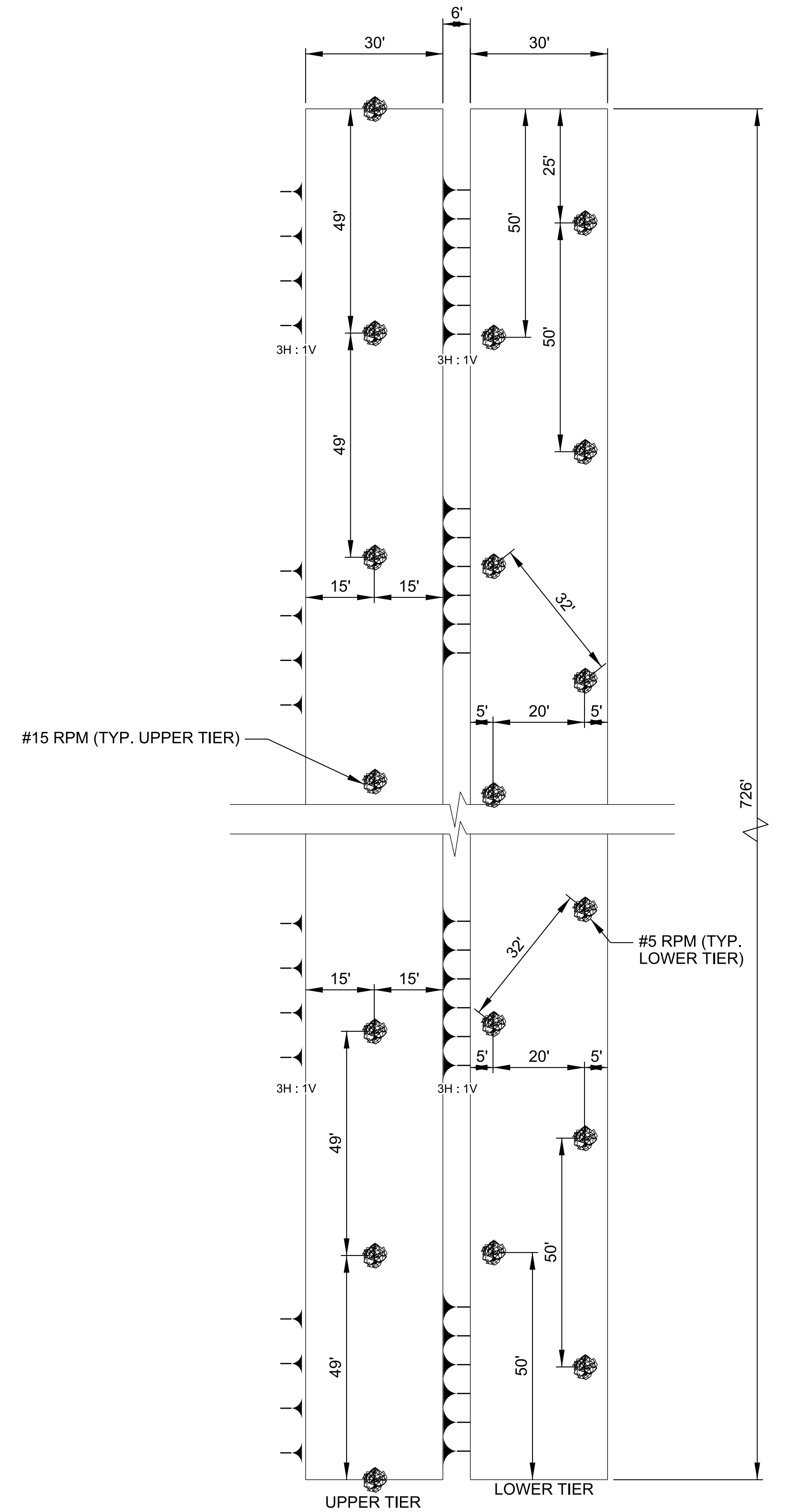

DWG REF(s) :

A1 TREE PLANTING PLAN (MEASURES F1 AND F3) - PLOT 3

SCALE : 1"=20'-0" 0 20' 40'

NOTES

1. TREE PLANTING RATES ARE AS FOLLOW:
   a. SIXTY #3 RPM SIZE TREES PER HALF ACRE PLOT,
   b. THIRTY #5 RPM TREES PER HALF ACRE PLOT, OR
   c. FIFTEEN #15 RPM SIZE TREES PER HALF ACRE PLOT.
2. TREE SPECIES AND PLANTING RATES ARE PROVIDED IN THE TREE PLANTING SCHEDULE.
3. TREES SHALL BE PLANTED TO ENSURE THAT THE SPECIES ARE INTERMIXED WITHIN EACH PLOT.
4. EACH TREE PLANTING AREA WILL BE SEEDED WITH THE SEED MIX SHOWN ON THE TREE PLOT SEEDING SCHEDULE. SEEDING RATE SHALL BE 10 POUNDS PER ACRE.
5. TEMPORARILY INUNDATED FORESTED WETLAND SHRUBS SHALL BE INTERPLANTED INTO EACH TREE PLOT TO PROVIDE SHADE COVERAGE/WEED COMPETITION WHILE THE LARGE GROWTH TREES MATURE.

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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SUBMITTED BY: | PROJECT CODE: EP101
PLOT SCALE: AS SHOWN | PLOT DATE: | FILE NAME: EP101_L-104xxx.dgn
SIZE: ANSI D

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
TREE PLANTING PLAN
PLOT 3

PLATE 28

Sheet ID
L-104

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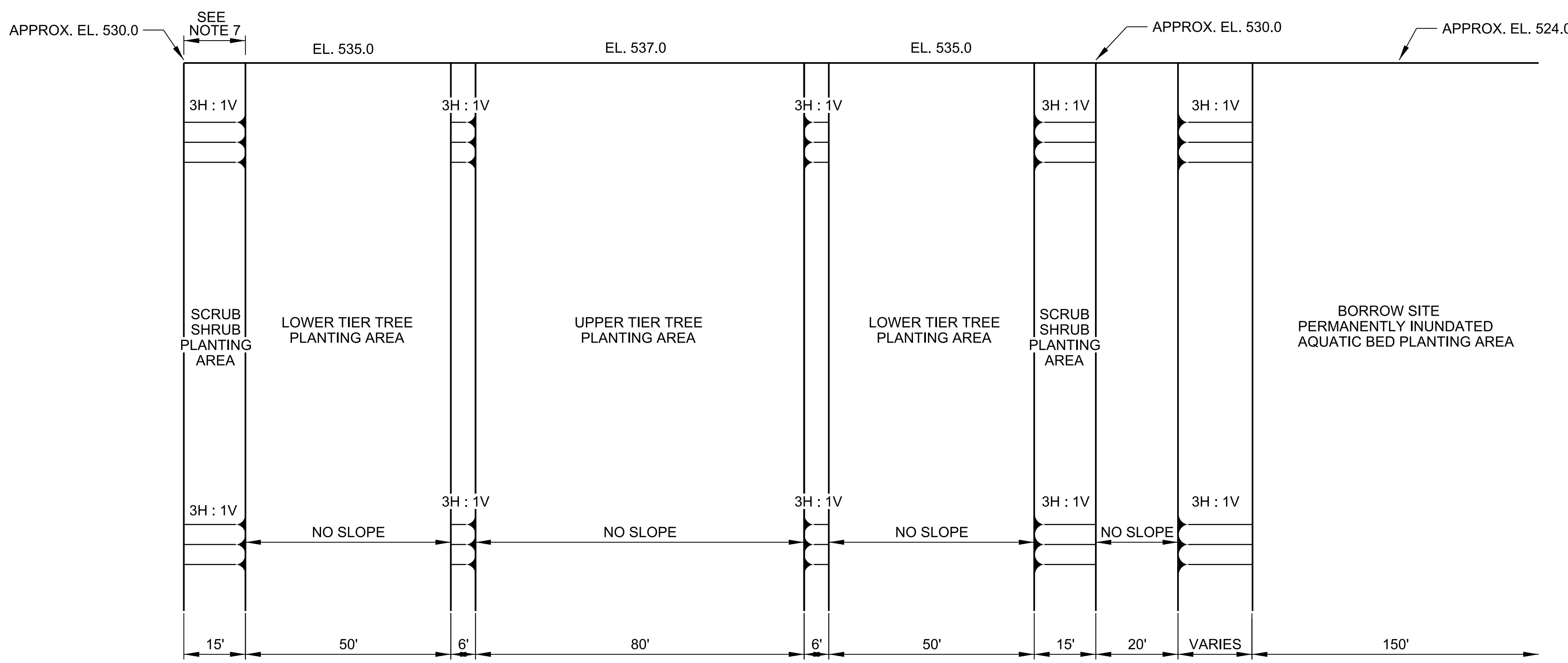
NOTES

1. TREE PLANTING RATES ARE AS FOLLOW:
   a. SIXTY #3 RPM SIZE TREES PER HALF ACRE PLOT,
   b. THIRTY #5 RPM TREES PER HALF ACRE PLOT, OR
   c. FIFTEEN #15 RPM SIZE TREES PER HALF ACRE PLOT.
2. TREE SPECIES AND PLANTING RATES ARE PROVIDED IN THE TREE PLANTING SCHEDULE.
3. TREES SHALL BE PLANTED TO ENSURE THAT THE SPECIES ARE INTERMIXED WITHIN EACH PLOT.
4. EACH TREE PLANTING AREA WILL BE SEEDED WITH THE SEED MIX SHOWN ON THE TREE PLOT SEEDING SCHEDULE. SEEDING RATE SHALL BE 10 POUNDS PER ACRE.
5. TEMPORARILY INUNDATED FORESTED WETLAND SHRUBS SHALL BE INTERPLANTED INTO EACH TREE PLOT TO PROVIDE SHADE COVERAGE/WEED COMPETITION WHILE THE LARGE GROWTH TREES MATURE.
6. PERMANENTLY INUDATED AQUATIC BED PLANTS SHALL BE PLANTED IN THE BORROW SITE AFTER MATERIAL HAS BEEN REMOVED.
7. THE SLOPE BETWEEN THE LOWER TIER TREE PLANTING AREA AND THE BORROW SITE SHALL BE PLANTED WITH A COMBINATION OF SCRUB SHRUB AND AQUATIC SPECIES, BASED ON ELEVATIONS.



DWG REF(s) :

A1 VEGETATION PLANTING PLAN (MEASURE F5)

SCALE : 1"=20'-0" 0 20' 40'

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ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
VEGETATION PLANTING PLAN
(MEASURE F5)

PLATE 29

Sheet ID
L-105

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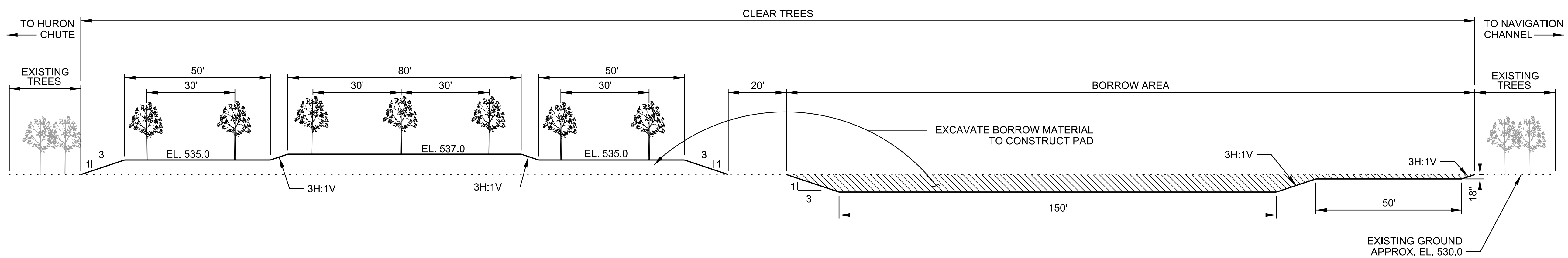

DWG REF(s) :

A1 MEASURE F5 FOREST DIVERSITY IN NON-DIVERSE FOREST LOCATION (537 TOP)

SCALE : 1"=20'-0"

US Army Corps of Engineers

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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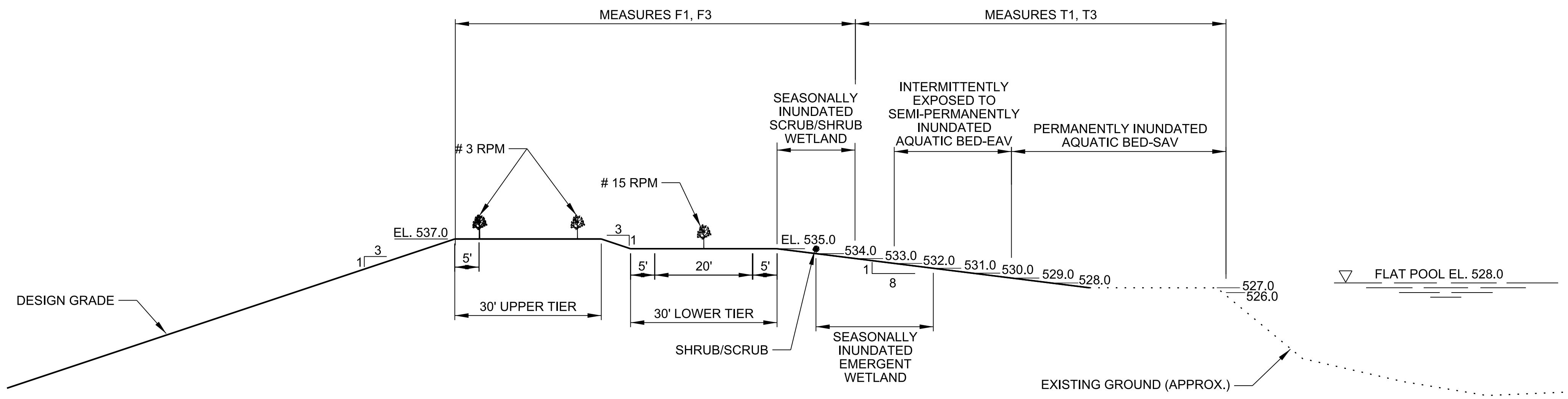
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
REFORESTATION
TYPICAL SECTION

PLATE 30

Sheet ID
L-301

NOTES

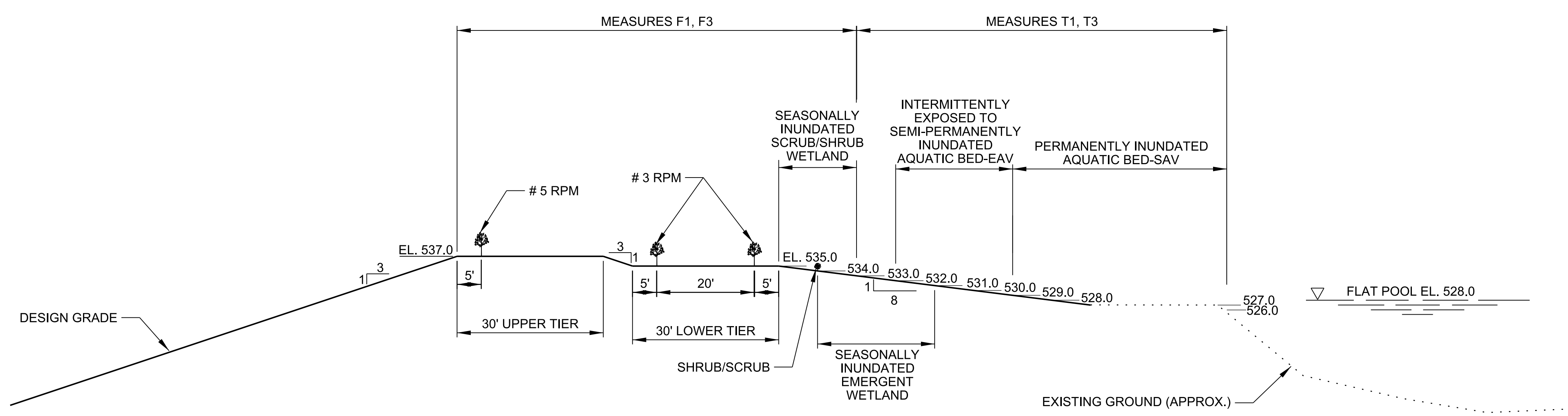
1. PLANTING SPCIES AND DENSITIES ARE SHOWN IN THE SCHEDULE.
2. SPECIES WILL BE RANDOMLY DISPERSED WITHIN EACH PLOT.



DWG REF(s) :

C1 TOPOGRAPHIC AND FOREST DIVERSITY MEASURES F1 AND F3 - PLOT 1

SCALE : 1"=15'-0"



DWG REF(s) :

A1 TOPOGRAPHIC AND FOREST DIVERSITY MEASURES F1 AND F3 - PLOT 2

SCALE : 1"=15'-0"

US Army Corps of Engineers

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: KNM | DATE: | SOLICITATION NO.: | CONTRACT NO.: | PROJECT CODE: EP101
DWN BY: JMF/EJJ | CKD BY: | SUBMITTED BY:
PLOT SCALE: AS SHOWN | PLOT DATE: | SIZE: ANSI D | FILE NAME: EP101_L-302xxx.dgn

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
REFORESTATION SITE
PLANTING DETAILS

PLATE 31

Sheet ID L-302

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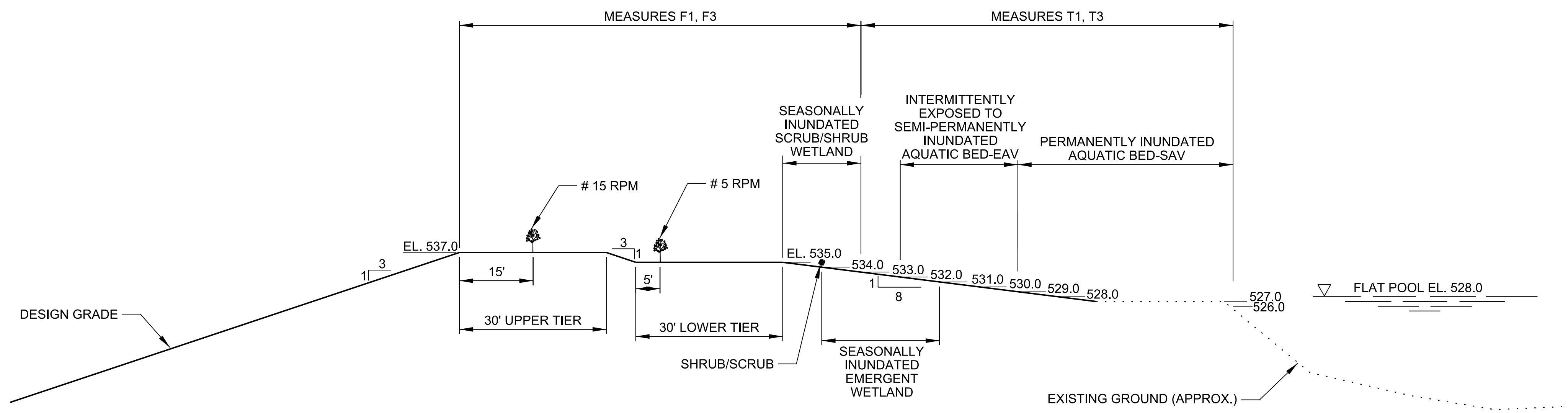
NOTES

1. PLANTING SPCIES AND DENSITIES ARE SHOWN IN THE SCHEDULE.
2. SPECIES WILL BE RANDOMLY DISPERSED WITHIN EACH PLOT.



DWG REF(s) :

A1 TOPOGRAPHIC AND FOREST DIVERSITY MEASURES F1 AND F3 - PLOT 3

SCALE : 1"=15'-0" 0 15' 30'

US Army Corps of Engineers

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
REFORESTATION SITE
PLANTING DETAILS

PLATE 32

Sheet ID
L-303

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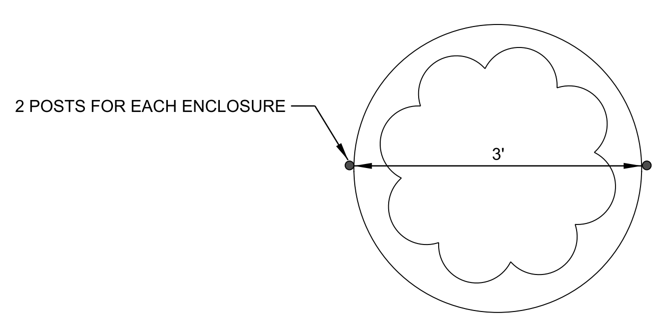


DWG REF(s) :

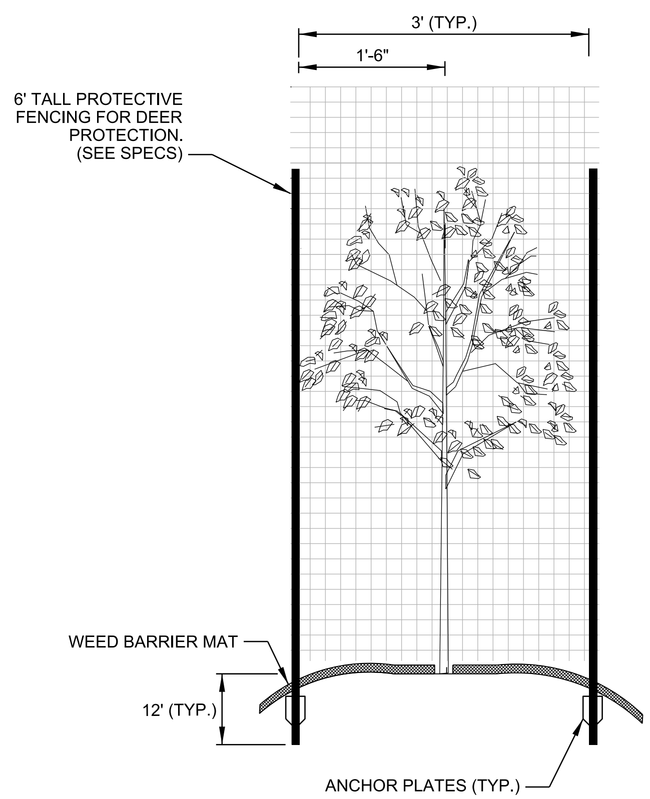
D1 TYPICAL FENCING DETAIL PLAN VIEW

SCALE : 1"=1'-0"

0 1' 2'

NOTES

1. TREES CONFORMING TO THE SPECIES AND NUMBER SPECIFIED SHALL BE PLANTED IN THE AREAS INDICATED.
2. PLANT PITS MAY BE DUG BY ANY METHOD. THE SIZE OF THE TREE PITS SHALL BE APPROXIMATELY THE SAME SIZE AS THE CONTAINER OR SLIGHTLY LARGER.
3. TREES SHALL BE PLANTED BETWEEN OCTOBER 25 AND NOVEMBER 30 DURING SUITABLE CONDITIONS AS SPECIFIED.
4. TREES SHALL BE PLANTED PLUMB (WITHIN 10 DEGREES OF VERTICAL) AND HELD IN POSITION UNTIL SUFFICIENT SOIL HAS BEEN PLACED AROUND THE ROOTS.
5. PLANTS SHALL BE SET IN RELATION TO SURROUNDING GRADE SO THAT THEY ARE 1/2 INCH TO 1 INCH DEEPER THAN THE DEPTH AT WHICH THEY WERE GROWN IN THE CONTAINER.
6. INSTALLED PLANTS SHALL BE MAINTAINED IN A HEALTHY GROWING CONDITION AS SPECIFIED.
7. TREES SHALL BE WRAPPED WITH A SPIRAL TREE WRAP MADE OF LOW DENSITY POLYETHYLENE, 24 TO 30 INCHES IN LENGTH, WITH A 6MM THICKNESS. THE TREE WRAP WILL BE PLACED ON EACH TREE STEM TO REDUCE HERBIVORY.

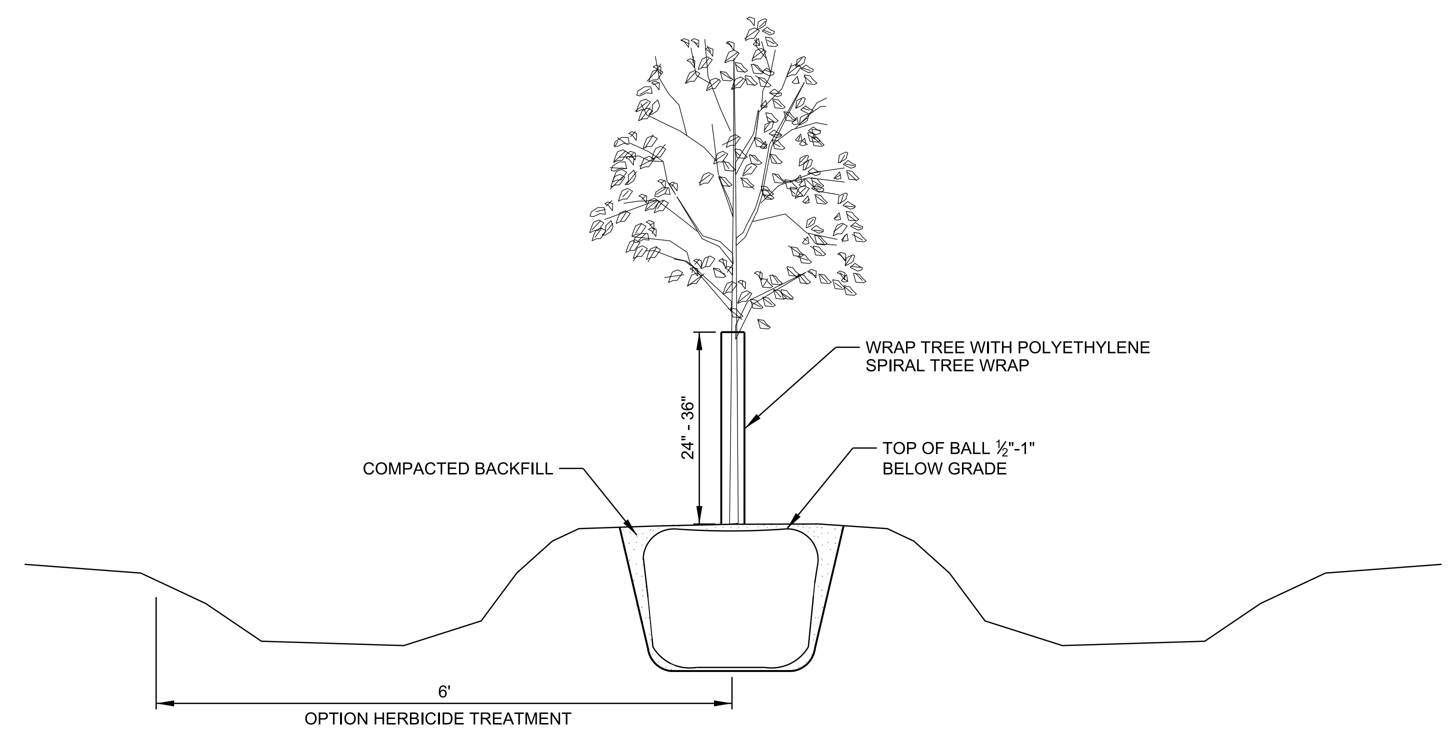


DWG REF(s) :

A1 TYPICAL FENCING DETAIL

SCALE : 1"=1'-0"

0 1' 2'



DWG REF(s) :

A3 TYPICAL CONTAINER TREE PLANTING DETAIL

SCALE : 1"=1'-0"

0 1' 2'

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
TREE PLANTING DETAILS

PLATE 33

Sheet ID
L-501

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Temporarily Inundated Forested Wetland Trees	
EL. 535 - 537	
#3 Size RPM (container at 10-1/8" diameter, 7-1/2" depth) density at 120 trees per acre spaced 20' x 20'	
#5 Size RPM (container at 11-7/8" diameter, 11" depth) density at 60 trees per acre spaced 30' x 30'	
#15 Size RPM (container at 18-3/8" diameter, 12-1/8" depth) density at 30 trees per acre spaced 40' x 40'	
Common Name	**Scientific Name**
River Birch	*Betula nigra*
Bitternut Hickory	*Carya cordiformis*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Common Hackberry	*Celtis occidentalis*
Common Persimmon	*Diospyros virginiana*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
Black Walnut	*Juglans nigra*
American Sycamore	*Platanus occidentalis*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
American Basswood	*Tilia americana*
Overcup Oak	*Quercus lyrata*

DWG REF(s) :

C1 TEMPORARILY INUNDATED FORESTED WETLAND TREE SCHEDULE

NO SCALE

Temporarily Inundated Forested Wetland Shrubs	
EL. 535 - 537	
#3 Size RPM (container at 10-1/8" diameter, 7-1/2" depth) density at 50 shrubs per acre	
Common Name	**Scientific Name**
Common Buttonbush	*Cephalanthus occidentalis*
Eastern Redbud	*Cercis canadensis*
Red-Osier Dogwood	*Cornus stolonifera*
Green Hawthorn	*Crataegus viridis*
Elderberry	*Sambucus canadensis*

DWG REF(s) :

B1 TEMPORARILY INUNDATED FORESTED WETLAND SHRUBS SCHEDULE

NO SCALE

Temporarily Inundated Forested Wetland Understory Seed Mixture	
EL. 535 - 537	
Seeding rate at 10 pounds 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*

DWG REF(s) :

A1 TEMPORARILY INUNDATED FORESTED WETLAND UNDERSTORY SEED MIXTURE SCHEDULE

NO SCALE

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ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
TEMPORARILY INUNDATED
FORESTED WETLAND
PLANTING SCHEDULE
PLATE 34

Sheet ID
L-601

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July 2013 Draft

Permanently Inundated Aquatic Bed	
EL. 526 - 529	
Potted Plant density TBD by ERDC	
Tuber/Rhizonme density average 1,500 plants per acre	
Common Name	**Scientific Name**
Illinois Pondweed	*Potamageton illinoisensis*
Sago Pondweed	*P. pectinatus*
American Wild Celery	*Vallisneria americana*
Coontail	*Ceratophyllum demersum*
American Elodea	*Elodea canadensis*

Intermittently Exposed to Semi-Permanently Inundated Aquatic Bed	
EL. 529 - 532	
Potted Plant density TBD by ERDC	
Tuber/Rhizonme density average 1,500 plants peracre	
Common Name	**Scientific Name**
Waterwillow	*Justicia americana*
Arrowhead	*Sagitarria latifolia*
Pickerelweed	*Pontederia cordata*
Smartweed	*Polygonum spp.*

Seasonally Inundated Emergent Wetland	
EL. 531 - 534	
Potted Plant density TBD by ERDC	
Tuber/Rhizonme density average 1,500 plants/acre	
Common Name	**Scientific Name**
Sedges	*Carex spp.*
Bulrush	*Scirpus spp.*
Blue Flag Iris	*Iris virginica*
Sweet Flag	*Acorus calamus*

Seasonally Inundated Scrub/Shrub Wetland	
EL. 533 - 535	
Potted Plant density TBD by ERDC	
#3 Size RPM (container at 10-1/8" diameter, 7-1/2" depth) density at 50 shrubs per acre	
Common Name	**Scientific Name**
Hibiscus	*Hibiscus lasiocarpos*
Common Elderberry	*Sambucus canadensis*
Buttonbush	*Cephalanthus occidentalis*
Dogwood	*Cornus stolonifera*
Sandbar Willow	*Salix interior*

DWG REF(s) :

A1 AQUATIC AND WETLAND PLANTING SCHEDULE
NO SCALE

US Army Corps of Engineers

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
AQUATIC AND WETLAND
PLANTING SCHEDULE

PLATE 35

Sheet ID
L-602

NOTES

1. FOREST SURVEY OF ISLAND WAS COMPLETED IN 1982 AND 2011.
2. INDIANA BAT SURVEY WAS COMPLETED IN 2012.
3. ELECTROFISHING.

DWG REF(s) :

A1 PRE-CONSTRUCTION MONITORING PLAN

SCALE : 1"=1000'-0" 0 1000' 2000'

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ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
PRE-CONSTRUCTION
MONITORING PLAN

PLATE 36

Sheet ID
O-101

NOTES

FUTURE MONITORING INCLUDES:

A. VEGETATION SURVEYS
B. TREE SURVEYS
C. FISH MONITORING
D. BATHYMETRY OVER DREDGE CUT EVERY FIVE YEARS
E. WATER QUALITY

DWG REF(s) :

A1 POST-CONSTRUCTION MONITORING PLAN

SCALE : 1"=1000'-0"   0   1000'   2000'

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ROCK ISLAND, ILLINOIS

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
POST-CONSTRUCTION
MONITORING PLAN

PLATE 37

Sheet ID
O-102

NOTES

ADAPTIVE MANAGEMENT INCLUDES:

AM 1 CONNECT POOL 1/POOL 2
AM 2 CONNECT POOL 1/GUN SLOUGH
AM 3 NOTCH GARNES CHUTE CLOSURE STRUCTURE

DWG REF(s) :

A1 ADAPTIVE MANAGEMENT PLAN
SCALE : 1"=1000'-0"
0 1000' 2000'

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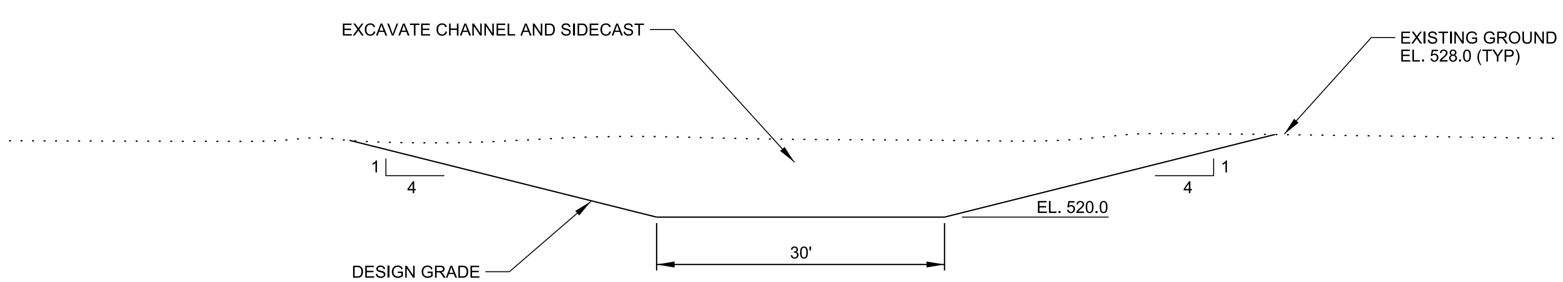
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
ADAPTIVE MANAGEMENT PLAN
PLATE 38

Sheet ID
O-103



DWG REF(s) :

A1 ADAPTIVE MANAGEMENT POOL CONNECTION TYPICAL SECTION (AM1 AND AM2)

SCALE : 1"=10'-0"

0 10' 20'

NOTES

1. DISTANCE TO BE EXCAVATED BETWEEN POOL 2 AND POOL 1 (AM1) IS APPROXIMATELY 130 FEET.
2. DISTANCE TO BE EXCAVATED BETWEEN GUN SLOUGH AND POOL 1 (AM2) IS APPROXIMATELY 195 FEET.

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ROCK ISLAND, ILLINOIS

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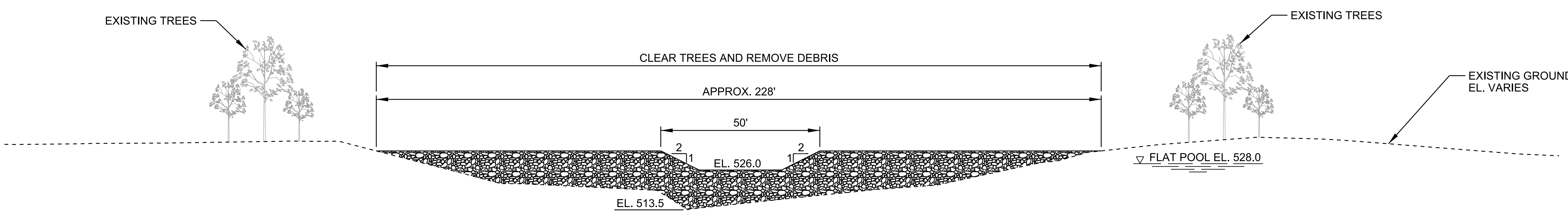
MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
ADAPTIVE MANAGEMENT
POOL CONNECTION
TYPICAL SECTION
PLATE 39

Sheet ID
O-301



DWG REF(s) :

A1 ADAPTIVE MANAGEMENT NOTCH CLOSURE STRUCTURE (AM3)

SCALE : 1"=20'-0" 0 20' 40'

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MISSISSIPPI RIVER
HURON ISLAND
DES MOINES COUNTY, IA
HURON ISLAND COMPLEX HREP
DEFINITE PROJECT REPORT
ADAPTIVE MANAGEMENT NOTCH
CLOSURE STRUCTURE (AM3)

PLATE 40

Sheet ID
O-302