UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA



US Army Corps
of Engineers ®
Rock Island District

2022
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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), Rock Island District, prepared this Feasibility Report with Integrated Environmental Assessment which explores the feasibility of alternative measures to address problems and opportunities associated with the Lower Pool 13 Habitat Restoration and Enhancement Project (Project). This Project is a part of the Upper Mississippi River Restoration (UMRR) Program. The study area includes the lower impounded region of Pool 13 on the Mississippi River between River Miles 522.5 and 529.0.

The project is located within the Upper Mississippi River National Wildlife and Fish Refuge (NWFR). The NWFR was established by Congress on June 7, 1924, to provide habitat for migratory waterfowl, birds, fish, and other wildlife species threatened by commercial and industrial development, as well as to provide educational and recreational opportunities to the public (USFWS, 2019).

The project objectives are:

1. Restore and enhance submerged aquatic vegetation coverage over the period of analysis, and
2. Restore and enhance coverage, species richness, and age distribution of the forest community over the period of analysis.

Project objectives were developed by collecting input from agency master plans, UMRR priority alignment, Refuge resource priority alignment, coordination with project sponsors and the Project Delivery Team (PDT), and comments received during the 2019 public open house. The PDT, interagency and partnership groups, and the public identified several additional issues in Pool 13 (e.g., fish overwintering habitat) which will be evaluated in future phases. Under Phase I, the scope of this study focuses on the southwest portion of the pool and addresses the primary problems in this particular study area. As guided by USACE policy, objectives were developed with a duration of 50 years as the study period of analysis. Construction is currently projected to begin in Fiscal Year (FY) 26. The measures expected to achieve the Project objectives include (Executive Figure 1):

- creation of low-elevation and sub-surface structures such as chevrons and rock mounds to reduce velocities and wave energy, and
- implementation of timber stand improvement techniques, including planting, thinning, and invasive species removal.

Costs and habitat benefits were estimated for the final array of alternatives. Habitat benefits were estimated using certified Habitat Suitability Index Models (HSI) and the Habitat Evaluation Procedures (HEP). Cost Effectiveness & Incremental Cost Analyses were conducted to identify cost effective plans and reveal changes in cost for increasing levels of environmental outputs.

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The Tentatively Selected Plan (TSP) (Figure ES-1) would partially restore native habitats by constructing low-elevation and sub-surface structures to improve conditions for growing submergent aquatic vegetation and implementing timber stand improvements that improve habitat for waterfowl and waterbirds. The Project outputs meet site management goals and objectives and support the overall goals and objectives of the UMRR Program and the UMR Refuge.

The Rock Island District's District Engineer has reviewed the Project outputs, a net gain of 711 Average Annual Habitat Units ($1,893 per Average Annual Habitat Unit), and determined that the implementation of the TSP is in the Federal interest. The Project first cost, including planning, engineering and design, adaptive management measures, construction management, and contingency, is $38,797,000.

All Project measures would be located on Federally-owned lands managed through a cooperative agreement with the U.S. Fish and Wildlife Service (USFWS); operation, maintenance, and repair of the lands would be the responsibility of the USFWS. Section 906(e) of the 1986 Water Resources Development Act specifies that first-cost funding for enhancement measures located on lands managed as a National Wildlife Refuge are 100% Federal.

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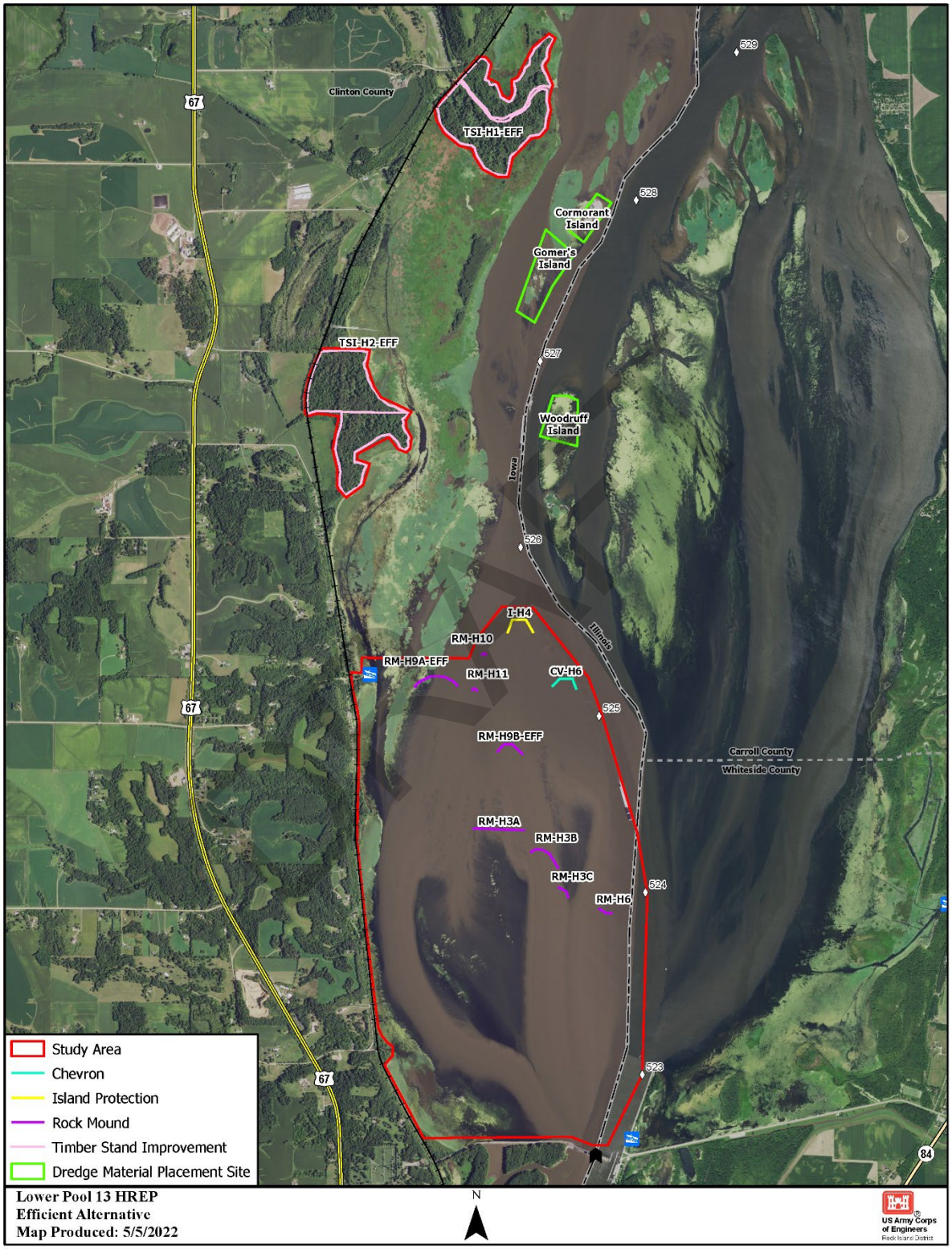

Figure ES-1. Project Measures

ACRONYMS

AEP	Annual Exceedance Probability
AHUU	Average Annual Habitat Unit
ADCP	Acoustic Doppler Current Profiler
APE	Area of Potential Effect
ARA	Abbreviated Risk Analysis
CAA	Clean Air Act
CEICA	Cost Effectiveness & Incremental Cost Analyses
CFS	Cubic Feet per Second
CY	Cubic Yards
District	Rock Island District
DO	Dissolved Oxygen
EA	Environmental Assessment
EC	Engineering Circular
EJ	Environmental Justice
EOP	Environmental Operation Principles
EPA	Environmental Protection Agency
EQ	Environmental Quality
ER	Engineer Regulation
ERDC	Engineering Research and Development
ESA	Environmental Site Assessment
ESA	Endangered Species Act
FT	Feet
FONSI	Finding of No Significant Impact
FSS	Fixed Site Sampling
FWCA	Fish and Wildlife Coordination Act
FWIC	Fish and Wildlife Interagency Committee
FWOP	Future Without Project
FY	Fiscal Year
GHG	Green House Gas
GIS	Geographic Information System
HEP	Habitat Evaluation Procedures
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HNA-II	Habitat Needs Assessment-II
HREP	Habitat Rehabilitation and Enhancement Project
HIS	Habitat Suitability Index
HTRW	Hazardous, Toxic, and Radioactive Waste
HUC	Hydrologic Unit Code
IADNR	Iowa Department of Natural Resources
IDC	Interest During Construction
ILDNR	Illinois Department of Natural Resources
IL DOT	Illinois Department of Transportation
IL EPA	Illinois Environmental Protection Agency
IPaC	USFWS Information for Planning and Consultation
IAWAP	Iowa Wildlife Action Plan
ILWAP	Illinois Wildlife Action Plan
IWR	Institute for Water Resources
L&D	Lock(s) and Dam

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LiDAR	Light Detection and Ranging
LTRM	Long Term Resource Monitoring
MAM	Monitoring and Adaptive Management
MBTA	Migratory Bird Treaty Act
MOA	Memorandum of Agreement
NAAQS	National Ambient Air Quality Standard
NAVD 88	North American Vertical Datum of 1988
NAWMP	North American Waterfowl Management Plan
NED	National Economic Development
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge
NER	National Ecosystem Restoration
NPEDS	National Pollutant Discharge Elimination System
NLEB	Northern Long-eared Bat
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NTU	Nephelometric Turbidity Unit
NWFR	National Wildlife and Fish Refuge
NWP	Nationwide Permit
O&M	Operation and Maintenance
OMRRR	Operations, Management, Repair, Rehabilitation, and Replacement
OSE	Other Social Effects
P&G	Principles and Guidelines
P&S	Plans & Specifications
PDT	Project Delivery Team
PED	Pre-Construction Engineering and Design
PPM	Parts Per Million
REC	Recognized Environmental Condition
RED	Regional Economic Development
RM	River Mile
RRCT	River Resources Coordinating Team
SAV	Submerged Aquatic Vegetation
SHPO	State Historic Preservation Office
SRS	Stratified Random Sampling
TSI	Timber Stand Improvement
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
UMR	Upper Mississippi River
UMRCC	Upper Mississippi River Conservation Committee
UMRR	Upper Mississippi River Restoration
UMRS	Upper Mississippi River System
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VE	Value Engineering
WLM	Water Level Management
WRDA	Water Resources Development Act

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1. INTRODUCTION

The purpose of this Feasibility Report with Integrated Environmental Assessment (EA), including the Finding of No Significant Impact (FONSI), is to evaluate the proposal for the Project within the UMRR program. The Feasibility Report and Integrated EA were prepared to meet USACE planning guidance and National Environmental Protection Act (NEPA) requirements.

The purpose of the main report is to summarize the multidisciplinary efforts of USACE, USFWS, U.S. Geological Survey (USGS), and the States of Iowa and Illinois' Departments of Natural Resources (IADNR and ILDNR, respectively) that led to the study recommendation. USACE organized the report to follow a general problem-solving format:

- Review existing conditions and anticipated future conditions;
- Identify project goals and objectives;
- Formulate restoration alternatives to address the goals and objectives;
- Identify costs and benefits of the restoration alternatives;
- Compare the alternatives on the costs and benefits;
- Recommend a single restoration plan for implementation; and
- Present a detailed analysis on the plan.

This Feasibility Report with Integrated EA presents a detailed account of the planning, engineering, construction details, and environmental considerations that resulted in the Tentatively Selected Plan (TSP). Once the public and agencies review and comment on the TSP the USACE may proceed with further feasibility level design and report approval. Final design and construction may proceed following report approval.

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1.1 Purpose and Need

The USACE proposes to rehabilitate and enhance the Study area through construction of measures that will maintain, enhance, and restore quality habitat for native and desirable plant and animal species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem. Though degraded, the Study area supports a diverse population of wildlife including waterfowl, migratory birds, fish, mussels, and mammals. Submerged aquatic vegetation within the study area represents a vital food source for migratory waterfowl within the Mississippi Flyway. Human activity within the UMR basin, floodplain, and channel has altered the hydrology, topography, and biotic communities present. Impoundment of the pool and permanently higher water elevations during the growing season have affected the health of aquatic vegetation and floodplain forest resources. Frequent inundation of floodplain forests is affecting forest composition and regeneration. The largest concern is that without intervention, the Project area is likely to experience forest fragmentation and a continued influx of invasive species. All of these alterations have reduced the quality and

diversity of aquatic and floodplain habitats and impaired ecosystem functions. While these stressors are likely to continue, as is the decline of the quality critical habitats, this Project provides an opportunity to improve the quality, diversity, and sustainability of aquatic, wetland and floodplain habitats.

The Study with Integrated Environmental Assessment (EA), including the Finding of No Significant Impact (FONSI) assesses the environmental effects of a reasonable range of potential alternatives or actions designed by the USACE, including the No Action plan, prior to decision making. The study aims to provide enough information to Federal and non-Federal decision makers to determine whether implementation of a proposed plan is a wise investment decision to address the aquatic ecosystem degradation. This plan will be identified as the National Ecosystem Restoration (NER) plan.

The need for rehabilitation and enhancement of this area is demonstrated by the large number of local, state, and Federal interests in the study area. Key factors identified as adversely affecting the area's natural structure and functionality of the river and its floodplain are altered hydrology, degradation of the floodplain forest, and degradation of aquatic habitat, including ecologically significant submerged aquatic vegetation habitat.

The project is consistent with agency management goals and was planned for the benefit of resident and migratory birds, fish, and other wildlife**.**

1.2 Authority

The Upper Mississippi River Restoration (UMRR) Program was authorized by the Water Resources Development Act (WRDA) of 1986 under Section 1103 (33 U.S.C. 2201 et seq.; P.L. 99-662, 1986) and extended indefinitely by the WRDA of 1999. UMRR is comprised of two elements: (1) plan, construct, and evaluate measures for fish and wildlife habitat improvement through Habitat Rehabilitation and Enhancement Projects (HREP), and (2) monitor the natural resources of the river system through the Long-Term Resource Monitoring (LTRM) element.

The original authorizing legislation has been amended several times since its enactment. See comprehensive list here: https://www.mvr.usace.army.mil/Missions/Environmental-Stewardship/Upper-Mississippi-River-Restoration/Key-Documents/.

1.3 Project Selection

The UMRR program is a regional program that includes The St. Paul, Rock Island, and St. Louis USACE districts. Interagency groups in each of these Districts, such as the Fish and Wildlife Interagency Committee (FWIC)[1] and River Resources Coordinating Team (RRCT)[2], identify, prioritize, and recommend projects for inclusion into the UMRR program.
The Federal Sponsor, the USFWS, with support from the state agencies, the IADNR and ILDNR, nominated the Pool 13 HREP for inclusion in the UMRR Program. The FWIC, a

[1] The FWIC enhances the exchange of fish and wildlife related technical information between field level experts and provides a forum for coordination between federal and state agencies.

[2] The RRCT provides a mechanism for all federal and state agencies with management and regulatory responsibilities along the Mississippi River and tributaries in the Rock Island District area to facilitate coordination of their programs and activities.

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committee of state and Federal natural resource specialists working on Pools 11-22, then ranked the Project based on needs along the UMR and the Illinois Waterway. After considering resource needs and deficiencies pool by pool, the FWIC and the RRCT supported and recommended the Project as providing aquatic, wetland, and floodplain benefits with opportunities for habitat enhancement.

1.4 Location and Scope

The construction of Lock and Dam 13 created Navigation Pool 13 in 1939. Pool 13 is a part of the Upper Mississippi River (UMR) 9-foot Channel Project (USACE, 2012). The pool extends 34.2 miles from Lock and Dam 13 near Fulton, IL upstream to Lock and Dam 12 near Bellevue, IA. Over 28,000 acres of aquatic habitat exist within the pool, including backwater lakes, sloughs, flowing channels, and impounded water residing over historically flooded islands and remnant islands (USFWS, 2019).

The study area focuses on the southwest corner of Lower Pool 13 between river miles (RM) 522.5 and 525.7 with forestry features extending up to RM 529. This section of the river ranges from 1.5 to 4.5 miles wide, covering approximately 11,500 acres of open water where very few land masses exist. The study area includes portions of Whiteside and Carroll Counties in Illinois, and Clinton County, Iowa. All project lands and features are managed by the USFWS as part of the Upper Mississippi River NWFR. Figure 1 provides a vicinity and study area map in relation to the larger Lower Pool 13 Project (i.e., the “study area” is the area assessed in this study and the “project” is the larger Lower Pool 13 project). The study area consists of backwater lakes, sloughs, flowing channels, and impounded water residing over historic flooded islands and remnant islands.

The PDT, interagency and partnership groups, and the public identified several issues in Pool 13 which will be evaluated in phases. Under Phase I, the scope of this study focuses on the southwest portion of the pool and addresses the primary problems in this particular study area. Future studies will evaluate restoring other structure, function, or processes throughout the pool and may focus on a larger geographic extent.

Field surveys, inventories, aerial photography, topographic surveys, Light Detection and Ranging (LiDAR) surveys, bathymetry surveys, wildlife and fisheries surveys, hydraulic modeling, water quality monitoring, soil borings, and habitat quantification procedures were completed to support the planning and assessment of proposed alternatives. The Long-Term Resource Monitoring (LTRM) program was crucial in the collection of much of the baseline data referenced above. A forest inventory was conducted by foresters from the Mississippi River Project Office to evaluate the species composition and average age of the existing forest. These observations and surveys accomplished by the District, USFWS, USGS, and DNR, along with future studies and monitoring, assisted in understanding the current and future conditions as well as assist in evaluating the performance of any constructed project.

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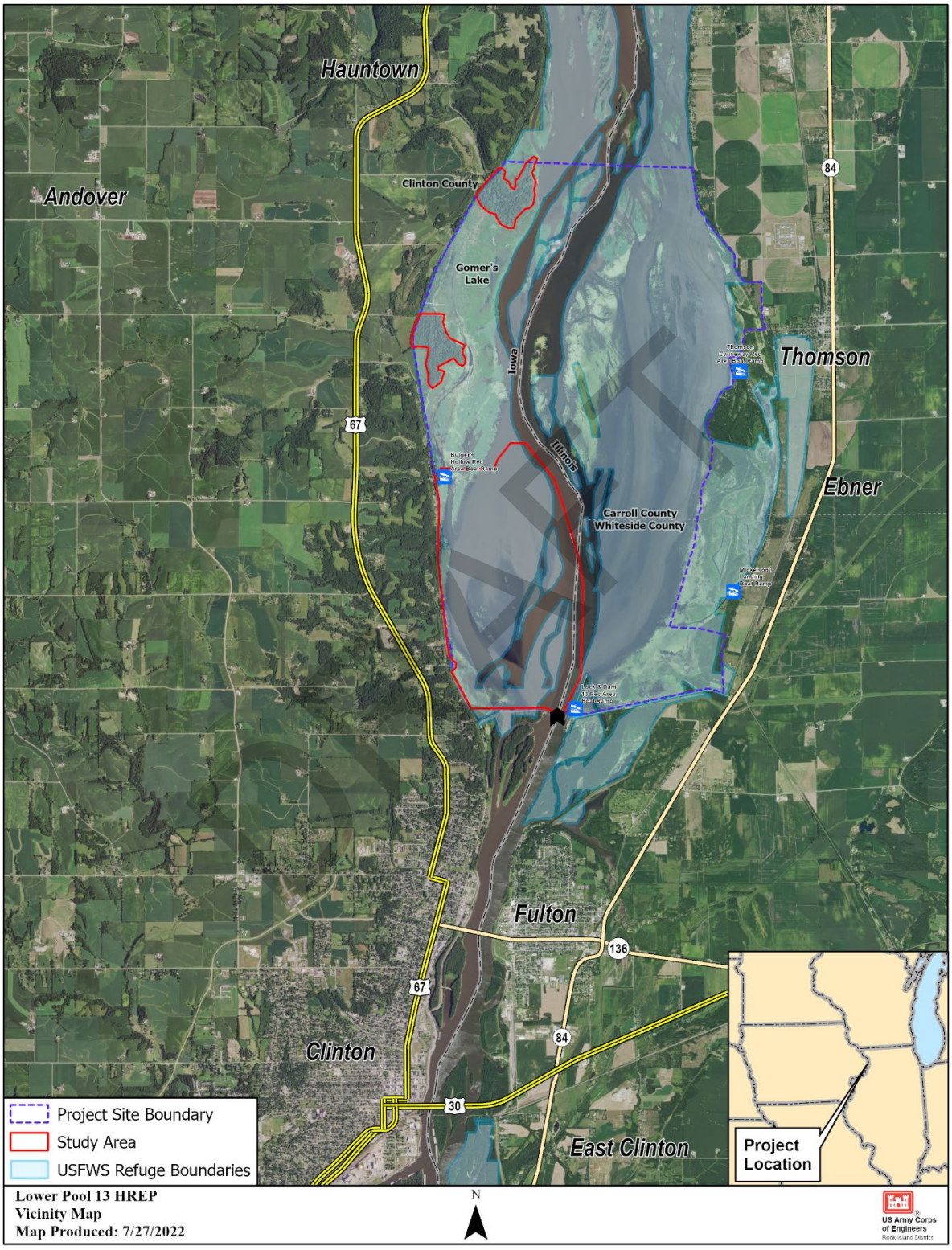

Figure 1. Vicinity and Study Area Map

1.5 Project Coordination

Development of this feasibility report was actively coordinated with the Sponsor, stakeholders, and state agencies during team meetings, phone conversations, and on-site visits to the study area (Appendix D, *Coordination and Public Involvement*). Participants in the planning of the Lower Pool 13 HREP included USACE, USFWS, USGS, IADNR, and ILDNR.

U.S. Army Corps of Engineers, Rock Island District. The USACE is responsible for project management and coordination with the Sponsor, Project partners, and other affected agencies. The USACE will submit the feasibility report; program funds; finalize Plans & Specifications (P&S); complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration.

U.S. Fish and Wildlife Service. The USFWS, the Federal Project Sponsor, provides technical and other advisory assistance during all phases of the study as well as provide assistance during implementation. The USFWS has an integral role in the collection and analyses of data as part of the monitoring and adaptive management plan for the project. The USFWS is responsible for operation, maintenance, and repair for the life of the project.

Iowa Department of Natural Resources. The IADNR, a non-Federal Project partner, has provided technical and other advisory assistance during all phases of the Project and would continue to provide assistance during implementation. The IADNR would have an integral role in the collection and analyses of data as part of the monitoring and adaptive management plan for the project.

Illinois Department of Natural Resources. The ILDNR, a non-Federal Project partner, has provided technical and other advisory assistance for measures in the Illinois portion of the study area and would continue to provide assistance during implementation. The ILDNR would have an integral role in the collection and analyses of data as part of the monitoring and adaptive management plan.

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1.6 Discussion of Prior Studies, Plans, Reports, and Existing Water Resource Projects

The following summarizes prior studies, reports, and projects which provided valuable information and guidance in the planning and/or design of the study. Literature cited is found at the end of the report and at the end of each appendix, as needed.

Upper Mississippi River System – Environmental Management Program, Pool 13, Spring Lake HREP, USACE, 1993. This HREP is located in Carroll County, IL, between RM 532.5 and 536. It encompasses approximately 3,300 acres of aquatic, wetland, and terrestrial habitat. The Definite Project Report was completed in 1993 and construction was completed in 2002. This HREP was used to inform the Project during the planning phase in regard to resource data and feasibility-level design of restoration measures; it will continue to be used to inform the Project regarding the design of aquatic diversity elements and other lessons learned from construction and monitoring of that HREP.

Upper Mississippi River System – Environmental Management Program, Pool 13, Potters Marsh HREP, USACE, 1992. This HREP is located in Carroll and Whiteside Counties, IL, between RM 522.5 and 526. It encompasses approximately 2,305 acres of aquatic, wetland,

and terrestrial habitat. The Definite Project Report was completed in 1992 and construction was completed in 1995. This HREP was used to inform the Project during the planning phase in regard to resource data and feasibility-level design of restoration measures; it will continue to be used to inform the Project regarding the design of aquatic diversity elements and other lessons learned from construction and monitoring of that HREP.

Upper Mississippi River System – Environmental Management Program, Pool 13, Pleasant Creek HREP, USACE, 2000. This HREP is located in Jackson County, IA, between RM 548.7 and 552.8. It encompasses approximately 2,530 acres of bottomland woods. The Definite Project Report was completed in 2000 and construction was completed in 2002. This HREP was used to inform the Project during the planning phase regarding resource data and feasibility-level design of restoration measures.

Upper Mississippi River System – Environmental Management Program, Pool 13, Browns Lake HREP, USACE, 1987. This HREP is located in Jackson County, IA, at RM 545.8. It encompasses approximately 453 acres of deep-water habitat. The Definite Project Report was completed in 1987 and construction was completed in 1990. This HREP was used to inform the Project during the planning phase regarding resource data and feasibility-level design of restoration measures; it will continue to be used to inform the Project regarding the design of aquatic diversity elements and other lessons learned from construction and monitoring of that HREP.

***Ecological Status and Trends of Selected Resources of the Upper Mississippi River System: A Report of the Long-Term Resource Monitoring Program, USGS, 2008*.** Monitoring data is summarized for 24 indicators of the ecological condition of the UMR System (UMRS) and Illinois River into one report, alongside historical observations and other scientific findings. This report provided recommendations for future environmental management of the UMRS and is used to support the development of HREP proposals, including Lower Pool 13.

Upper Mississippi River Restoration Environmental Management Program Environmental Design Handbook, USACE, 2006 and 2012. These handbooks evaluate project measures and incorporate lessons learned throughout the life of the program, which was applied during the Project planning phase regarding feasibility-level design of restoration measures.

Upper Mississippi River System Ecosystem Restoration Objectives, USACE, 2009. The Report serves as a backdrop for the formulation of specific restoration projects and their adaptive ecosystem management components used to support the development of HREP proposals, Lower Pool 13.

UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan. USFWS, 2006. This plan guides the administration and management of the UMR National Wildlife and Fish Refuge (NWFR) and contains six goals and 41 associated objectives, as well as implementation strategies to achieve the objectives. As Lower Pool 13 is part of the UMR NWFR, the wildlife and habitat goals contained in the comprehensive conservation plan were considered during the planning phase in order to ensure synchronization between the Project and NWFR goals.

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Upper Mississippi River National Wildlife and Fish Refuge Habitat Management Plan, USFWS, 2019. This plan guides the habitat management of the UMR NWFR managed lands and waters. Lower Pool 13 is part of the UMR NWFR and the Priority Resources of Concern outlined in the habitat management plan were considered during the planning phase in order to ensure synchronization between the Project and NWFR management.

Iowa Wildlife Action Plan: Securing a Future for Fish and Wildlife-A Conservation Legacy for Iowans, IADNR, 2015. First approved in 2006, the Iowa Wildlife Action Plan (IAWAP) is a 25-year strategy for conservation of all wildlife in Iowa. The IAWAP is a proactive plan designed to conserve all wildlife in Iowa before they become rare and more costly to protect.

Illinois Comprehensive Wildlife Conservation Plan & Strategy, ILDNR, 2005. The Illinois Wildlife Action Plan (ILWAP) guides the conservation of wildlife and their habitats for the people of Illinois. The plan focuses primarily on non-game species, especially vulnerable species, known as the Species in Greatest Conservation Need (SGCN). The ILWAP is organized by habitat into seven Campaigns, each with its own strategic plan for increasing the quality and quantity of wildlife habitat in Illinois. These plans are implemented across the DNR and by partner organizations and agencies, collectively known as the Illinois Wildlife Action Team.

1.7 Resource Significance

It is challenging to assign a monetary value to environmental resources. Therefore, these resources are considered from a public, institutional, and technical standpoint. These three categories are used to determine if the ecosystem is significant enough to warrant Federal investment.

Institutional Recognition: Institutional recognition means the importance of an environmental resource is acknowledged in the laws, adopted plans and other policy statements of public agencies, tribes or private groups.

Institutional Recognition of Pool 13
In Section 1103 of the WRDA of 1986, the U.S. Congress designated the Upper Mississippi River System as a "nationally significant ecosystem and a nationally significant commercial navigation system." The National Research Council's Committee on Restoration of Aquatic Ecosystems targeted the UMR for restoration as one of only three large river-floodplain ecosystems so designated. The Upper Mississippi River Basin Association is an advocate for restoration of habitat on the UMR. In addition, the Upper Mississippi River Conservation Committee (UMRCC) recognizes the importance of the floodplain forest to the fish and wildlife of the river.

Public Recognition: Public recognition means some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities reflecting an interest or concern for that resource.

Public Recognition of Pool 13
The public recognizes the UMR, including Pool 13, as a nationally, regionally, and locally significant resource as part of the UMR. For example, American Rivers, a non-governmental organization dedicated to protecting and restoring healthy, natural rivers,

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listed the Mississippi River in America's Top Ten Endangered Rivers for 2004. The river was a "special mention" on the 2011 list. The UMR Floodplain Wetlands are designated as a Ramsar Wetland of International Importance (Secretariat of the Convention on Wetlands, 2020) and the UMR National Wildlife Refuge has been designated as an Important Bird Area (National Audubon Society, undated). Also, the National Research Council's Committee on Restoration of Aquatic Ecosystems has targeted the UMR and the Illinois River for restoration (NRC, 1992).

Technical Recognition: Technical recognition means the resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity describe technical significance. Differences across geographical areas and spatial scales may determine whether a resource is significant.

- *Scarcity* is a measure of a resource's relative abundance within a specified geographic range.
- *Representativeness* is a measure of a resource's ability to depict the natural habitat or ecosystems within a specified range.
- *Status and Trend* measures the relationship between previous, current, and future conditions.
- *Connectivity* is the measure of the potential for movement and dispersal of species throughout a given area or ecosystem.
- *Limiting Habitat* is the measure of resources present supporting significant species.
- *Biodiversity* is a measure of the variety of distinct species and the genetic variability within them.

Technical Recognition of Pool 13

The UMR ecosystem consists of hundreds of thousands of acres of bottomland forest, islands, backwaters, side channels, and wetlands. Within the UMR, Pool 13 is most ecologically similar to Pools 3-9 when compared to other pools and unimpounded portions of the UMR. This grouping of ecologically similar pools was designated in the HNA-II as constituting the Upper Impounded cluster (McCain, *et. al*., 2018). This Upper Impounded cluster is characterized by the greatest amount of deep, lentic, off-channel areas with stable water levels, compared to other clusters of the UMRS. Pool 13 and other pools in the Upper Impounded cluster are also recognized as having the lowest total suspended solids concentration, which in turn promotes an abundance of submerged aquatic vegetation (SAV). This abundance of SAV is extremely important for many species, including migratory birds. As a whole, the Mississippi River is a part of a major bird migration route, termed the Mississippi Flyway. More than 300 species of birds have been documented at the NFWR (USFWS, 2006) which is approximately one-quarter the total number of species in the United States.

In Pool 13, waterfowl are considered particularly important due to their large numbers, visibility, and technical recognition. Nearly 30 species of waterfowl, including the canvasback (*Aythya valisneria*), use the NWFR. Canvasbacks are typically the most abundant waterfowl species using the NWFR in the fall (U.S. Fish and Wildlife Service 2006, 2019), and the NWFR is known to be an important migration staging area for this species (Serie et al. 1983, Korschgen et al. 1988, Serie and Sharp 1989, Baldassare 2014). The 2004 North American Waterfowl Management Plan (NAWP; North American

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Waterfowl Management Plan, Plan Committee 2004) classified canvasbacks as having a moderately high continental priority, with moderately high regional nonbreeding importance and nonbreeding need in Waterfowl Conservation Region 23 (WCR) which encompasses the NWFR. The 2017 Upper Mississippi River Great Lakes Joint Venture has also prioritized canvasbacks and considers it a focal species (Soulliere et al. 2017). Finally, the NWFR has prioritized the canvasback as well, and considers it to be a NWFR priority resource of concern (USFWS, 2009). The open impounded portion of Lower Pool 13 provides critical habitat for this priority species during migration and is one of the most heavily used canvasback areas of the NWFR.

2. EXISTING AND FUTURE WITHOUT PROJECT (FWOP)

The future without project (FWOP) condition is the forecasted condition of the study area for the next 50 years assuming that no significant action is taken to address the resource problems identified.

2.1 Period of Analysis

To determine if there is a Federal interest to restore habitat the USACE tries to capture the cost and benefits over a reasonable period of time to fully understand the investment decision. A 50-year period of analysis was used to forecast future conditions since it is a long enough period of time to capture benefits while reasonably minimizing forecasting uncertainties. The economic period of analysis was limited to 50 years in accordance with USACE Regulations (ER 1105-2-100), even though management measures are anticipated to continue having beneficial effects beyond 50 years. Base year is the year where it is assumed a constructed project will start accruing benefits, for this study a base year of 2033 was assumed. Therefore, the period of analysis for this study is 2033 to 2082.

Though initially justified over a 50-year economic period of analysis, USACE projects remain in service much longer and are generally designed with a 100-year horizon.

2.2 General Setting

Pool 13 of the Upper Mississippi River (UMR) is the area between Lock and Dam 13 at River Mile (RM) 522.5, near Fulton, Illinois, and Lock and Dam 12 at RM 557, at Bellevue, Iowa. Mississippi River Pool 13 has a drainage area of approximately 85,500 square miles. At Lock and Dam 13 (L&D 13) at Fulton, IL gage, the median flow is 50,900 cfs and the 0.01 annual exceedance probability[3] (AEP) is 283,000 cfs. When flows are below 131,000 cfs, water surface elevations are regulated by the low-head navigation dam. The authorized flat pool elevation at L&D 13 is 582.4 ft NAVD88. The normal operation band is 6 inches (582.0 ft – 582.5 ft NAVD88). The winter operation band is 1 foot (581.4 – 582.4 ft NAVD88) but is not typically utilized (USACE, 1996). When discharges exceed 131,000 cfs, the gates are lifted out of the water and the river is allowed to “run its course” (open river condition). The 0.01 AEP water

[3] Throughout this section and all subsequent sections, flood storm events and their resultant inundation will be referred to by Annual Exceedance Probability (AEP), which is the probability that this storm or level of flooding may be realized or exceeded in any given year. For example, a flood event with a 0.01 AEP would have a 1% chance of occurring every year. Additionally, in the past, flood events have often been described by their “return period” – or the estimated average length of time between flood events of a similar magnitude. A 0.01 AEP event would have been referred to as having a 100-year return period or being a 100-year event.

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surface elevation at L&D 13 is 593.1 ft NAVD88.

Pool 13 includes portions of the Upper Mississippi River NWFR managed by the USFWS Savanna District. Spring Lake, Potter's Marsh, Pleasant Creek and Brown's Lake all represent past HREP's that the NWFR now manages. The IA DNR manages the Green Island Wildlife Management Area, state parks and recreation areas, and USFWS manages the Lost Mound Unit, formerly the Savanna Army Depot. The Cities of Sabula and Clinton, IA, and Savanna, IL, lie along the river near the study area. Each city has developed shorelines, including homes and businesses on the waterfront. There are no public drinking water intakes in Pool 13. The US Fish and Wildlife Service (USFWS) lands occupy most of the study area. Several tributaries enter Lower Pool 13 in the vicinity of the study area. These include the Elk River, Plum River, and Maquoketa River.

In general, Pool 13 includes a relatively undeveloped floodplain. The lower portion of the pool is similar to other impounded areas of the UMR and composed of mostly open water habitat. The shallow portion of this open water represents important habitat for migratory birds, especially waterfowl. Large beds of *Vallisneria americana* (wild celery) are found in this area of Pool 13, and they, along with other species of submerged aquatic vegetation (SAV), serve as an important food source for migrating waterfowl. However, over the last century, human activity within the UMR basin has altered the hydrology, topography, and biotic communities present. Increased lateral connectivity and years of continual sediment deposition has degraded aquatic and forest habitats and, in some cases, caused non-native invasive species to dominate plant communities. Impoundment of the pool has permanently increased the water table elevations and has affected the health of the floodplain forest habitat on islands and adjacent floodplain areas. These higher water tables are affecting forest composition and regeneration. All of these alterations have reduced the quality and diversity of aquatic and floodplain habitats and impaired ecosystem functions.

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2.3 Natural Environment

2.3.1 Floodplain Forest

Representing one of the largest blocks of floodplain habitat in the contiguous United States, this stretch of the Mississippi River is bordered by steep wooded bluffs which rise 100 to 600 feet above the river valley. The lower impounded region of Pool 13 supports over 12,000 acres of floodplain forest, wetlands, and deep-water habitats. A reconnaissance walk of the floodplain forest were completed in the fall of 2020 and spring of 2021. These efforts provided an assessment of current forest conditions. Additional details on this work and the data collected can be found in Appendix A. In general, floodplain forest within the study area is comprised of mature forest having well-established trees in the canopy. The primary tree species are silver maple (*Acer saccharinum*) and eastern cottonwood (*Populus deltoides*), both exhibiting very limited natural regeneration or desirable understory establishment. In addition, there are scattered canopy gaps within the mature forest dominated by herbaceous invasive species. These canopy gaps were likely formed by the death of overmature trees or windthrow during storm events. The canopy gaps allow increased sunlight availability and support multiple invasive species including reed canary grass (*Phalaris arundinacea*) and Japanese hops (*Humulus japonicus*).

It is expected that the forest will experience severe change over the next 50 years if no action is

taken. Mature cottonwoods and silver maples are estimated at approximately 80 years old, giving most only 20 years until they reach the end of their lifespan. These trees will die throughout the forested area of the project, leaving behind large canopy gaps with little to no understory or natural recruitment. These canopy gaps will then allow for further establishment of invasive species and prevent future recruitment. It is likely that an overall transition to an open canopy structure will occur. There are currently very few hard mast trees across the forested area that could provide a seed source for natural recruitment. Undesirable species such as mulberry and boxelder are likely to take their place. Overall, under the FWOP condition, tree species and structural diversity will decline and invasive species presence will increase.

2.3.2 Aquatic Vegetation

Wetlands in Pool 13 are dominated by trees, shrubs, emergent, rooted floating-leaved, and SAV. Emergent and rooted floating-leaved aquatic vegetation species are important sources of both habitat and forage for native species in Pool 13. Rooted floating-leaved species such as American lotus (*Nelumbo lutea*) and white water-lily (*Nymphaea odorata*) provide habitat and cover for multiple species of fish and aquatic mammals. These species also represent crucial habitat for secretive marsh birds, a Priority Resource of Concern for the NWFR (USFWS, 2019). Common emergent species found in lower Pool 13 include stiff arrowhead (*Sagittaria rigida*), broadleaf arrowhead (*Sagittaria latifolia*), river bulrush (*Scirpus fluviatilis*), and common cattail (*Typha latifolia*). In addition to habitat and cover, arrowhead species provide important forage for migrating waterfowl and aquatic mammals in the form of energy-rich tubers, which are used by the plants to overwinter and germinate the following year. Within the study area, little-to-no emergent vegetation exists currently due to suboptimal water depth and water velocities.

Submerged aquatic vegetation also plays a vital role as both habitat and forage in Pool 13 for native fish and migratory waterfowl. Beginning in the early 2000's, Pool 13, along with a number of other pools on the UMR, exhibited a sharp increase in the frequency and abundance of SAV within the pool (Figures 2 and 3). Between 2003 and 2006, percent frequency of SAV in the impounded reach of the pool increased by over 30% (LTRM, 2019). While the principal driver of this expansion of SAV is not fully understood, this increase does coincide with a period of relatively low water levels and low turbidity during the growing season.

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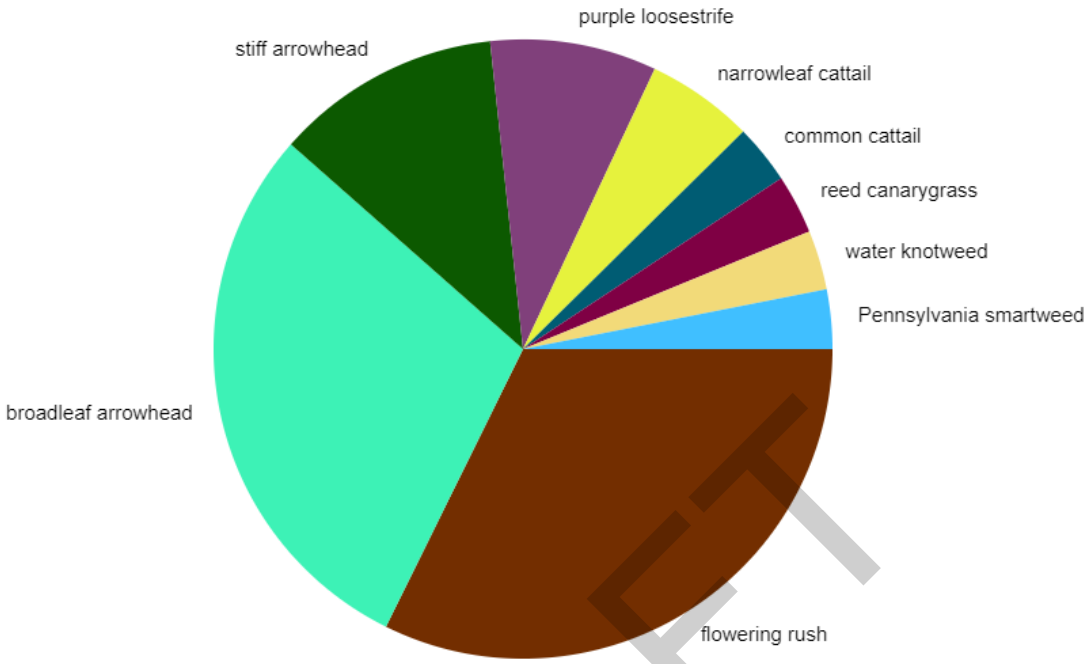

Figure 2. Relative Frequency of Emergent Aquatic Species Sampled in the Impounded Reach of Pool 13 for 2021. Relative Frequency Compares the Frequency of Occurrence for One Species to All Other Species Sampled (LTRM, 2022).

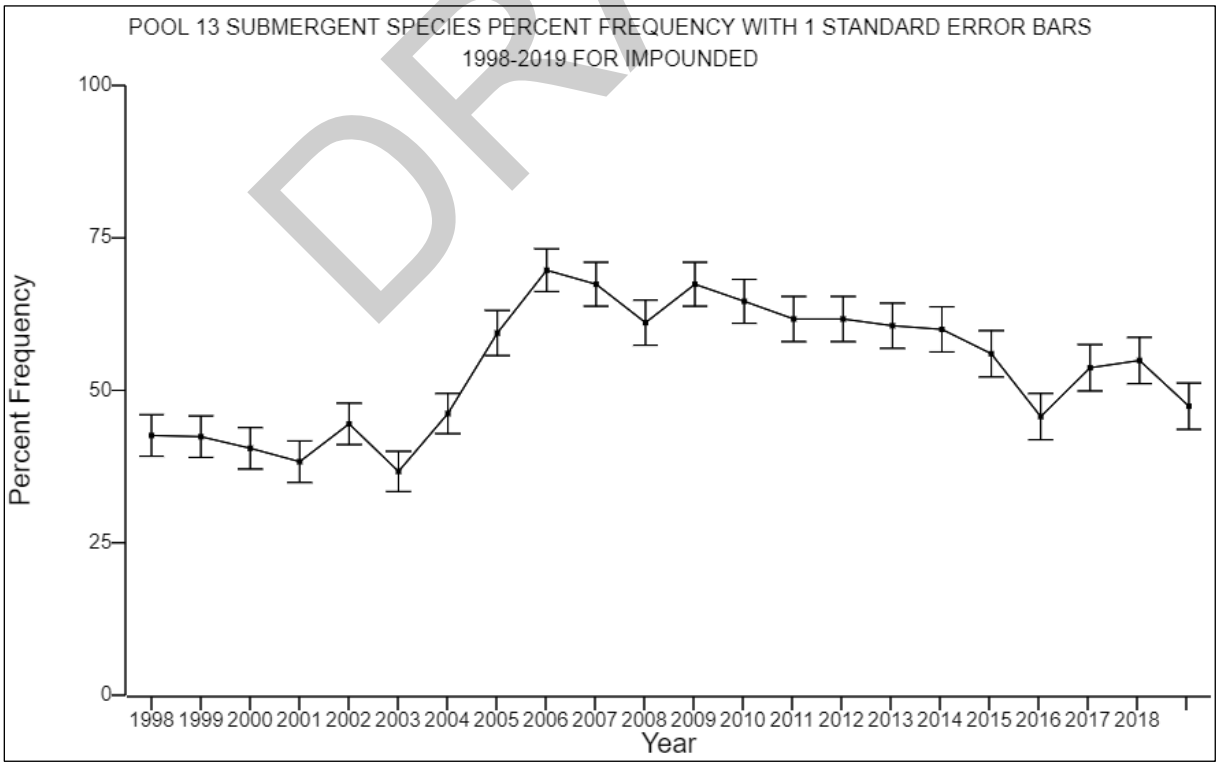

Figure 3. Percent Frequency of All Species of SAV Sampled Between 1998-2019 (LTRM, 2022)

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Over 10 species of SAV are found in the impounded reach of Pool 13, including coontail (*Ceratophyllum demersum*), wild celery (*Vallisneria americana* Michx.), Canadian waterweed (*Elodea canadensis*), water stargrass (*Heteranthera dubia*), and multiple pondweed species (*Potamogeton* sp.).

Vallisneria americana Michx. (also referred to locally as wild celery, water celery or eelgrass) is a perennial submerged aquatic plant and the most abundant species of SAV found in Lower Pool 13, being found in over 40% of sites sampled in 2019 as shown in Figure 4 (LTRM, 2019). Wild celery possesses ribbon-like leaves that can extend up to 2 meters in length (McFarland, 2006). Reproduction in the UMRS is most often accomplished asexually using underground rhizomes, allowing wild celery to spread rapidly and form dense beds of aquatic vegetation (McFarland, 2006). Wild celery overwinters as enlarged buds that remain dormant during fall though early spring, and resume growth when water temperatures rise in the spring and early summer. These “winter buds” are carbohydrate storage organs, and the carbohydrates are necessary to fuel the new growth in the spring. These carbohydrates are also the reason waterfowl relish winter buds as a forage during fall and spring migration.

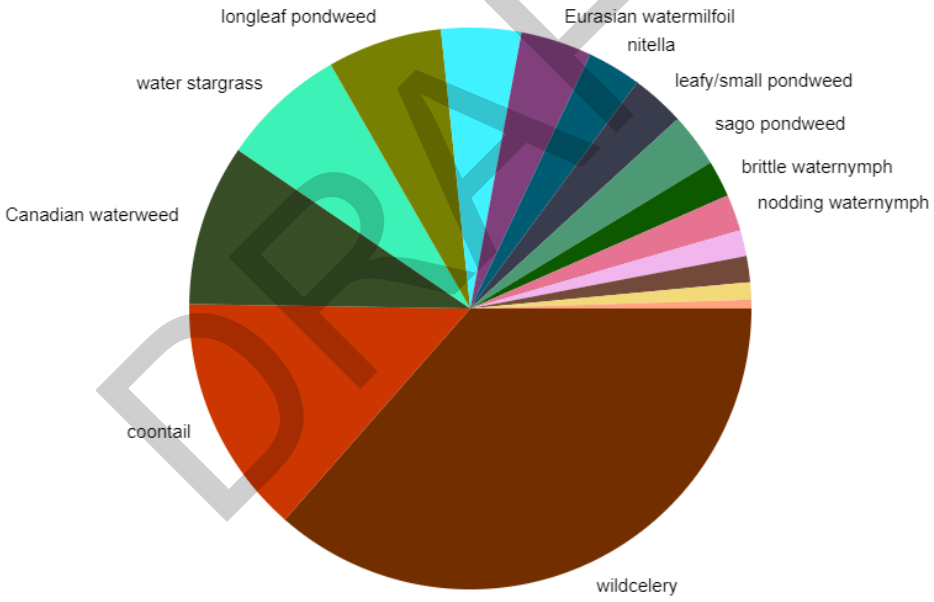

Figure 4. Relative Frequency of SAV Species Sampled in the Impounded Reach of Pool 13 for 2021 (LTRM, 2022)

These energy-rich tubers serve as a crucial food source for waterfowl during their fall migration. Tens of thousands of ducks can be seen in Lower Pool 13 in the fall, including canvasbacks, a Priority Resource of Concern for the NWFR (USFWS, 2019). Per the Habitat Management Plan for the NWFR, the goals for permanent and semi-permanent wetlands are to prevent the declines in SAV and enhance permanent/semi-permanent wetland systems to provide habitat for waterfowl, shorebirds and other waterbirds. Additionally, the NWFR seeks to provide diverse habitat for other wetland-dependent wildlife while preserving the ecological integrity of the wetlands. (USFWS, 2019).

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Wild celery and other species of SAV exhibited a sharp increase in abundance in Pools 8 and 13 beginning in the early 2000's (Figure 5). Percent frequency of wild celery peaked in 2009 in Pool 13. Since that time, resource managers with the IADNR have observed and documented declines in the presence of wild celery over the last decade (Figure 6).

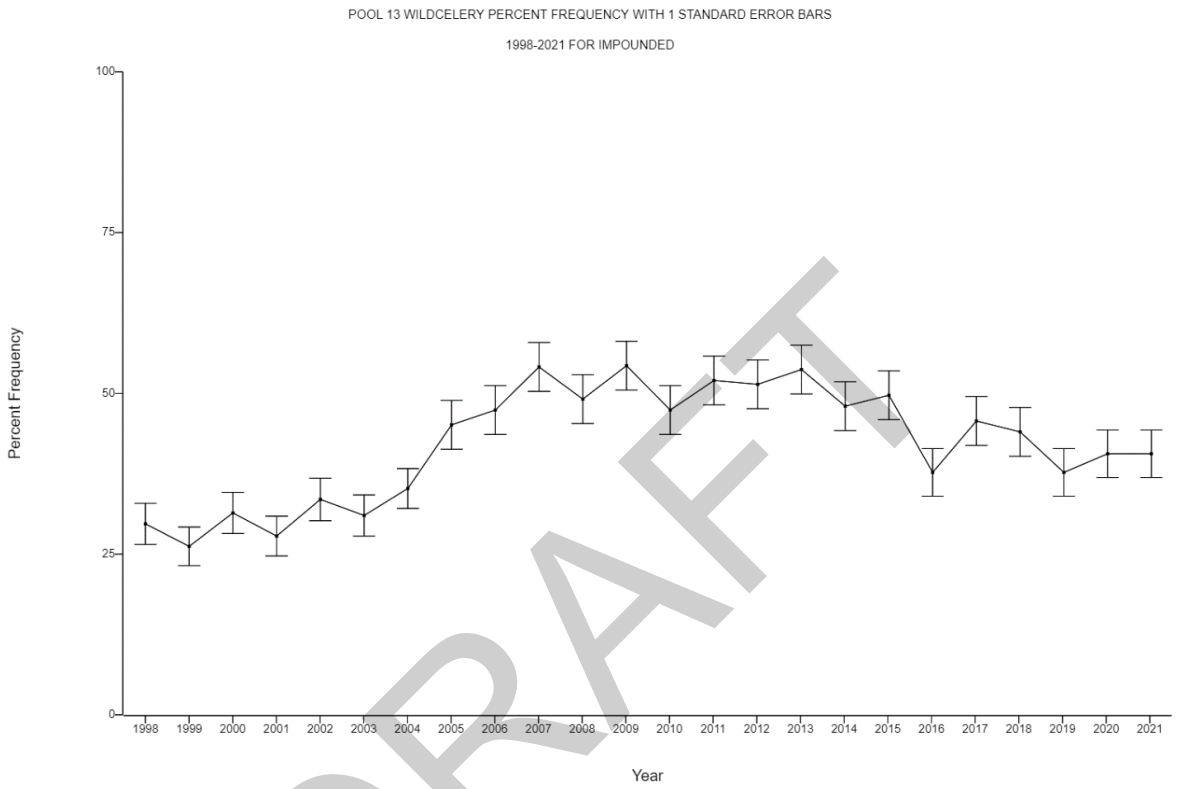

Figure 5. Percent Frequency of Occurrence of Wild Celery (*Vallisneria americana* Michx.) in the Lower Impounded Reach of Pool 13

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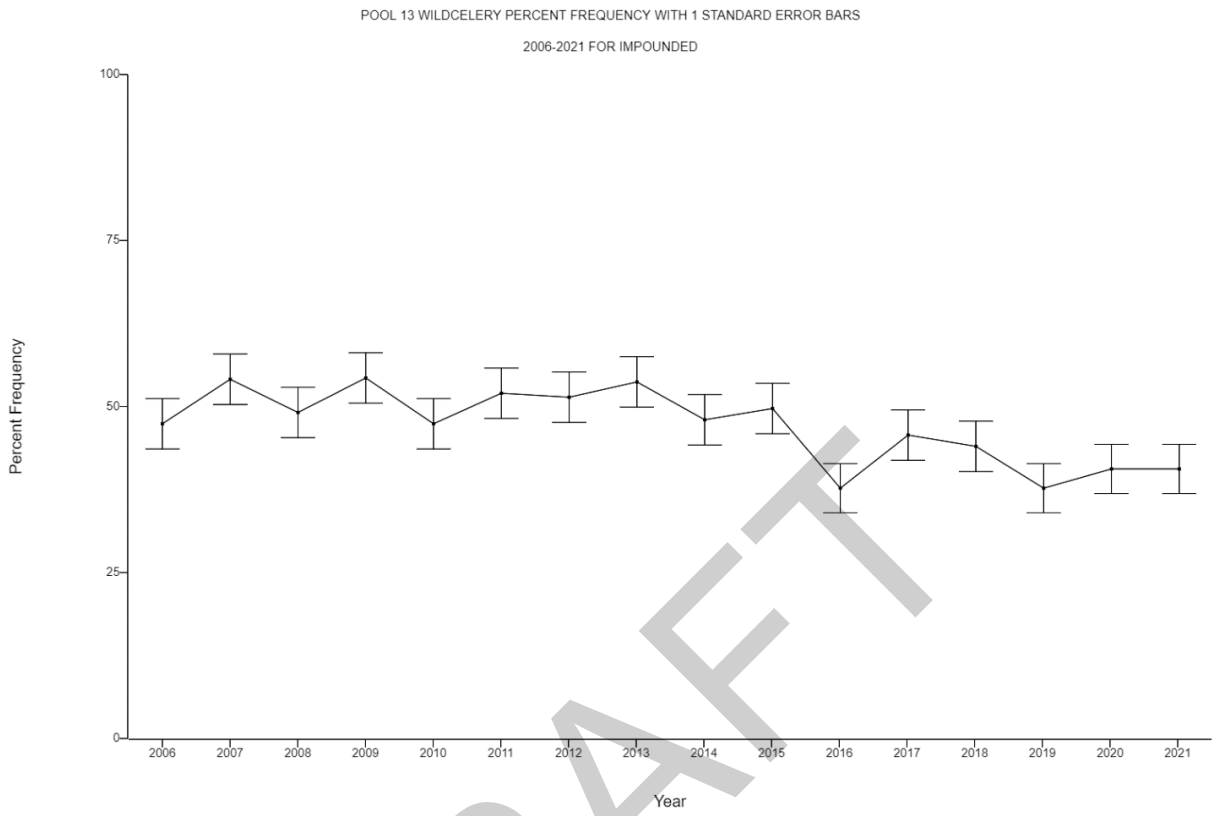

Figure 6. Percent Frequency of Occurrence of Wild Celery (*Vallisneria americana* Michx.) in the Lower Impounded Reach of Pool 13 between 2006 and 2021 (LTRM)

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It is expected that declines of this magnitude would continue under the FWOP condition. Effects of climate change are likely to exacerbate this decline with increased flooding. At this rate, percent frequency of wild celery and other species of SAV would likely drop to zero by 2053. Macroinvertebrates that utilize SAV for food and habitat would also decline under this condition. Both wild celery and macroinvertebrates represent critical food sources for migratory waterfowl, and the loss of these food sources would result in declines in waterfowl use of Pool 13. Thousands of waterfowl rely on Pool 13 for energy needed for migration, and the loss of this food source may contribute to population-level declines for multiple species. Emergent vegetation presence within the study area is expected to remain low. Addition details on FWOP conditions and assumptions can be found in Appendix A, *Environmental,* Attachment A, *Habitat Benefits Analysis*.

2.3.3 Fish and Wildlife

Pool 13 supports an abundance of native wildlife. Bald eagle (*Haliaeetus lecocephalus*) use of the NWFR has increased dramatically in recent years. Pool 13 provides crucial stopover habitat for migrating eagles while also supporting a number of active nesting sites for year-round residents, making this stretch of the river a popular destination for bird watchers. As one of the four major migration flyways in North America, the Mississippi River Flyway offers ideal conditions for migratory birds and the UMR floodplain corridor is an important corridor for neotropical migratory birds, a NWFR Priority Resource of Concern (USFWS, 2019). Birds like

the prothonotary warbler (*Protonotaria citrea*) and the cerulean warbler (*Setophaga cerulea*) are a favorite of bird watchers. These species utilize the floodplain forest community within Pool 13 for stopover habitat, as well as breeding and nesting habitat. The diverse array of habitat types of floodplain forests typically tend to support higher abundances of species and individuals. 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.

Pool 13 is also heavily used by migrating waterfowl. The NWFR is a part of the Mississippi Flyway, which is used by millions of birds as a migration corridor; an estimated 40% of the continent's waterfowl are believed to migrate through this corridor each fall (Reid et al., 1989). The Mississippi Flyway is considered a critical migration corridor for 10 species of waterfowl, including tundra swans (*Cygnus columbianus*), canvasback, lesser scaup (*Aythya affinis*), and blue-winged teal (*Anas discors*). The large beds of wild celery and other species of SAV in the lower portion of Pool 13 are especially important to canvasbacks during their fall migration. Pool 13 also attracts many species of colonial nesting birds, including great blue herons (*Ardea herodias*), white pelicans (*Pelecanus erythrorhyncos*), double-crested cormorants (*Phalacrocorax auritus*), and great egrets (*Ardea alba*). Islands within Pool 13 boast the largest concentration of nesting cormorants in the Upper Mississippi River, with over 1,000 nests being documented (USFWS, 2004).

This section of the NWFR is also home to over 90 species of fish, of which 34 are considered common or abundant (Steuck et al., 2010). Species that have been identified within the study area include common species such as crappie (*Pomoxis* sp.), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*), as well as rarer species such as blue sucker (*Cycleptus elongatus*), grass pickerel (*Esox americanus*), and lake sturgeon (*Acipenser fulvescens*) (LTRM Fisheries Database). From a sport fishing perspective, bluegill are the most caught species within this pool. Threats facing this and other popular sport-fish species include loss of spawning and over-wintering habitat due to sedimentation.

Over 50 species of freshwater mussels have been identified on the mainstem of the Upper Mississippi River, however only 44 species have been sampled in the last 35 years (UMRCC, 2004). Due to over-exploitation, water pollution, and habitat alteration over the last 100 years, mussel populations have declined rapidly. In North America, an estimated 55 percent of freshwater mussel species are in danger of extinction (UMRCC, 2004). To stem these declines, protection and enhancement of mussel habitat is a priority of many HREP's on the Upper Mississippi River through the UMRR Program.

A 2019 pool-wide survey of Pool 13 found 30 species and estimated the population of mussels in the pool at over 300 million individuals. Many of these individuals (~50%) were young (age 0) paper pondshell mussels (*Utterbackia imbecilis*). This indicates very successful recruitment of mussels, albeit for a short-lived species. This survey effort also found the Federally Endangered Higgins eye pearlymussel (*Lampsilis higinsii*) within the study area. This single, live individual was approximately 2 years old and prompted the Project Delivery Team (PDT), Sponsor, and agency partners to conduct an informal survey of proposed project features in July 2021. During this survey, a second, live Higgins eye was found near a proposed project feature. In order to avoid and minimize potential impacts to Higgins eye and other mussel species, a quantitative mussel survey is scheduled for June 2022. Data gathered from this survey will be used to update the existing conditions section of this report.

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Under the FWOP condition, fish and wildlife within the study area are likely to suffer the effects of a degraded system. Floodplain forest decline documented in Section 2.3.1.1 will result in decreased habitat quality for resident and migratory bird species. Increased invasive species presence will reduce nesting habitat for neotropical migratory songbirds like the prothonotary and cerulean warblers. The loss of mature trees and established canopy will reduce available habitat for heron rookeries and decrease available roost trees for tree-roosting bat species. Waterfowl that rely on SAV for energy during migration will likely alter migration patterns in order to find food. Species like the canvasback that have experienced population level declines may suffer additional losses in numbers. Overall, the loss of mature floodplain forest and the decline of SAV will cause severe negative impacts to many native species.

2.3.4 Endangered Species

2.3.4.1 Federally Threatened and Endangered Species

The USACE consulted the USFWS Information for Planning and Consultation (IPaC) website on 11 May 2022 to identify the potential presence of Federally-listed threatened and endangered species within the defined project action area. USFWS lists six T & E species and one candidate species on the official species list (Table 1). While IPaC lists seven species, five have the potential to occur within the boundaries of the study area. The other listed species require habitat not found within the study area and are therefore not discussed further in this report.

Table 1. List of Threatened and Endangered Species Provided by USFWS IPaC Website for the Study Area. E=Endangered, T=Threatened, & C=Candidate.

(IPaC accessed May 11, 2022)

Common Name	Scientific Name	Status
Indiana Bat*	*Myotis sodalis*	E
Northern Long-eared bat*	*Myotis septentrionalis*	T
Higgins Eye Pearlymussel*	*Lampsilis higginsii*	E
Sheepnose Mussel*	*Plethobasus cyphyus*	E
Monarch Butterfly*	*Danaus plexippus*	C
Eastern Prairie Fringed Orchid	*Platanthera leucophaea*	T
Western Prairie Fringed Orchid	*Platanthera praeclara*	T

* Species potentially occurring within the study area.

The Northern Long-eared bat (NLEB) is a medium-sized bat that hibernates in caves and mines in the winter and in the summer roosts singly or in colonies under the bark or in cracks and crevices of trees. Large mature silver maples and cottonwoods often possess large cracks and flaking bark required roosting, making floodplain forest extremely important for this species. NLEB is relatively widespread, and USFWS lists NLEB as a threatened species because a fungal pathogen causing white-nose syndrome is sharply reducing populations. Indiana bats are very small bats, weighing in at only one-quarter of an ounce. Like the Northern Long-eared bat, Indiana bats hibernate in caves and mines in the winter and spend the summer roosting under loose tree bark on dead or dying trees. During summer, males roost alone or in small groups, while females roost in larger groups of up to 100 bats or more (USFWS 2006). Indiana bats are

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found over most of the eastern half of the US, where the primary threats to their population include disturbance during hibernation, habitat degradation and white-nose syndrome.

The Higgins eye pearlymussel is a freshwater mussel that inhabits large rivers, where it is usually found in deep water with moderate currents. Higgins eye possess a yellow-brown shell with green rays that is often up to 4 inches long (Miller & Payne, 2007). Freshwater mussels, including Higgins eye, are prey for wildlife like muskrats, otters, and raccoons; they filter water which improves water quality; and mussel beds create microhabitats on river bottoms that provide food and cover for other aquatic life. Higgins eye depend on deep, free-flowing rivers with clean water, and today much of their historic habitat has been changed from free-flowing river systems to impounded river systems. Impoundments changed water flow patterns, substrate characteristics, and host fish habitat which, in turn, affect how Higgins eye feed, live, and reproduce. Municipal, industrial, and farm run-off degrade water quality. As filter-feeders, mussels concentrate chemicals and toxic metals in body tissues and can be poisoned by chemicals in their water. Dredging and waterway traffic produce siltation which can cover river substrate and mussel beds.

The sheepnose mussel is a medium-sized freshwater mussel that grows to 5 inches in length. This species is found across the Midwest and Southeast and is found in large rivers and streams with moderate to swift currents (USFWS, 2002). The construction of dams on rivers and streams across the sheepnose mussel's range has disrupted the natural flow and eliminated suitable habitat for this species. Dams also prevent the upstream movement of fish species necessary for the reproduction and dispersal of this, as well as other, mussel species. The monarch butterfly is large and conspicuous, with bright orange wings surrounded by a black border and covered with black veins. Adult monarchs feed on the nectar of many native flowering species and represent one of the major pollinating species in the UMRS. Adult monarch butterflies lay their eggs exclusively on milkweed host plants (*Asclepias* sp.). After a thorough assessment of the monarch butterfly's status, the USFWS found that adding the monarch butterfly to the list of threatened and endangered species is warranted but precluded by work on higher-priority listing actions. With this decision, the monarch becomes a candidate for listing under the Endangered Species Act (ESA), and its status will be reviewed each year until it is no longer a candidate. Neither section 7 of the ESA nor the implementing regulations for Section 7 contain requirements for Federal agencies with respect to candidate species, however steps to reduce adverse effects are recommended.

Both the Eastern and Western prairie fringed orchid inhabit similar habitats along the Mississippi River in Iowa and Illinois. Mesic prairie, sedge meadows, marsh edges, and bogs all support these species provided enough sunlight is available. These species persist in areas where periodic disturbance occurs, including grazing, mowing, and fire. While the range of these species overlaps the study area, neither the Eastern or Western prairie fringed orchid is expected to occur within the project boundary.

2.3.4.2 Illinois & Iowa State Listed Species

Both Illinois and Iowa list a number of species as state endangered or state threatened. The IADNR Natural Areas Inventory and the Illinois Endangered Species Protection Board list 89 species as endangered or threatened. This includes, 42 species of plants, 13 fish, 10 reptiles/amphibians, 8 birds, 7 mussels, 4 insects, 3 mammals, and 1 snail species. IADNR also lists 42 species as species of Special Concern. These species are not protected under the Iowa

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Threatened and Endangered Species Law, but often have protections under additional state laws governing hunting and fishing. The state of Illinois does not have species listed under the Special Concern category.

2.3.5 Migratory Birds

The USFWS IPaC website also supplies a list of migratory bird species that can occur within the study area. The 11 species of migratory birds listed by USFWS is shown in Table 2. Within this list, USFWS lists Birds of Conservation Concern (BCC) with the goal of "accurately identifying the migratory and non-migratory bird species that represent our highest conservation priorities" (USFWS, 2015). These are species that are likely to become threatened or endangered without the implementation of conservation measures.

Table 2. List of Migratory Birds Potentially Occurring in the Study Area
(IPaC data accessed 11 May 2022)

Common Name	Scientific Name	Status
American Golden-plover	*Pluvialis dominica*	BCC
Bald Eagle	*Haliaeetus leucocephalus*	Eagle Act
Bobolink	*Dolichonyx oryzivorus*	BCC
Golden Eagle	*Aquila chrysaetos*	Eagle Act
Henslow's Sparrow	*Ammodramus henslowii*	BCC
Lesser Yellowlegs	*Tringa flavipes*	BCC
Prothonotary Warbler	*Protonotaria citrea*	BCC
Red-headed Woodpecker	*Melanerpes erythrocephalus*	BCC
Rusty Blackbird	*Euphagus carolinus*	BCC
Short-billed Dowitcher	*Limnodromus griseus*	BCC
Wood Thrush	*Hylocichla mustelina*	BCC

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2.3.6 Invasive Species

Invasive and exotic species are the "greatest threat to ecosystem integrity within the NWFR system" (USFWS, 2019). The UMR NWFR experienced ecological degradation as a result of invasive fish, plant, and invertebrate species over abundance. As these species spread, they displace native plant and animal species, often creating monocultures of themselves.

An ever-increasing list of uninvited fish to the Upper Mississippi River is cause for alarm by anglers, commercial fishermen, ecologists, and others who admire the river. Foremost among these being the four species of invasive carp (big head (*Hypophthalmichthys nobilis*), black (*Mylopharyngodon piceus*), silver (*Hypophthalmichthys molitrix*), and grass (*Ctenopharyngodon idella*)) that were imported to control weeds, snails, and plankton at fish farms. As adults, these large species compete with native paddlefish, buffalo, and gizzard shad for food. They also compete with many other native fish species during their larval stages (Howell, et. al., 2014).

In addition to fish, invasive plant species occur throughout the study area and the entirety of the Upper Mississippi River NWFR. Approximately 15 species of invasive plants have been shown to adversely affect the native plants and habitat found on the NWFR, including purple loosestrife

(Lythrum salicaria), reed canarygrass (*Phalaris arundinacea*), Japanese hops (*Humulus japonicus*) and garlic mustard (*Alliaria petiolata*). Invasive invertebrates pose an additional threat to native species. Zebra mussels (*Dreissena polymorpha*) attach themselves to native mussels, interfering with the siphoning and feeding of native mussel species. The faucet snail or mud Bithynia (*Bithynia tentaculata*) is another invasive species that negatively impacts native species in the NWFR. Bithynia reproduce quickly and attach themselves to submergent aquatic vegetation. These large assemblages of snails can weigh down the aquatic vegetation, reducing the amount of light that the vegetation receives and ultimately killing the plants (Weeks et. al., 2017).

Invasive species presence and abundance is expected to increase under FWOP conditions. The loss of mature trees and resulting canopy gaps will allow the proliferation of reed canary grass and other invasive species that require full sunlight. This transition from a closed canopy to a more open system will reduce native tree recruitment and further exacerbate the spread of invasive vegetation. Invasive fish and invertebrate populations are expected to increase as water clarity declines, as many invasive carp species are able to thrive in turbid conditions.

2.4 Physical Environment

2.4.1 Tributaries

Five tributaries enter Pool 13 upstream of the study area: the Apple River, Rush Creek, the Elk River, the Plum River and the Maquoketa River. Figure 7 shows the study area in relation to these five tributaries.

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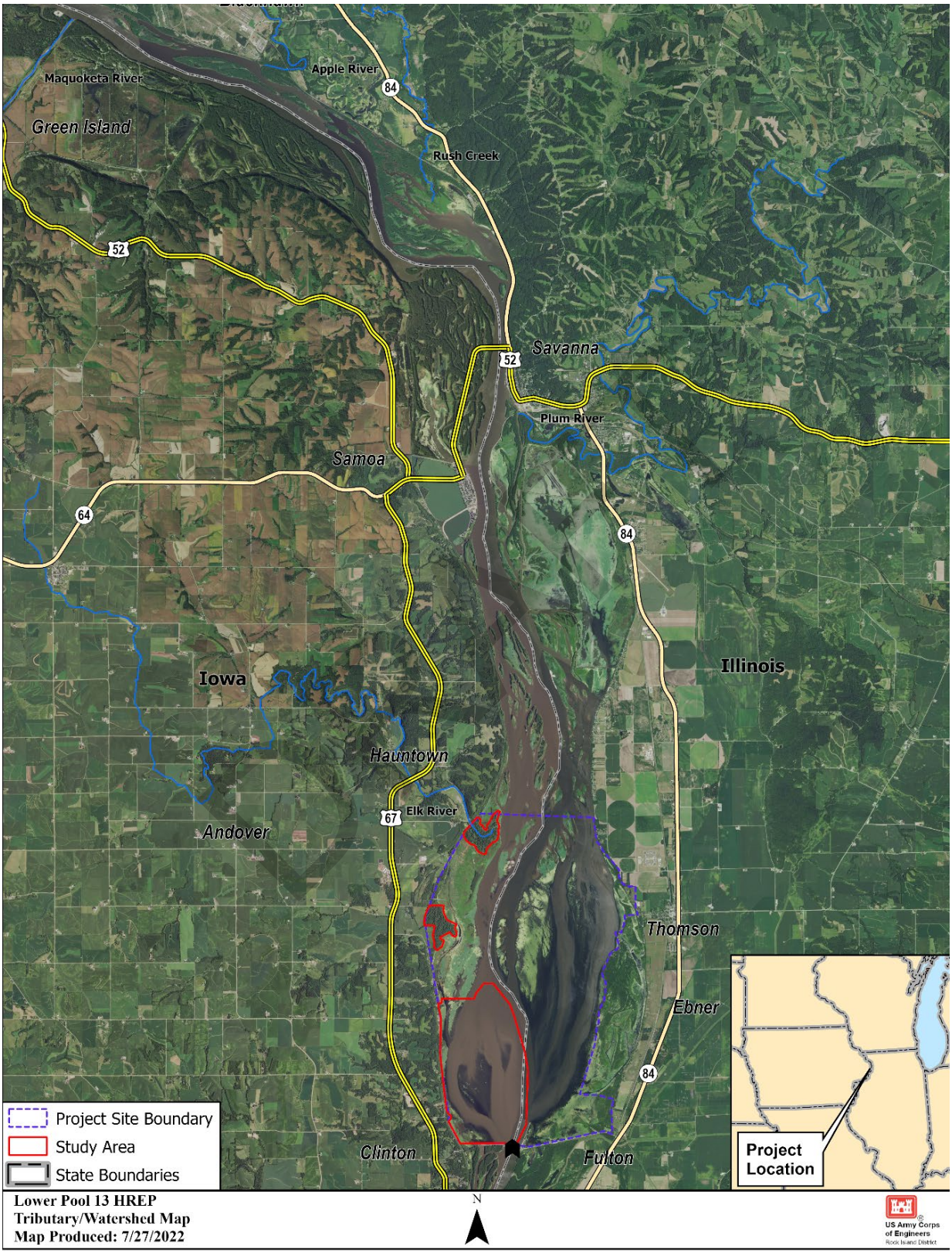

Figure 7. Tributary and Study Area Map

The Apple River flows into Pool 13 at UMR Mile 545.2 from the north. The Apple River watershed is 261 square miles in area with predominantly agricultural land cover. At the Mississippi River-Apple River confluence, the Apple River contributes approximately 3% of river flow to the Mississippi River (assuming 0.5 AEP for each river) (USGS, 2016).

At UMR Mile 542, Rush Creek flows into Pool 13 from the north. The Rush Creek watershed is 81 square miles in area with predominantly agricultural land cover. At the Mississippi River – Rush Creek confluence, Rush Creek contributes approximately 1% of river flow to the Mississippi River (assuming 0.5 AEP for each river) (USGS, 2016).

Elk River flows into Pool 13 at UMR Mile 528.7 from the west. The Elk River watershed is 77 square miles in area with predominantly agricultural land cover. At the Mississippi River – Elk River confluence, the Elk River contributes less than 1% of river flow to the Mississippi River (assuming 0.5 AEP for each river) (USGS, 2016).

At UMR Mile 537, the Plum River flows into Pool 13 from the east. The Plum River watershed is 298 square miles in area with predominantly agricultural land cover. At the Mississippi River – Plum River confluence, the Plum River contributes approximately 3% of river flow to the Mississippi River (assuming 0.5 AEP for each river) (USGS, 2016).

At UMR Mile 548.5, the Maquoketa River flows into Pool 13 from the west. The Maquoketa River watershed is 1,870 square miles in area with predominantly agricultural land cover. At the Mississippi River – Maquoketa confluence, the Maquoketa River contributes approximately 11% of river flow to the Mississippi River (assuming 0.5 AEP for each river) (USGS, 2016).

No significant changes to tributaries are expected under FWOP conditions. Potential increases in streamflow may occur due to climate change. For more information on climate change, refer to Appendix E, *Engineering,* Attachment A, *Hydrology and Hydraulics.* Land use and land cover near these tributaries is expected to remain predominantly agriculture-based, and the associated run-off and sediment inputs into Pool 13 is expected to continue.

2.4.2 Geology and Soils

Surficial geology consists of Deforest Formation, Quaternary System silty clay loams and clay loams associated with the modern channel of the Mississippi River valley. Bedrock geology consists of Ordovician Age, Galena Group limestones and shales, and Maquoketa Formation shales, dolomites and limestones (Iowa DNR, 1998).

The Natural Resources Conservation Service (NRCS) publishes soil surveys for most counties in the United States. Information in a pre-published soil survey indicated that the dominant soil type present in the study area is generally classified as the Algansee-Kalmarville Complex, a coarse to loamy series developed in alluvial materials. There are no prime and/or unique soils identified within the study area and no changes to the current geology or soils are expected under FWOP conditions. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

Detailed information including geotechnical sampling will be investigated during design phase of the project.

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2.4.3 Land Use

The Study Area includes land and water in both Iowa and Illinois, as well as land managed by both USACE and USFWS. Multiple land use plans exist that guide the management of resources within the Study Area:

- MVR Mississippi River Project Master Plan
- USFWS Upper Mississippi River National Wildlife and Fish Refuge Habitat Management Plan
- USFWS Upper Mississippi River National Wildlife and Fish Refuge Comprehensive Conservation Plan
- Iowa Wildlife Action Plan
- Illinois Comprehensive Wildlife Conservation Plan and Strategy
- Illinois Wildlife Action Plan Implementation Guide

These plans designate land classifications and guide management of habitat, wildlife, natural resources, and recreation within the study area. Proposed actions within the Study Area should work in concert with existing land use plans.

2.4.4 Hydraulics and Hydrology

The hydrology in the study area has changed significantly since the construction of the lock and dam system on the Upper Mississippi River. For low to intermediate flows, water levels in Lower Pool 13 HREP study area are controlled by Mississippi River L&D 13). L&D 13 is a low-head navigation dam and is not operated for flood control. The primary purpose of the dam is to maintain sufficient depth for commercial navigation. When inflows exceed capacity of the dam, the gates are lifted out of the water and the river is allowed to run its course (USACE, 1996).

Throughout the Upper Mississippi River, near static water levels have been created immediately above each of the dam structures. Figure 8 illustrates the difference between the natural variations in water levels seen in the tailwater stages of the dam and the near static water levels that exist immediately upstream from the dam. Figure 9 demonstrates the change in inundation extent within the protect area from 1915 (pre-impoundment) and 2015 (post-impoundment). Pre-impoundment, the Mississippi was approximately 0.5 mile wide during typical flow conditions in the area of interest. Post-impoundment, the Mississippi ranges from 1.5 to 4.5 miles wide during typical flow conditions in the area of interest.

Impoundment and a lack of bathymetric diversity drive fairly uniform flow velocities throughout the study area. Figure 10 shows the simulated distribution of existing condition velocities when discharge at L&D 13 is 60,000 cfs (roughly the median flow condition for the growing season). Velocities of 0.33 – 0.67 feet per second dominate the study area for this flow condition. UMRR Long Term Resource Monitoring (LTRM) velocity grab measurements are available within the study area for discharges near 60,000 cfs. The velocity values range from 0.13-1.18 feet per second (see Appendix E, *Engineering,* Attachment A, *Hydrology and Hydraulics,* for additional information).

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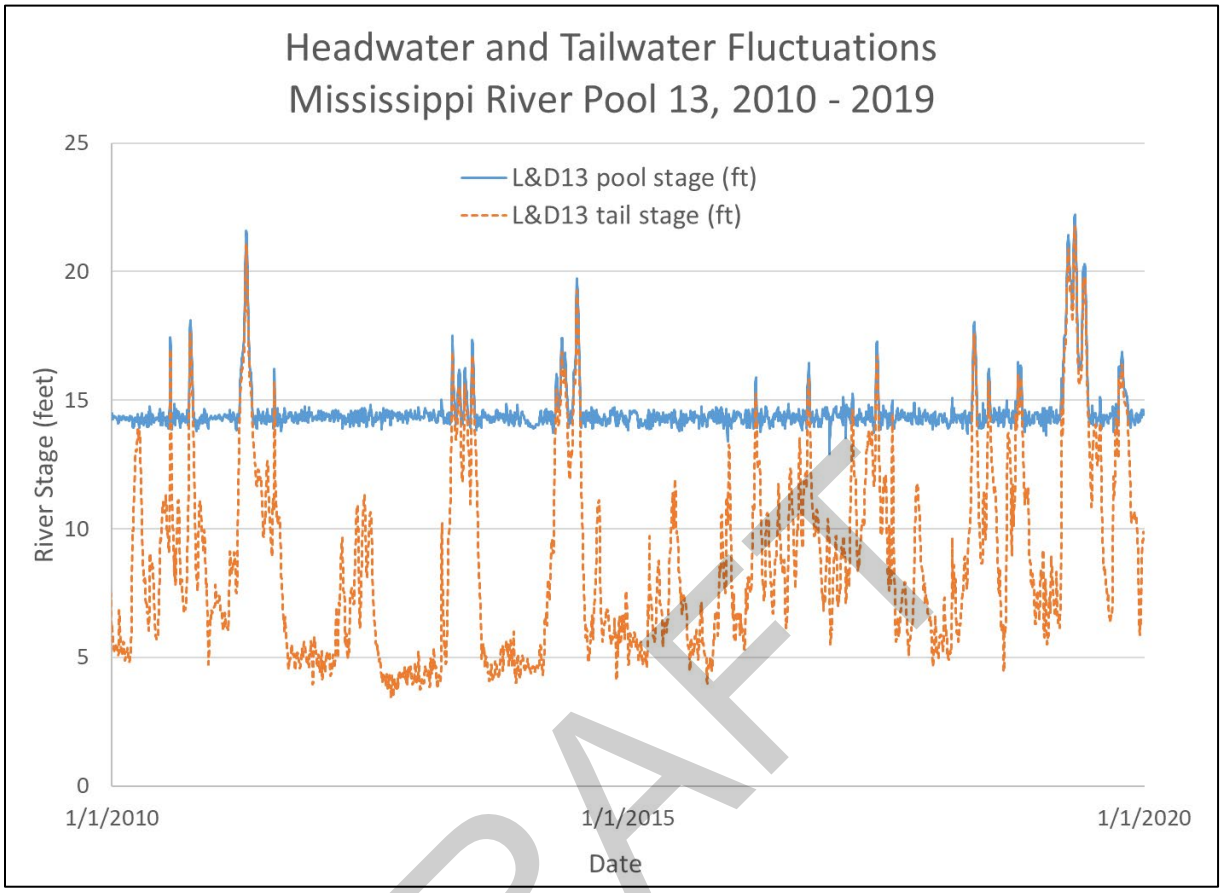

Figure 8. Pool and Tail Stage at Mississippi River L&D 13 at Fulton, IL Gage, 2010 - 2019

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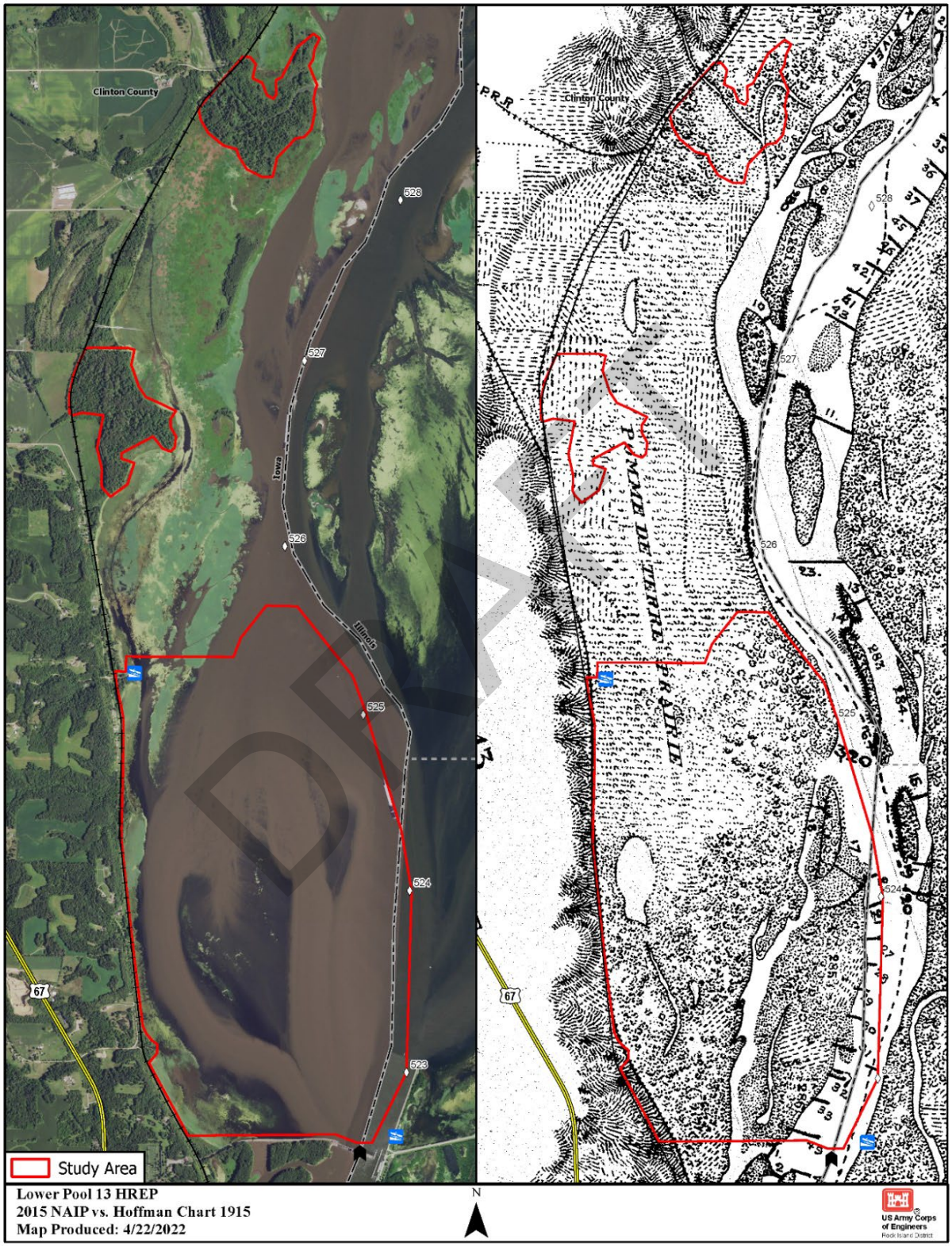

Figure 9. Typical Inundation Extents in 2015 (Post-Dam, left) and 1915 (Pre-Dam, right)

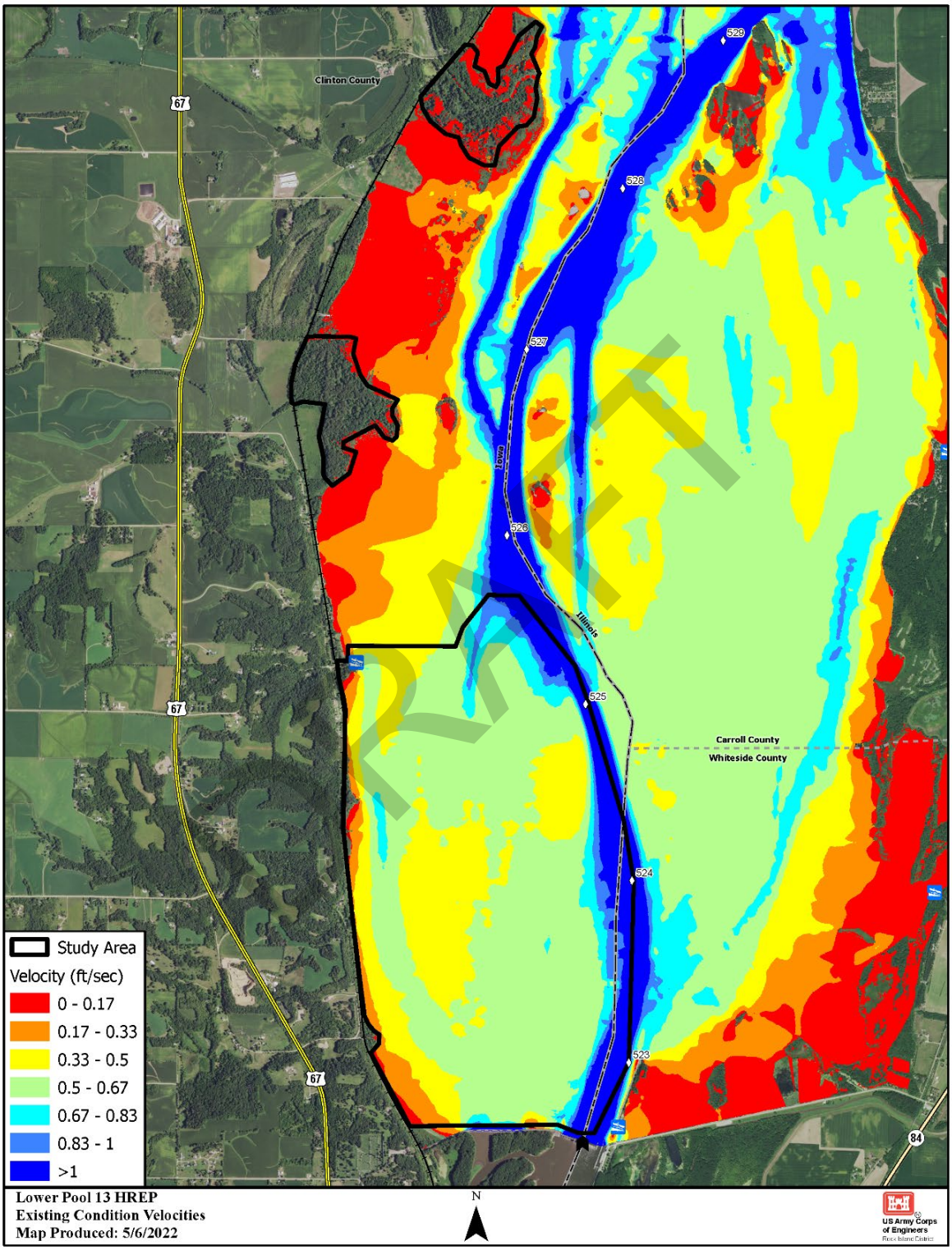

Figure 10. Existing Condition Velocities Simulated in 2D HEC-RAS for the 55% Duration Flow Condition (60,000 cfs)

Within the study area of Lower Pool 13 these near static water levels have created a system that functions much like a shallow lake (Scheffer, 1997). Consistent water levels with relatively low flows allowed the proliferation of SAV often associated with shallow lakes, including wild celery. While this species of aquatic vegetation provides important habitat and food for a number of species, the prolonged static water levels resulted in a loss of topographic and bathymetric diversity in the pool. Increased turbidity and sedimentation rates caused backwaters and side channels to fill in, creating a system that provides a relatively uniform river bottom. This lack of depth diversity negatively impacts the species diversity of freshwater mussels and native fish (Newton et al., 2008, Hansen & Steuck, 2012). Lack of natural water level variation also impacts the diversity of emergent and submergent aquatic vegetation. Emergent vegetation species such as arrowhead (*Sagittaria* sp.) and bulrush (*Scirpoides* sp.) require periods of low water and exposed substrate in order to germinate (Johnson *et al*., 2010). As a result, many species of emergent aquatic vegetation are rare or absent from the study area and the total area of emergent aquatic vegetation remains low (~5%). In addition, the elevated water tables favor tree species that tolerate wetter conditions, such as silver maple. These conditions prevent many hard mast species from establishing and reduce the diversity of forest communities. These changes in vegetation reduced habitat suitability and food availability for many fishes, waterfowl and other birds, and mammals (Fremling, 2005).

The duration of high or low flows has ecological and engineering significance. Ecologically, the number of days of high flow per year as well as high velocities can affect vegetation communities, aquatic organisms, sediment transport, nutrient cycling, and other ecological components and processes. Extended periods of low flows can result in longer residence times in aquatic areas causing increased water temperatures, changes in dissolved oxygen, and higher incidence of algae blooms. From an engineering perspective, longer durations of high flows that overtop ecosystem restoration project features could become detrimental to these structures by causing erosion, increased sediment deposition, and affecting the establishment of riparian vegetative communities. Low flows, if associated with drought conditions, can also negatively affect the establishment of the planted vegetation used to stabilize ecosystem restoration project features.

The current operation of Lock & Dam 13 will continue under the FWOP conditions. The 9-Foot Channel Project will continue to ensure navigation will occur on the UMR. As such, near-static water levels within the study area are likely to continue and seasonal water level variation will remain low, resulting in low numbers of emergent aquatic vegetation species and coverage.

2.4.5 Bathymetry and Sedimentation

Typical water depths in the study area were computed from the Lower Pool 13 topobathy. Surface and the median water surface elevations simulated for the growing season. As shown in Figure 11, the majority of the study area is roughly 4– 6 feet deep with some slightly deeper (6-10 feet) areas in the southeast corner of the study area and along the western side channel south of Gomer's Lake. A diversity of depths and elevations provides a range of conditions for different plant and animal species, resulting in a more diverse and resilient ecosystem; however, bathymetric diversity in Lower Pool 13 has declined since the construction of L&D 13. This lack of depth diversity limits the habitat types available to native species.

The Upper Mississippi River and Maquoketa River are the largest contributors of sediment to Pool 13. Within the study area, Elk River is a potential sediment source. Island erosion in

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upstream areas can also contribute to the sediment load (UMRBA, 2007). Within the study area, 7 dredging events have taken place within recent years (1999 – 2019). Immediately upstream of the study area, the 9-foot Channel Project dredging needs are considered chronic. Temporal and spatial variability are inherent in the numerous processes that drive sediment deposition, thereby sediment deposition rates are also dynamic. A literature review was conducted regarding sedimentation rates in the Upper Mississippi. Accounting for the variability in reported values and assumed variability of deposition within the study area, an average annual sediment deposition rate of 0.4 in/year (1 cm/year) was assumed for the study area. If this assumed average annual sediment deposition rate continues, an estimated 1.7 feet of sediment is expected to be deposited within the study area over a 50-year period. Under these FWOP conditions, bathymetric diversity is expected to remain low.

Please see Appendix E, *Engineering,* Attachment E, *Survey, Mapping, and Geospatial Data* and Appendix E, *Engineering,* Attachment A, *Hydrology and Hydraulics* for additional information.

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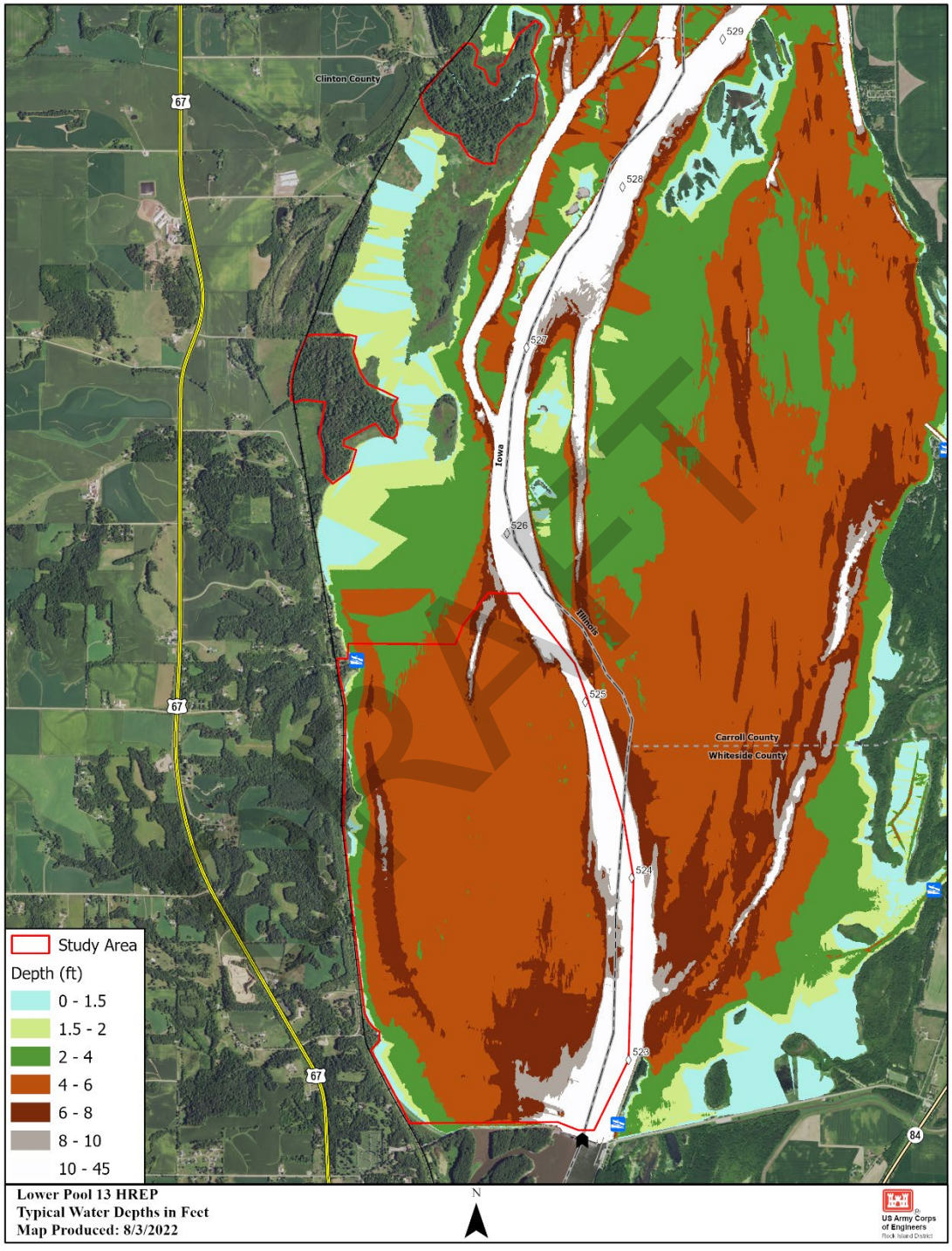

Figure 11. Typical Water Depths in the Study Area in Feet. Depths computed from Lower Pool 13 HREP composite elevation surface (Appendix E, *Engineering,* Attachment E, *Survey, Mapping, and Geospatial*) and median water surface elevations simulated for the growing season (Appendix E, *Engineering,* Attachment A, *Hydrology and Hydraulics*)

2.4.6 Wind Fetch

Wind fetch is defined as the unobstructed distance wind can travel over water in a constant direction (Rohweder, *et. al*., 2008). Fetch is an important characteristic of open water because longer fetch can result in larger wind-generated waves. From 2014 to 2019 at L&D 13, the 50% exceedance duration windspeed was 4.41 mph during the growing season, and the prevailing wind direction during the growing season was from the south-southeast. The impoundment caused by the construction of L&D 13 created a large, relatively shallow area upstream of the dam resulting in long wind fetch lengths. The wind generated waves can lead to increases in sediment resuspension and turbidity. Wave heights for windspeeds under 15 mph were observed to be about 20 cm.

Additional wind information on can be found in Appendix E, *Engineering,* Attachment A, *Hydrology and Hydraulics*.

2.4.7 Water Quality

Several data sources are available to examine water quality in the study area. The UMRR Program's LTRM element monitors the status and trends of the UMRS's natural resources, including focused monitoring in Pool 13 as a "trend pool." In addition to the significant LTRM datasets, USACE conducts discrete and continuous water quality monitoring at HREPs during critical seasonal stress periods in order to establish baseline conditions where project features may be implemented and to evaluate project performance after construction. The PDT initiated water quality monitoring at targeted locations in the study area in December 2018. An overview of the data is presented in Appendix E, *Engineering*, Attachment D, *Water Quality*.

Water quality in the study area is influenced by inflows as well as the high lateral hydraulic connectivity in the large, and relatively shallow, impounded area of Pool 13. Tributaries such as the Maquoketa, Elk, Apple, and Plum Rivers and the Mississippi River transport sediment and nutrient runoff into the pool. Island erosion in upstream areas can also contribute to the sediment load and increased connectivity (UMRBA, 2007). Wind-wave action resuspends fine sediments into the water column and can uproot plants in silt substrates.

The potential for poor water clarity and increased velocities in the study area due to these factors is concerning for the sustainability of aquatic vegetation. Large beds of aquatic vegetation currently exist in some portions of the study area. These beds may increase roughness and trap sediments, resulting in locally improved velocity conditions and water clarity, but they are also subject to degradation if velocities increase above optimal levels or if poor water clarity limits light penetration and suppresses photosynthesis (UMRBA, 2007). The recovery of SAV following periods of decline is also inhibited by excess suspended sediments. Light-related criteria necessary to support and sustain SAV during the growing season in the UMRS include a minimum Secchi disk depth of 50 cm, a maximum total suspended solids (TSS) concentration of 25 mg/L, and a maximum turbidity of 20 NTU (UMRCC, 2003).

In 2022, the USGS analyzed long-term trends in LTRM data for TSS in the main channel Pools 4, 8, 13, 26, and Open River and 10 select tributaries of the UMRS. This parameter was chosen as an indicator of water clarity and depths of light penetration for comparison across the system. For the period of analysis 1994-2019, declining TSS trends, indicative of improving water clarity, were observed in all study reaches and tributaries except Pool 13, the Maquoketa River, and

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the La Moine River, a tributary to the Illinois River, which increased, indicating water clarity is decreasing. In addition, suspended solids have shown a significant declining TSS trend, indicating improved water clarity, in similar geomorphic reaches upstream of Pool 13 (Pools 4 and 8). This beneficial trend in the upper pools has been linked to an increase in aquatic vegetation. However, a similar trend was not observed in Pool 13. There was a resurgence in SAV in Pool 13, but it was not to the extent of the upper pools and has declined since 2010. The 2022 study also found that main channel TSS concentrations increased from upstream to downstream reaches. The impacts of additional tributary sediment loads as watershed area increases moving downstream are likely key factors in Pool 13 having higher concentrations than the upper pools and thus reducing the potential for SAV growth and expansion in Pool 13.

Spatial differences in water clarity throughout the study area are visually apparent in aerial imagery, with the darker areas indicating clearer water and reflecting the locations of vegetation beds in contrast to the sediment-laden flowing channels (see Figure 7). To further visualize the spatial differences in reference to established water clarity criteria, LTRM random sampling data were mapped in the impounded area, see Appendix E *Engineering*, Attachment B, *Civil and Environmental Engineering*.

Looking at the summer growing season in the impounded area only, the LTRM Stratified Random Sampling data indicate a slight overall improvement in water clarity in the impounded area of Pool 13 (Figures 12 and 13). The estimated average trend is -0.7% per year for median turbidity and -0.8% per year for suspended solids; however, considering the 90% confidence intervals, this trend is not a statistically significant change (USGS, 2022). It appears summer turbidity and suspended solids values were generally decreasing from 1993 to 2007 but have since reversed. There are a couple of periods where much of the data meets the SAV water clarity thresholds; in 2000-2008 and 2012-2016, the median turbidity and TSS values were below 20 NTU and 25 mg/L, respectively.

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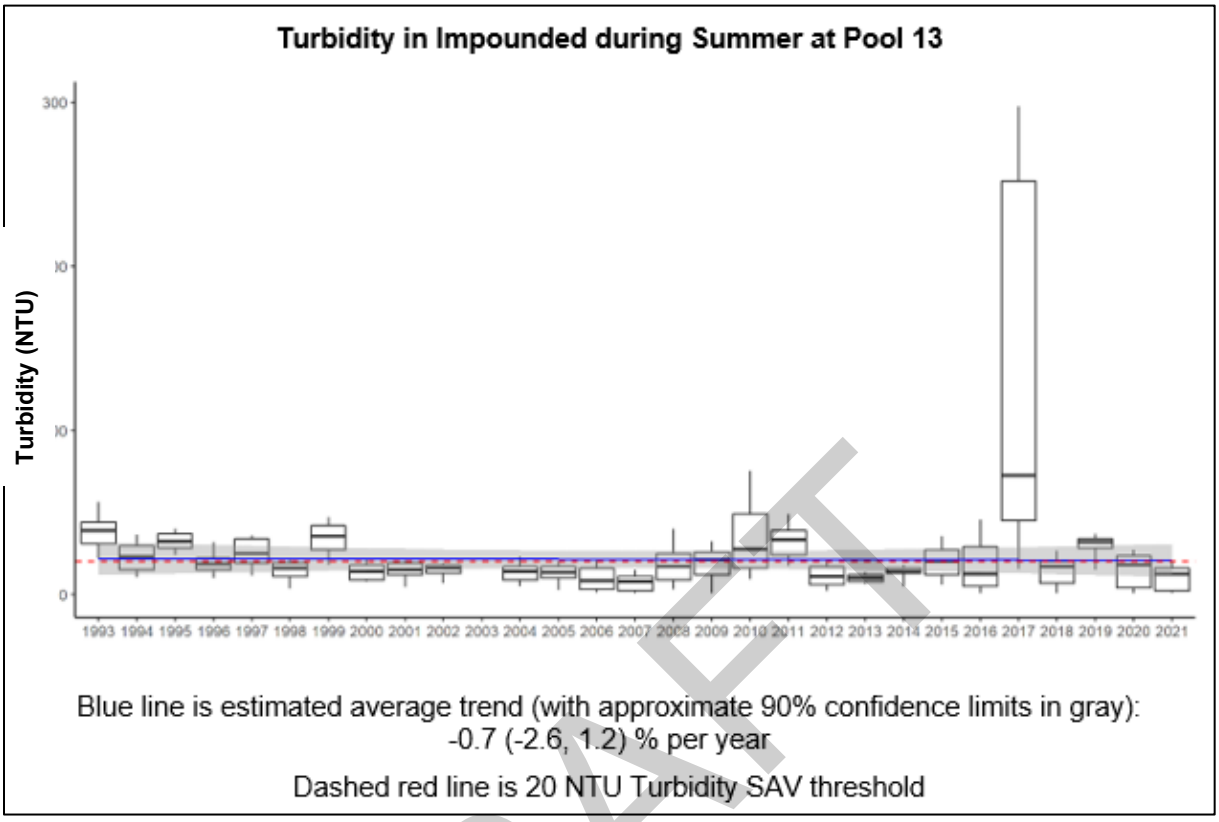

Figure 12. Pool 13 Summer Turbidity at Impounded Sites (USGS, 2022)

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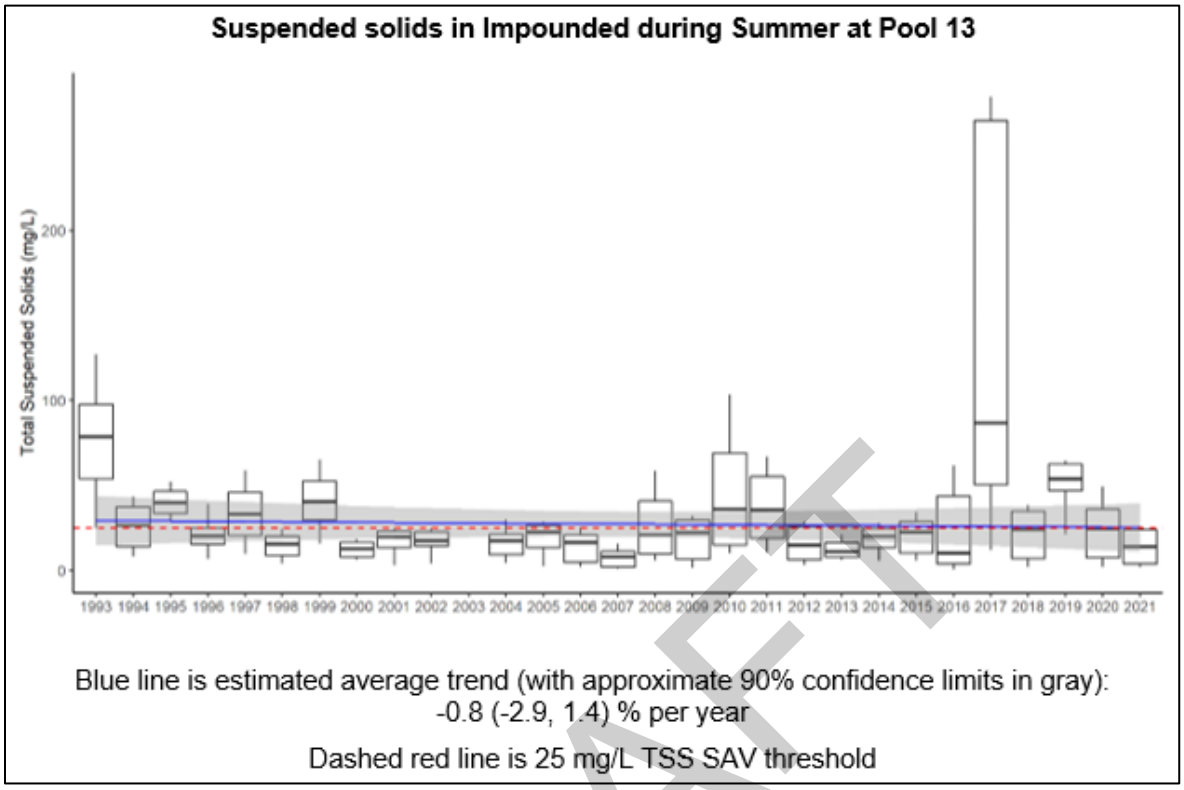

Figure 13. Pool 13 Summer Suspended Solids Concentrations at Impounded Sites (USGS, 2022)

USACE-collected data from two sites in the impounded area (W-M525.1G and W-M525.5L) during the summers of 2019-2021. Both sites have a very low percentage of readings that meet TSS criteria for SAV. In terms of turbidity and secchi disk depth readings, site W-M525.5L hits the criteria for SAV less than 30% of the time for the growing seasons monitored thus far, and site W-M525.1G meets the criteria between closer to 65% of the time. See Appendix E, *Engineering*, Attachment D, *Water Quality* for maps and figures.

Although slight improvements in water clarity have been observed in the impounded area since the inception of LTRM water quality monitoring in the early 1990s, the declines observed in more recent years are expected to continue. The decline in water clarity is indicated by the increasing trend in TSS in Pool 13 observed by the USGS (2022). Sediment inputs from upstream sources and tributaries, such as the Maquoketa River where TSS is also increasing, island erosion, increased connectivity, and wind-wave resuspension are likely leading to the lack of suitable water clarity conditions in Pool 13 and are expected to continue to negatively affect the study area and limit the growth, expansion, and recovery of SAV. The future condition assumes water quality trends would continue to degrade with associated declines in aquatic vegetation.

2.4.8 Green House Gas Emissions and Climate Change

Existing greenhouse gas emissions are related to commercial and recreational use of the Mississippi River within the study area, as well as emissions from Clinton, IA and Fulton, IL.

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This includes emissions from recreational boating, fishing, and hunting. Commercial emissions within the study area come from barge traffic utilizing the 9-Foot Channel Project as well as dredging operations required to maintain access to the navigation channel. It is expected that these activities and their emissions will continue at their current rate under the FWOP conditions.

In terms of climate change, changes in the annual and long-term hydrologic cycles of the Mississippi River influence the study area. Two factors influencing hydrology in the vicinity of the study area include (1) snowmelt and precipitation events throughout the Upper Midwest, which includes the portions of the Mississippi River above Clinton, Iowa, and the entire watershed; and (2) local and regional precipitation. In general, there is a seasonal pattern to the river's hydrology with peak flows typically occurring in the spring and early summer associated with rain and snowmelt followed by declining flows from early summer through early fall. Regional summary reports prepared by USACE in 2015 indicate increasing trends in observed air temperature, significant increasing trends in total annual precipitation, and an upward trend in mean, low, and peak streamflow in the Upper Mississippi River Basin region (USACE, 2015). Changes in hydrology (e.g., wet vs. dry periods) ultimately influence what floodplain habitats establish and are able to persist.

Available literature suggests the following future conditions near the study area:

- Warmer temperatures and heat waves of longer duration
- Increases in total precipitation and magnitude of extreme precipitation events
- Increases in severity, length, and frequency of droughts
- Potential increases in spring and winter streamflow and decreases in summer streamflow

USACE online tools (https://maps.crrel.usace.army.mil/projects/rcc/portal.html) found the following near the study area:

- A substantial increase in annual maximum monthly stream flow over time has not been observed or predicted.
- A significant increase in the maximum number of consecutive days that a moderate (5-year) flood water surface elevation is exceeded each year has not been observed.
- A significant increase in peak annual discharge has been observed.
- Regarding ecosystem restoration, the HUC 04 watershed at this location is relatively less vulnerable to climate change compared to the other 202 HUC 04 watersheds in the Continental United States.

For additional details on the climate change analysis completed for this study please see Appendix E, *Engineering*, Attachment A, *Hydrology and Hydraulics*.

2.4.9 Hazardous, Toxic, and Radioactive Waste

The PDT completed a Phase I Environmental Site Assessment (ESA) was completed in the spring of 2022 for the study area and adjacent area. The Phase I ESA documented the study area history, reviewed state and Federal environmental databases, and identified potential Recognized Environmental Conditions (RECs). Information is provided in Appendix E, *Engineering*, Attachment H, *Hazardous Toxic and Radioactive Waste Documentation* report.

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There is one Historic REC present near the study area. This area of the Historic REC has been designated as a No Work Zone in regard to HREP measures, and therefore no construction activities will occur there. No other RECs, real or potential HTRW issues are present in the study area.

HTRW and RECs near the study area are not anticipated to change under FWOP conditions.

2.5 Human Environment

2.5.1 Air Quality

The U.S. Environmental Protection Agency (USEPA) is responsible for implementation of the Clean Air Act (CAA). Under authority of the CAA, the USEPA established National Ambient Air Quality Standards (NAAQS) for the following criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), inhalable particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), fine particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and sulfur dioxide (SO_2). When and area meets established criteria for each of the six NAAQS pollutants it is called an attainment area. Areas that do not meet the criteria are called non-attainment areas, and areas recovering from non-attainment status are called maintenance areas.

Established under the CAA (42 USC section 176(c)(4)), the general conformity rule (40 C.F.R. §§ 93.150–93.165) ensures that Federal actions comply with NAAQS. In order to meet this CAA requirement, a federal agency must demonstrate that every action that it undertakes, approves, permits or supports would conform to the appropriate State Implementation Plan. To do so, the Federal agency must determine either that the action is exempt from general conformity regulations or make a conformity determination consistent with the general conformity requirements. A conformity determination is not required in attainment areas.

Clinton County in Iowa and Carroll and Whiteside Counties in Illinois are all classified as attainment areas for each of the six USEPA listed contaminants and therefore a conformity determination is not required (USEPA, 2019). These classifications are not expected to change under the FWOP conditions.

2.5.2 Cultural Resources

Historic properties are integral, nonrenewable elements of the physical landscape and a major component of the Upper Mississippi River valley. Collectively, the archaeological record indicates continual human occupation within the Pool 13 locality for approximately 13,000 years, after glaciers receded making the area habitable for people. The sequence of archaeological and historic contexts includes Paleo, Archaic, Woodland, Mississippian/Plains Village, Oneota, Historic Native American, and Historic Euro-American.

The USACE took the following steps to identify historic properties pursuant to 36 CFR 800.4:

- background research consisting of reviewing available archaeological and geomorphological investigations within Pool 13,
- reviewing geodatabase information including shipwrecks within Pool 13, and

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- reviewing historic aerial imagery and maps of the Study Area, and
- consulting with the Iowa I-Sites Online Geospatial Information System (GIS) and Geodatabase and Illinois Inventory of Archaeological Sites database.

Limited previous investigations have been completed within the Study Area including those completed for USACE developed picnic and boating areas. After completing background research, no historic properties were identified in the Study Area; however, the USACE determined a field investigation was needed to consider potential effects to historic properties. Identification efforts will also include consultation with the Iowa and Illinois State Historic Preservation Offices (SHPO) and Tribal Historic Preservation Offices of Ho-Chunk Nation of Wisconsin, Kickapoo Tribe of Oklahoma, Miami Tribe of Oklahoma, Osage Nation, Sac and Fox Nation of Missouri in Kansas and Nebraska, Sac and Fox Nation, Oklahoma, Sac and Fox Nation of the Mississippi in Iowa, and Winnebago Tribe.

For more detailed information regarding Cultural Resources within the Study Area see Appendix A, *Environmental*.

2.5.3 Socioeconomic Resources

The study area includes portions of Clinton County, Iowa, as well as parts of Carroll and Whiteside Counties, Illinois. Population statistics are shown in Table 3. The largest racial/ethnic group across the three counties is White, ranging from 84-93% of the population. The next largest racial/ethnic group is Hispanic or Latino which represents as much as 12% of the population (Whiteside Co, IL) to as little as 3% (Carroll Co, IL and Clinton Co, IA). Those who identify as Black or African American make up between 1% and 3% of the population of these counties (US Census, 2010).

Table 3. Population Data, Median Income, and Precent Below Poverty Level for the Three Counties within the Study Area (US Census Bureau, 2021)

County	Population (2010 Census)	Population (2020 Census)	Median Income ($)	Poverty
Clinton (IA)	49,116	46,460	52,221	12.5%
Carroll (IL)	15,387	15,702	52,813	10.5%
Whiteside (IL)	58,498	55,691	57,172	9.1%

Populations within the three counties surrounding the study area have remained stable or declined over the last decade. Over the next 50 years, these trends are expected to continue. No significant changes to the demographics of the area are expected under the FWOP conditions.

2.5.4 Environmental Justice

Environmental justice (EJ) is defined as 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, with no group bearing a disproportionate burden of environmental harms and risks. The study area was evaluated using the EPA's Environmental Justice Screening and Mapping Tool (EJSCREEN) (USEPA, 2022) and the Council of Environmental Quality's Climate and Economic Justice

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Screen Tool (beta version) (CEQ, 2022). The EJSCREEN tool identified a 7% value for communities of color in the affected area which is lower than the 50% threshold and not meaningfully greater than the general population in the affected area. The EJSCREEN tool identified a low-income population to the south of the study area near Lyons, Iowa. The CEQ beta tool did not identify disadvantaged communities. As stated in Section 2.5.3 above, the demographics of the area are not expected to significantly change under the FWOP conditions. Changes to environmental laws, regulations, and policies are not expected under the FWOP. See Appendix B, *Economic and Social Considerations*, for EJ analysis.

2.5.5 Noise Levels

The study area is located on the Upper Mississippi River NWFR, resulting in few sources of noise. Train traffic represents the most significant source of noise in the study area, followed by boat traffic, both from recreational boaters as well as barges utilizing the 9-Foot Channel Project. No changes to noise are anticipated under the FWOP conditions.

2.5.6 Recreation and Aesthetics

The Upper Mississippi River Valley has long served as a source of recreational opportunity with its scenic environment, fish, wildlife, water resources, and temperate climate. Endowed with the basic requirements for outdoor activities, the 9-foot Channel Project has further enhanced the recreational potential of the area. No longer do periods of drought reduce river stages to the point where navigation becomes hazardous or impossible, and the relatively stable pools created by the project provide large water areas for water skiing, fishing, and other water-related activities. Numerous marinas and boat-launching facilities, situated along the shores of the pools, make recreational boating safer and more pleasurable.

The natural character the study area within the NWFR contributes to its recreational and aesthetic desirability. Substantial Federal land is available in Pool 13 and the vast majority of it is managed for fish and wildlife as part of the Upper Mississippi River NWFR. As a result, the stopover habitat and food that Pool 13 provides for migrating waterfowl make it a destination for hunters and birdwatchers alike. A culture of both recreational and commercial fishing continues in the communities near the study area in both Iowa and Illinois. With public boat launches, picnic sites, playgrounds, trails, and campgrounds nearby many residents and visitors engage in popular recreational activities including camping, fishing, hunting, boating, swimming, and picnicking (Figure 14).

2.5.6.1 *High Density Recreation*

The Thomson Causeway Recreation Area is located at the intersection of Main Street and Lewis Avenue in Thomson, IL, and is adjacent to Potters Marsh Wildlife Area. Thomson Causeway Recreation Area covers approximately 245 acres and features a campground with a total of 131 designated camping sites. The sites amenities include a fire ring, picnic table, and shared water hydrant. The campground also consists of paved roads throughout the park, a three-land sewer dump station for recreational vehicle campers, an additional walk-up dump station, three shower buildings with flushable toilets, two sets of vault toilets, three playgrounds, horseshoe pits, three reservable picnic shelters, a gravel boat ramp with access to the main channel and backwaters and the Hidden Slough Nature Trail offers a ¾ mile hike through bottom land forest. The campground and boat ramp are open to paying campers from May 1

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through the fourth Sunday in October. The boat ramp is open to the general public with no fee starting on the Monday following the fourth Sunday in October through April 30.

2.5.6.2 *Low Density Recreation*

The Bulger's Hollow Recreation Area covers approximately 14 acres and is located 5 miles north of Clinton, IA. The campground has 26 first-come, first-serve campsites comprised of 17 RV sites and 9 tent camping sites. Facilities include a playground, sewer dump station, paved boat ramp, gravel parking lot, drinking water, picnic tables, picnic shelter campfire rings and vault toilets. There is no electrical service or flush toilets. The area is monitored by a volunteer campground host who assists campers with the self-registration process and is available to answer visitor questions. The campground is open year-round with fee dates of May 15 through October 15.

No changes to established recreation sites are anticipated under FWOP conditions. USACE will continue to operate and manage both high and low-density recreation in and near the study area. However, as aquatic and floodplain forest habitat continue to degrade, visitation to these recreation sites is anticipated to decline. Boating, fishing, hunting, and camping are all dependent upon the natural resources and aesthetics of the region. Declines in waterfowl use of Pool 13 will result in fewer hunters, and loss of mature floodplain forest will cause declines in migratory bird populations, resulting in fewer bird watchers using the area.

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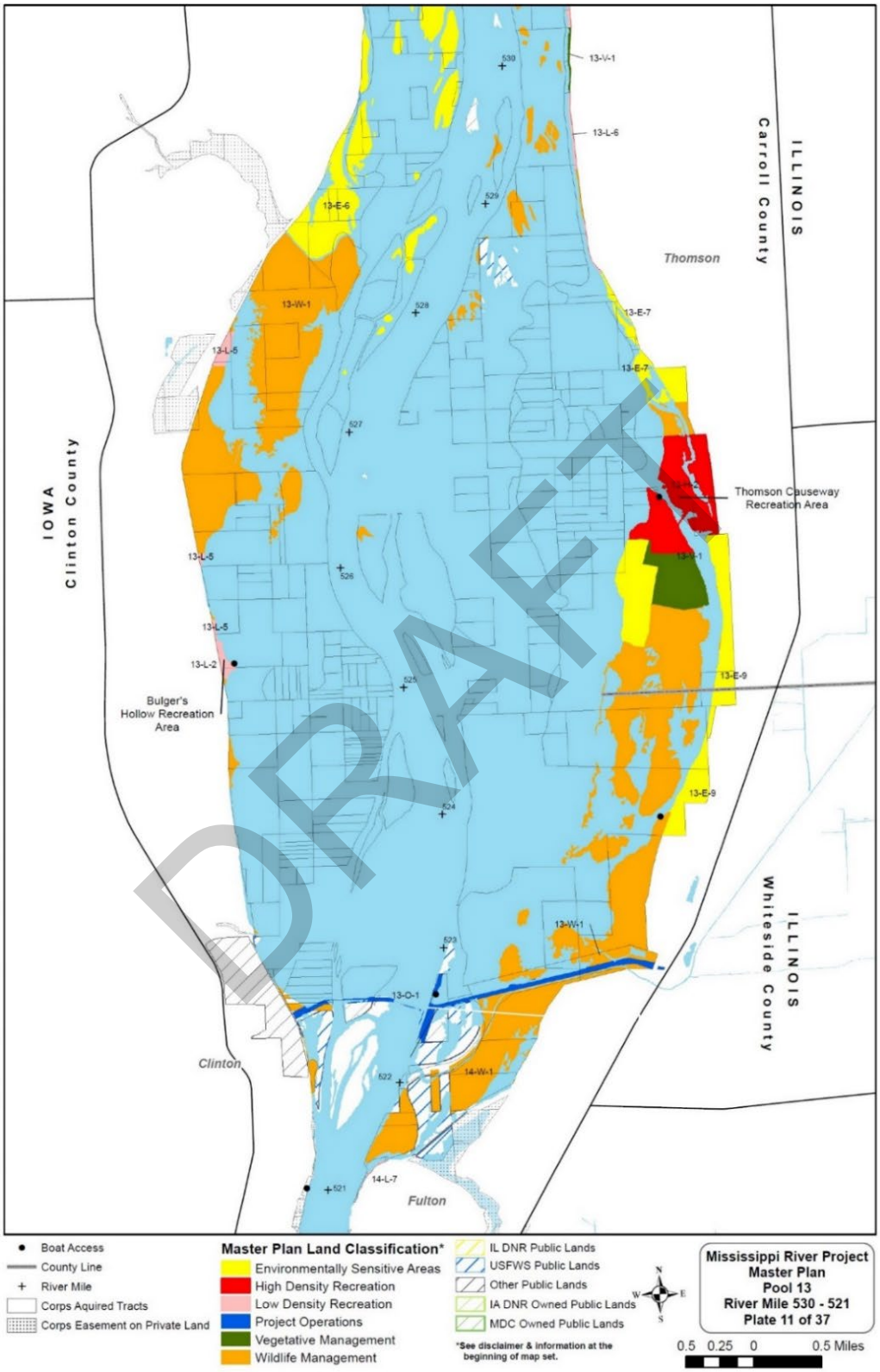

Figure 14. Existing Public Lands, Recreation Areas, and Access as Described in the Mississippi River Project Master Plan (USACE, 2022)

2.6 Summary of Future Without Project Condition

Estimated future habitat conditions for the study area without restoration and rehabilitation are based on observed and predicted changes over time for Pool 13 and the adjacent forested area. Aquatic resources would continue to be adversely affected by increased frequency and duration of flooding, wave action, increased velocities, and declines in water clarity. Wind resuspension of sediments, sediment load and the associated increased turbidity, coupled with high velocities within the pool, have led to reduced aquatic plant acreage and habitat quality for migrating waterfowl. As SAV acreage declines, the increase in turbidities and suboptimal velocities accelerates, indicating a form of feedback loops between SAV structure, water clarity, and flow. Current trends in Long Term Resource Monitoring (LTRM) vegetation data indicate a decline in SAV over the last 12 years (LTRM, 2022). Assuming current trends continue, SAV is likely to disappear entirely by the year 2055 if no action is taken.

Overall, the summarized forest management areas collectively have trees in the canopy that will not persist. The main consideration of concern is that there is limited or no adequate natural regeneration of trees to replace the expected mortality of trees in the canopy that are reaching expected maximum age of the most prevalent tree species. Invasive species will continue to degrade floodplain forest areas and mature trees will eventually die off affecting quality habitat.

3. PROBLEM IDENTIFICATION

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, was developed to guide the formulation and evaluation studies of major Federal water resources agencies. These principles and guidelines are commonly referred to as the “P&G,” and will be cited throughout the plan formulation sections of this study.

3.1 Factors Influencing Habitat Change

Impoundment, changes in land use, and climate are likely the main drivers affecting habitat change in the study area. Many of these factors have synergistic effects to the physical, chemical, and/or biological environment. These drivers are further detailed below.

3.1.1 Stressors and Driver Interactions

The major drivers of change in Lower Pool 13 (impoundment, changes in land use, and climate) manifest themselves through a number of distinct stressors within the study area. These stressors are specific, measurable effects caused by the overarching drivers and represent the problems that this study seeks to address. These specific stressors and their relation to the drivers are further detailed below and in the conceptual model (Figure 15).

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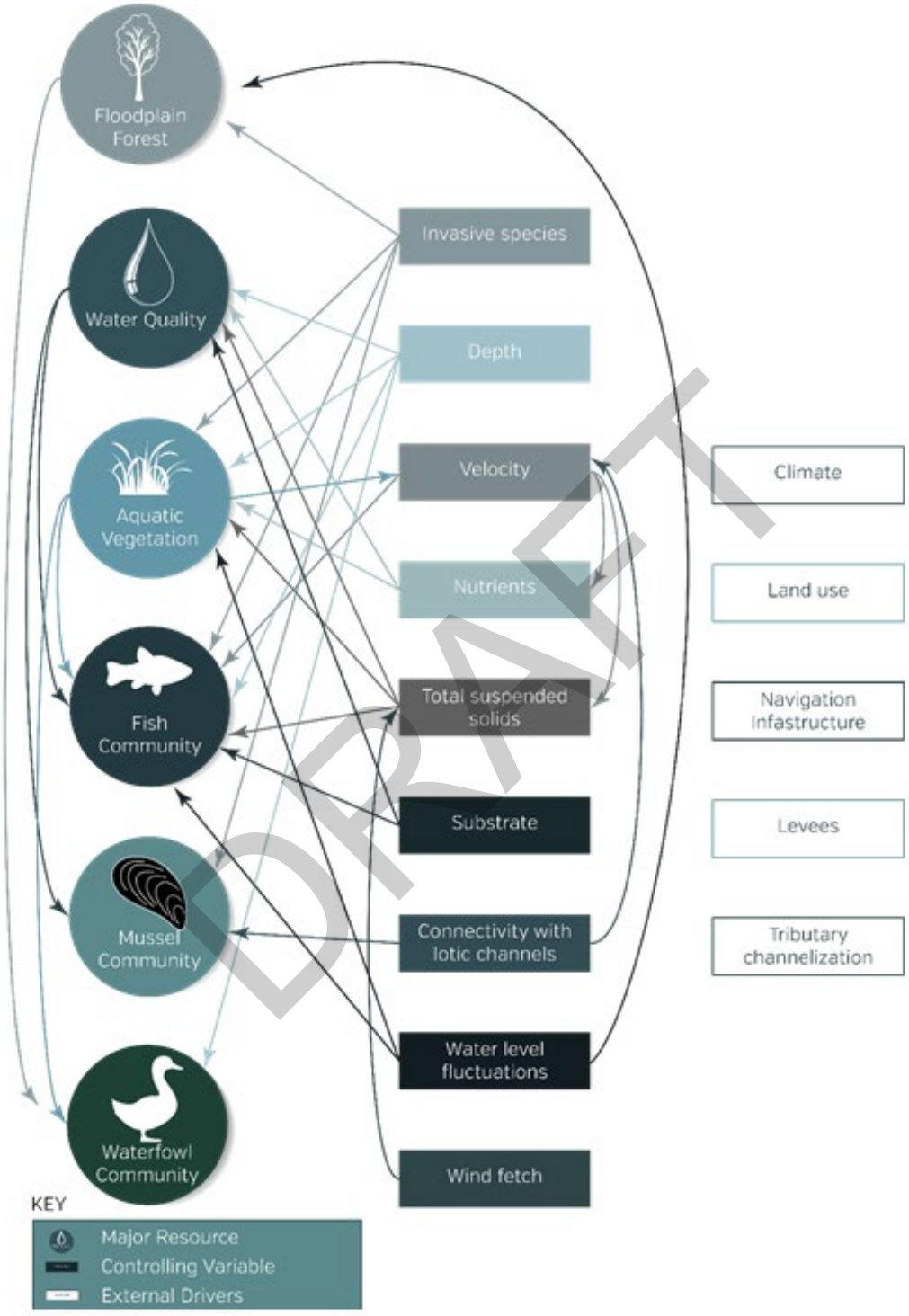

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Figure 15. Conceptual Model Illustrating the Relationships Between External Drivers, Their Controlling Variables, and the Major Resources in the Impounded Area of the Pool. Model was adapted from Bouska et al., 2018

3.1.2 Wind Fetch

The effects of impoundment have created a large, relatively shallow area immediately upstream of Lock and Dam 13 that lacks natural islands and wind breaks. This large fetch length runs across the pool allowing for the buildup of large wind-generated waves. In shallower areas, these waves possess enough energy to resuspend bottom sediment, thereby increasing turbidity, reducing light penetration, and negatively affecting the coverage and diversity of SAV.

3.1.3 Velocity

Historically, islands, sandbars, sloughs, and side channels provided a variety of depths and flows within the study area. Islands create more variable flows, particularly in the form of low-velocity zones upstream and downstream of the island and high-velocity areas lateral to the island. The areas of low velocity support multiple species of submerged and emergent aquatic vegetation, while higher flows provide suitable habitat for native fish and mussel species. Currently, the lack of islands and natural water level variation results in very little flow diversity in the impounded area of Pool 13.

3.1.4 Frequency & Duration of Flooding

Flooding attributes such as duration, frequency, depth and timing have been identified throughout the literature as being the primary drivers of floodplain forest ecology. Lack of tree regeneration, reduction of species diversity, and increased tree mortality can be directly attributed to the increase in flood frequency and duration over time and higher water tables. These losses in habitat value limit the present and future ability of the study area to attract and sustain a diverse community of resident and migratory wildlife species.

3.2 Interactions and Feedback Loops

As Figure 15 illustrates, interactions between stressors and resources are abundant. For example, elevated velocities can prevent the establishment of SAV, and even actively erode existing beds of vegetation (Chambers *et. al.,* 1991). Alternatively, large areas of aquatic vegetation impact water velocities, slowing flows and allowing vegetation to colonize new areas (Cornacchia, *et. al*., 2020). As vegetation declines, it no longer slows velocities in that immediate area, resulting in increasing velocities and accelerated degradation of vegetation. Similar interactions have been observed with wind-driven waves and the resuspension of sediment. Vegetated areas tend to not only slow velocities, but also reduce wave energy, thereby reducing the probability that sediment is resuspended and maintaining water clarity (Lan, 2020; Koch, 2001). As vegetation declines, less of the area is protected from wind-driven waves, allowing waves to resuspend sediment, reduce water clarity, and further stress the existing vegetation. While these close-knit interactions cause major problems for the persistence of aquatic vegetation, they provide a unique opportunity to increase the impact of restoration measures in the study area. By protecting core areas of aquatic vegetation from decline, features can impact a much larger potential area of influence via the feedback loops between vegetation, velocity, and wind-driven waves.

A similar feedback system exists within the floodplain forest of the study area. Existing canopy

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gaps throughout much of the study area are inundated with invasive species. Invasives such as reed canary grass require full sunlight in order to thrive and tend to dominate these large openings in the forest. As large, mature trees reach the end of their lifespan, they are often susceptible to blow-down during high wind events, leaving a newly created opening in the canopy. Invasive plant species are often quick to colonize these new areas, preventing natural regeneration of native tree species. As more mature trees die off, invasive species presence increases, further reducing natural recruitment and causing a transition to an open system that lacks an overstory layer.

3.3 Problems and Opportunities Identification

Sections 3.3, 3.4, and 3.5 describe the development of study objectives and constraints, including the identification of problems and opportunities, goals and/or recommendations of overarching or related programs, all of which are directly related to and support study objectives, and resource significance of the study area.

Problem 1. Submerged Aquatic Vegetation. The degradation process of SAV is highly complex, and several affecting factors are often interlinked. Processes such as suboptimal velocities and poor water clarity caused by open water, upstream suspended sediment load, and resuspension of bottom sediments due to wind driven wave action are known to negatively affects aquatic vegetation. Assuming current trends continue, SAV is likely to disappear entirely by the year 2055 if no action is taken. The loss of SAV would negatively affect the resident and migratory bird species that depend on SAV for food. Additionally, the loss of SAV would reduce available fish habitat, increase the amount of wave action that erodes shorelines, increase turbidity in the river, and increase the amount nutrients in the system that would have otherwise been absorbed.

Opportunity. There is an opportunity to improve water clarity, reduce re-suspension of sediments, and improve velocity conditions for subaquatic vegetation (SAV) growth. Increasing the abundance and coverage of aquatic vegetation improves nursery areas for fish and waterfowl food resources. There is an opportunity to improve flow diversity and substrate for mussel habitat. There is also an opportunity for beneficial use of dredged material to enhance and restore islands and other terrestrial landforms which provide important habitat for migratory birds and other wildlife.

Problem 2. Floodplain Forest. The entire UMRS has undergone dramatic changes in the extent, composition, and structure of its floodplain forests over the last 80 years. Reduced native tree recruitment, reduction of species diversity, and increased tree mortality can be directly attributed to the increase in flood frequency and duration and higher water tables. Based on the forest inventory, if current trends continue, the floodplain forested areas in the study area will likely be overtaken by invasive species within the period of analysis. The loss of forested floodplain would negatively impact the local and migratory species that utilize the forested floodplain as a food source and travel corridors.

Opportunity. There is an opportunity to restore and enhance the age distribution, species richness and structure of the current floodplain forest habitat in the study area. Floodplain forests are essential life support systems to a tremendous array of wildlife species. Improving floodplain forest habitat in the study area improves stop-over habitat for neotropical migratory birds, improves breeding habitat for resident birds, improves maternity and roosting habitat for

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bats, increases pollinator habitat, and increases forest resiliency.

3.4 Goals and Objectives

The study area lies within the Upper Mississippi River NWFR; therefore, NWFR management goals and objectives were used to inform the development of the goals and specific project objectives. Study goals and objectives were developed considering the problems affecting the study area's natural resources, UMRR program ecosystem objectives for the reach (USACE, 2009), broad goals and objectives identified in the UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS, 2006), and the identification of UMR National Wildlife and Fish Refuge Priority Resources of Concern (USFWS, 2019) relevant to the study area. Item 6 of Appendix D, *Coordination and Public Involvement*, provides additional information about the legislation, policy, and foundational planning documents that allowed the UMR NWFR, the federal sponsor, to fully support the project. The study goals are:

- Improve water clarity to maintain and enhance SAV benefitting migratory waterfowl and other associated fish and wildlife species, and
- Improve diversity and abundance of floodplain forest resources benefitting resident and migratory bird and bat communities.

The following study objectives were developed based on the study area problems, opportunities, and goals, as well as the Federal objective and regulations (Table 4):

1. Restore and enhance SAV coverage in the study area over the period of analysis; and
2. Restore and enhance coverage, species richness, and age distribution of the forest community in the study area over the period of analysis.

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Table 4. Summary of Study Area Problems, Opportunities, NWFR Priorities, and Goals and Objectives

Study Objective	Problems, Effects, and Opportunities	Study Goals	NWFR Priority Alignment
1. Restore and enhance SAV coverage over the period of analysis.	**Problem Statement: SAV** Processes such as suboptimal velocities and poor water clarity caused by upstream suspended sediment load and resuspension of bottom sediments due to wind driven wave action, negatively affects aquatic vegetation. **Effects of Problem:** Reduced abundance and coverage of aquatic vegetation. **Project Opportunities** • Reduce re-suspension of sediments. • Improve water clarity. • Improve velocity conditions for SAV • Increased abundance and coverage of aquatic vegetation • Increased waterfowl food resources. • Increased fish nursery habitat. • Flow diversity for mussel habitat • Mussel habitat/substrate improvements • Protect and enhance islands and other terrestrial landforms	**UMMR Reach Goals** • Manage for a more natural hydrologic regime • Manage for processes that input, transport, assimilate, and output material within UMR basin river floodplains • Manage for processes that shape a physically diverse and dynamic river floodplain system • Manage for a diverse and dynamic pattern of habitats to support native biota • Manage for viable populations for native species within diverse plant and animal communities **Study Goal** Improve water clarity to maintain and enhance aquatic vegetation, benefitting migratory waterfowl communities.	**NWFR Priority Habitats:** • Lentic backwater lakes and impounded areas • Lotic main channel border, secondary channel & tertiary channel • Marsh **NWFR Priority Resources of Concern:** • Canvasback and scaup • Dabbling duck guild • Tundra swan • Secretive marsh birds • Native fish and mussels

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Study Objective	Problems, Effects, and Opportunities	Study Goals	NWFR Priority Alignment
2. Restore and enhance coverage, species richness, and age distribution of the forest community over the period of analysis.	**Problem Statement: Floodplain Forest** Pattern of increased flooding has resulted in reduced recruitment of native tree species and an increase in prevalence of invasive species. **Effects of Problem:** • Reduced quality and quantity of forest • Loss of forest resiliency • Reduced acreage, diversity, and age structure of floodplain forest **Project Opportunities** • Stop-over habitat for neotropical migratory birds • Breeding habitat for Prothonotary and Cerulean Warbler, and Red-Shouldered Hawk • Maternity and roosting habitat for bats • Breeding and foraging habitat for waterfowl • Increase forest resiliency • Increase pollinator habitat	**UMMR Reach Goals** • Manage for a more natural hydrologic regime • Manage for processes that input, transport, assimilate, and output material within UMR basin river floodplains • Manage for processes that shape a physically diverse and dynamic river floodplain system • Manage for a diverse and dynamic pattern of habitats to support native biota • Manage for viable populations for native species within diverse plant and animal communities **Study Goal** Improve diversity and abundance of floodplain forest resources benefitting resident and migratory bird and bat communities.	**NWFR Priority Habitats:** • Bottomland Forest **NWFR Priority Resources of Concern:** • Transient Neotropical migrant passerines • Prothonotary and Cerulean Warbler • Red-Shouldered Hawk • Tree Roosting bats • Dabbling duck guild • Midwestern wooded swamp and floodplains

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3.5 Constraints and Considerations

Planning constraints are temporary or permanent limits imposed on the scope of the planning process and the choice of solutions. These limits can be related to the ecological, economic, engineering, legal, and administrative aspects of a project. Some constraints are states of nature, whereas others are based on the design of built structures and other engineering considerations. Legislation and decision makers can impose other constraints and such human-imposed constraints are possible to change. USACE established the following planning constraints to guide and set boundaries on the formulation and evaluation of alternatives.

The following constraints and considerations were included in plan formulation:

- **Navigation.** Ensure measures do not negatively impact the 9-foot Navigation Channel Project.

- **Flood Heights.** Restoration measures should not increase flood heights or adversely affect private property or infrastructure and align with state and local standards.

- **Environmental.** Construct measures consistent with Federal, state, and local laws. Compliance and coordination under NEPA require environmental impacts to be minimized and avoided to the extent practicable. This includes impacts to Federally Listed Threatened & Endangered Species. Additional constraints considered when analyzing alternatives are as follows:
    - Minimize impacts to Federal and state-listed threatened and endangered species, including the Higgins eye pearly-mussel found within the study area.
    - Avoid impacts to tree-roosting bat species by cutting trees outside of the roosting season (October 1-March 31)
    - Avoid impacts to adjacent tributaries.
    - Avoid and reduce disturbance to nesting bald eagles
    - Minimize waterbird and migratory bird impacts
    - Avoid impacts to colonial nesting bird species
    - Avoid adverse impacts to cultural resources
    - Avoid adverse social justice impacts
    - Avoid negative impacts to wetlands
    - Avoid Recognized Environmental Concern (REC) location as indicated in the HTRW Phase I ESA

Where feasible, restoration measures address USFWS NWFR priorities and reduce O&M to address limits of NWFR resources.

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4. FORMULATION OF PROJECT ALTERNATIVES

The USACE planning process, as well as NEPA, requires the USACE to evaluate a range of reasonable alternatives.

4.1 Management Measures

A management measure is a feature (such as a structural element that requires construction or assembly on-site) or an activity (a non-structural action) that can be combined with other management measures to form alternative plans.

Management measures were developed to address Project problems, meet study goals and objectives, and to capitalize on study area opportunities outlined in Section 3. Management measures were derived from a variety of sources including prior studies, existing projects, and the interdisciplinary team. These measures have been implemented successfully throughout the UMR and are based on the *Upper Mississippi River Restoration Program – Environmental Design Handbook* (December 2012) and lessons learned from other large river ecosystem restoration projects including those designed and constructed in the Upper Mississippi River Restoration program.

Table 5 presents the general measures that were considered for implementation of the Lower Pool 13 HREP. More details are available in Appendix E, Engineering. Features were sited based on multiple considerations and constraints as outlined in Appendix E, *Engineering*, Attachment B, *Civil and Environmental Engineering*.

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Table 5. General Measures Considered for Lower Pool 13 HREP

Aquatic Measures			
Type of Measure	**Representative Photograph**	**Description**	**Study Goal and Objective**
Chevron	 Beaver Island HREP. Source: USACE, 2019	Structure made of rock placed in river and pointing upstream (top elevations vary)	Deflect flow and promote SAV growth (Objective 1)
Rock mound	 Source: UMRR-EMP Environmental Design Handbook, 2012	Series of large rock placed in the river that are not constructed in a chevron shape	Deflect flow and promote SAV growth (Objective 1)

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Aquatic Measures			
Type of Measure	**Representative Photograph**	**Description**	**Study Goal and Objective**
Island construction	 Source: UMRR-EMP Environmental Design Handbook, 2012	Rock berm and land created in the river from dredged material	Rock berm reduces flow and creates a barrier to wind driven waves to promote SAV growth (Objective 1) and dredged material placement improves island habitat (Project opportunity)
Island Protection	 Huron Island HREP. Source: USACE, 2020	Material placed along island shoreline	Shield islands and habitat from eroding

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Aquatic Measures			
Type of Measure	**Representative Photograph**	**Description**	**Study Goal and Objective**
Excavation	 Beaver Island HREP. Source: USACE, 2021	Dredge cuts	Required for barge access to shallow areas to construct features such as chevrons or rock mounds. Material excavated could be used for beneficial purposes such as island construction
Closure structures	 Source: UMRR-EMP Environmental Design Handbook, 2012	Typically structures made of stone to close an area off from flow during certain conditions	Sediment and velocity reduction (Objective 1)

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Aquatic Measures			
Type of Measure	**Representative Photograph**	**Description**	**Study Goal and Objective**
Diversion berms	 Huron Island HREP. Source: USACE, 2020	Structures typically made of soil and rock to deflect sediment and reduce flows	Shoreline and SAV habitat protection
Forestry Measure			
Timber Stand Improvement	 Thinning Treatment, Beaver Island HREP. Source: USACE, 2021	Thinning, tree and shrub planting, and invasive species removal (non-structural)	Manages existing forestry habitat to improve forest health and habitat quality (Objective 2)

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4.2 Screening of Measures

Measures were screened and eliminated throughout the plan formulation process based on the Principles and Guidelines criteria.

- Completeness: Extent to which the measure provides and accounts for all necessary investments or actions to ensure realization of the planning objectives.
- Effectiveness: Extent to which the measure contributes to achieving the planning objectives.
- Efficiency: Extent to which the measure is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment.
- Acceptability: Workability and viability of the alternative plan with respect to acceptance by Federal and non-Federal entities and the public, and compatibility with existing laws, regulations and public policies.

Non-structural measures were considered but not selected for alternative formulation because they were found to be incomplete, ineffective, or not within the scope of the project. Four measures were initially identified but not retained for further consideration:

- Excavation – measure was screened due to effectiveness at meeting study objectives in the re-scoped study area.
- Closure structures – measure was screened due to effectiveness at meeting study objectives. Closure structures would not be effective in the re-scoped study area.
- Diversion berm – measure was screened due to not being efficient at meeting study objectives. Ten different diversion berms were initially considered but were screened because other measures were prioritized, berms evolved into other measures, constructability, and cost concerns, and would be efficient in the re-scoped study area.
- Island protection – protection of existing island shoreline was considered but screened due to not being efficient at meeting study objectives. Specifically, island erosion analysis, site visit observations, data research and re-scoping and prioritization efforts screened island protection features. If site conditions change these islands could be evaluated in the future.

The measures carried forward for alternative formulation included:

- Chevrons (CV)
- Rock mounds (RM)
- Island construction (I)
- Timber stand improvements (TSI)

Note that access dredging is necessary for the construction of the chevrons, rock mounds, and island construction. Three placement sites (Cormorant Island, Gomer's Island, and Woodruff Island) were identified for beneficial use of the dredged material. The material would be used to create island habitat for colonial nesting birds.

Measures were sited to provide optimum conditions for SAV including reducing velocities during

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the growing season and providing wave breaks to reduce the resuspension of sediments. Locations were based on numerous considerations including:

- Sponsor Recommendations
- Site visits
- Water Depths
- Water Quality Monitoring Data (LTRM and USACE)
- Sediment Sources
- Vegetation Monitoring
- Habitat Suitability Index
- Velocity
- Wind Wave Modeling
- Sediment Evaluations
- Canvasback Use Area
- Mussel Surveys
- Aerial Photography and Mapping
- Navigation Impacts
- Access Dredging
- Recreational Boating Impacts
- Floodplain Impacts
- Hazardous, Toxic and Radioactive Waste
- Real Estate Boundaries.

The USACE used best professional judgement in developing silvicultural prescriptions. The study area was evaluated and a reconnaissance survey was completed in two areas where TSI would be most effective. Potential measures were developed in the context of:

- the most suitable forest community type,
- the development stage of the forest,
- the degrading elements causing risk to maintaining forest diversity, resilience, and growth, and
- the desired managed condition for wildlife habitat needs of a particular area.

Timber stand improvements include a thinning treatment to achieve a forest growth response to meet desirable forest health, diversity, and resilience best suited for that area based on current environmental and forest conditions. Silvicultural prescriptions include containerized trees and/or shrubs, or willow cuttings for planting efforts to achieve forest growth response and invasive species treatment. Additional information is included in Appendix E, *Engineering*, Attachment B, *Civil and Environmental Engineering.*

4.3 Formulation of Alternatives

Alternatives are combinations of measures that would contribute to the planning objectives. In general, a measure may stand alone as an alternative that can be implemented independently or in combination with other measures.

For the Lower Pool 13 project, none of the measures under consideration were considered exclusive (could not be combined with other specific measures) or dependent (needed another measure to physically function).

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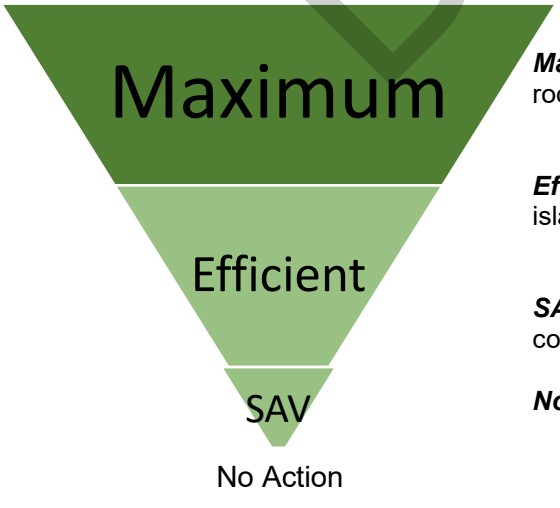
Because there were minimal types and locations of potential measures the strategy used to combine them into alternatives was to start with the ideal scenario, or the maximum alternative, and subtract measures in a meaningful way. The following is a list of all the alternatives considered:

1. No Action Alternative. This is defined as the alternative that no Federal action takes place.
2. Maximum Alternative. This strategy provides a set of measures recommended by subject matter experts that would create conditions promoting SAV growth and restore forest conditions to the greatest extent possible, given the current limitations of the site.
3. Efficient Alternative. This strategy takes the set of measures recommended from the maximum alternative and only carries forward measures that are expected to produce similar benefits for less cost by minimizing access dredging and reducing the quantity of rock needed to create the measure.
4. Maximize Submerged Aquatic Vegetation Alternative. This strategy focuses on only achieving the first objective of restoring submerged aquatic vegetation.

The Maximum, Efficient, and SAV alternatives (Figure 16) all include the creation of an island (I-H4). The Maximum alternative includes an additional chevron structure (CV-H10) than the Efficient and SAV alternatives. The Maximum alternative includes 10 rock mound structures which is one more structure than the SAV plan. The Efficient alternative was further reduced to eight rock mounds with one of the rock mounds (RM-H9A) smaller in size to cut down on costs. Reducing the amount of rock mounds also results in less access dredging which further reduced costs. The Maximum and Efficient Plans include TSI measures in the same two floodplain forest areas located in the northwest portion of the study area. The Maximum alternative has more suppressed tree cutting, more tree and shrub planting, more reed canary grass treatment, and an addition of herbaceous plant planting for improved benefits of pollinator species. The Efficient Alternative includes the base minimum requirement to correct the existing forest and achieve the project objective of restoring and enhancing coverage, species richness, and age distribution of the forest community. TSI is not part of the SAV focused alternative.



Maximum Alternative – greatest amount and extent of chevrons, rock mounds, island construction and timber stand improvements

Efficient Alternative – limited number of chevrons, rock mounds, island construction and timber stand improvement

SAV Alternative – chevrons, rock mounds, and island construction that would *only* achieve the SAV objective

No Action – no implementation of the project

Figure 16. Final Array of Alternatives Based on Extent of Proposed Federal Action

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Table 6 and Figure 17 display the measures (as described in Table 5) in the final array of alternatives.

Table 6. Features in the Final Array of Alternatives

MAXIMUM Plan	EFFICIENT Plan	SAV Plan
Island Creation	**Island Creation**	**Island Creation**
I-H4	I-H4	I-H4
Chevron	**Chevron**	**Chevron**
CV-H6	CV-H6	CV-H6
CV-H10		
Rock Mound	**Rock Mound**	**Rock Mound**
RM-H9A-MAX	RM-H9A-EFF	RM-H9A-MAX
RM-H9B	RM-H9B	RM-H9B
RM-H10	RM-H10	RM-H10
RM-H11	RM-H11	RM-H11
RM-H3A	RM-H3A	RM-H3A
RM-H3B	RM-H3B	RM-H3B
RM-H3C	RM-H3C	RM-H3C
RM-H6	RM-H6	RM-H6
RM-H7		RM-H7
RM-H12		
Forestry	**Forestry**	**Forestry**
TSI-H1-MAX	TSI-H1-EFF	
TSI-H2-MAX	TSI-H2-EFF	

I=Island Creation
CV=Chevron
RM=Rock Mound
TSI=Timber Stand Improvement
MAX=Maximum
EFF=Efficient

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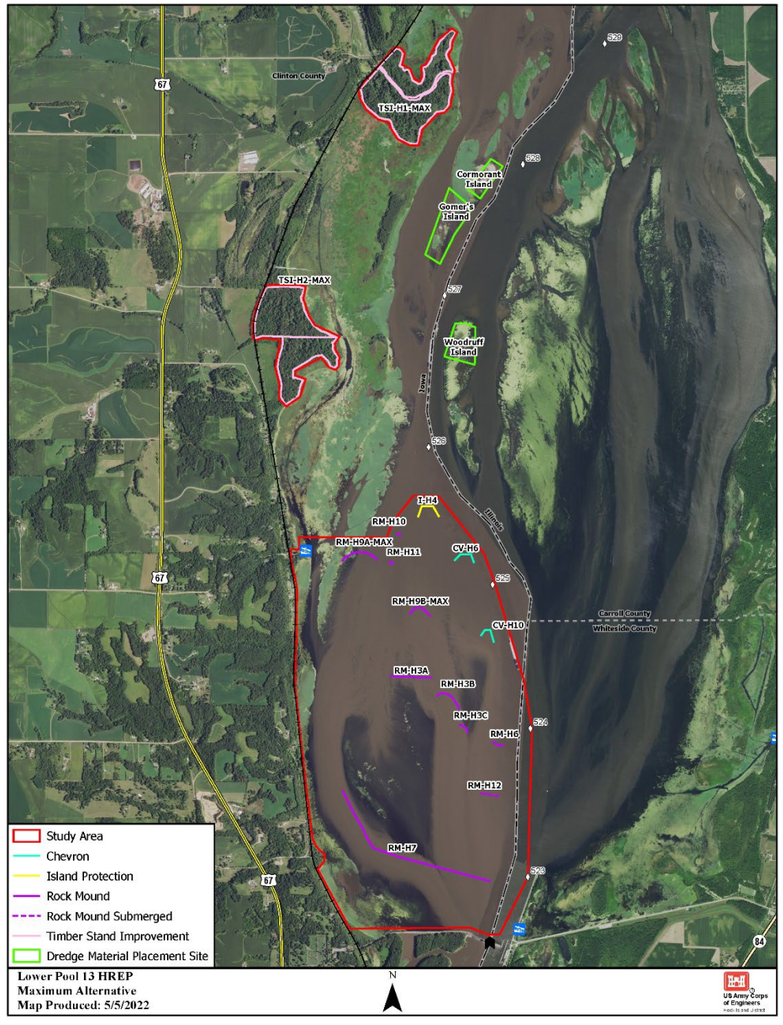

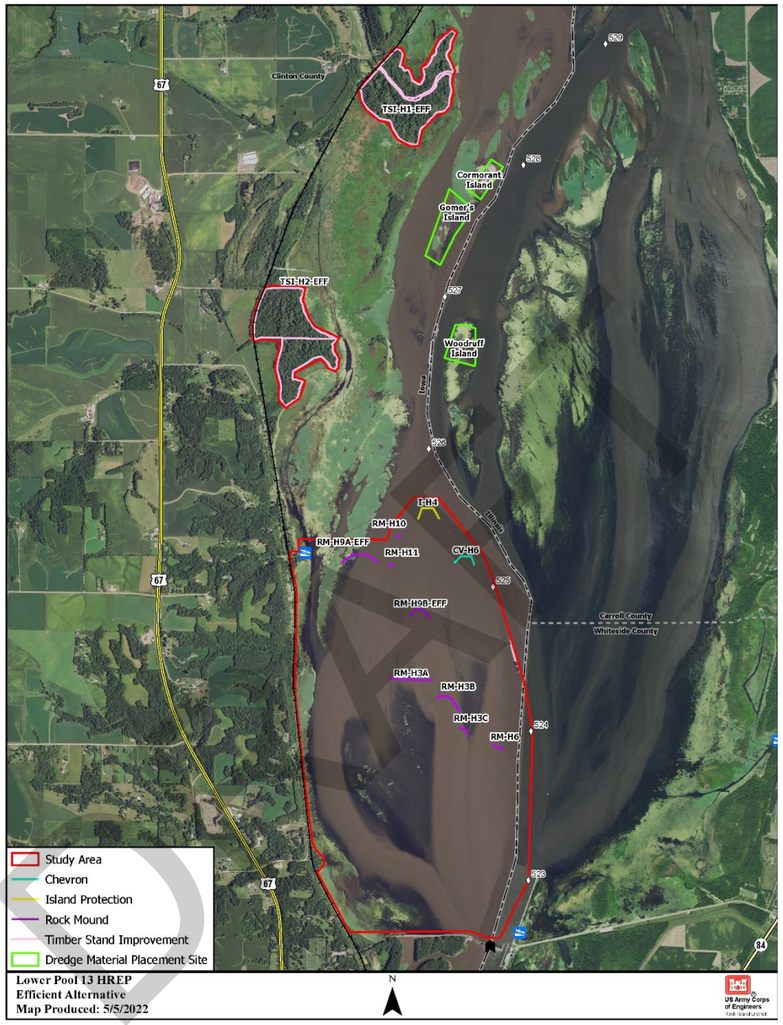

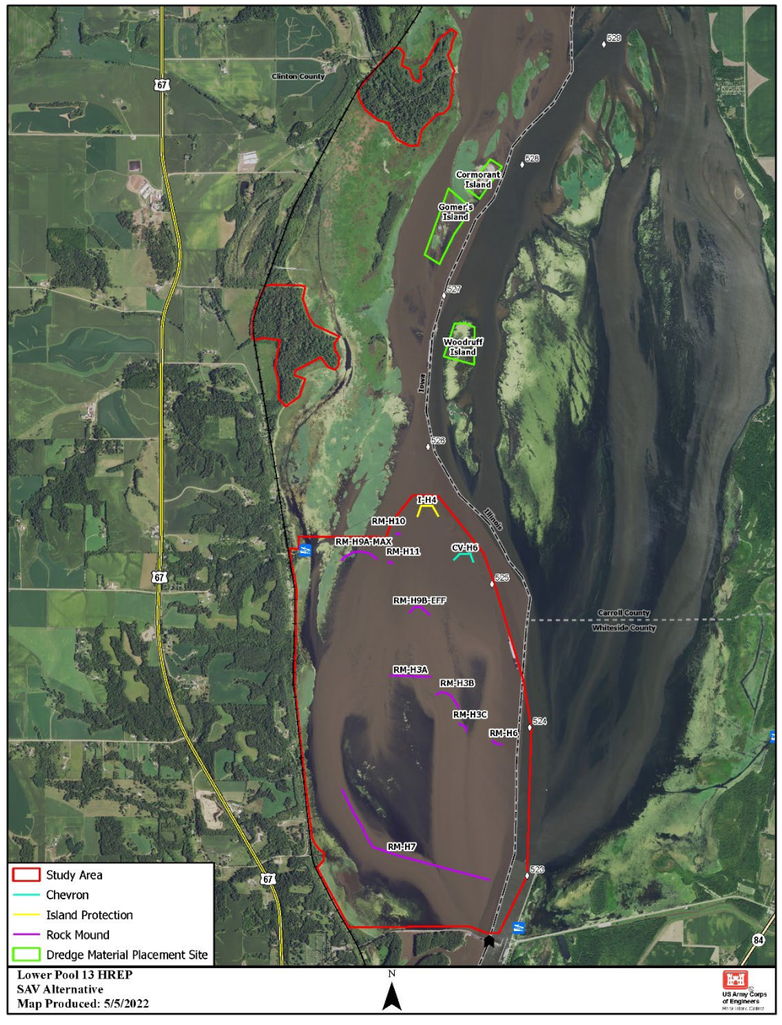

Figure 17. Maximum, Efficient, and SAV Alternatives (Final Array of Alternatives)

5. EVALUATION AND COMPARISON OF ALTERNATIVES

5.1 Evaluation of Alternatives

This section describes the alternatives that were evaluated. It also documents the process used to determine the environmental benefits and costs for each alternative. Finally, it compares the alternatives against each other to help determine the Tentatively Selected Plan.

5.1.1 Environmental Benefits Analysis

To quantify habitat benefits of the alternatives, the USFWS Habitat Evaluation Procedure (HEP) was used (U.S. Fish and Wildlife Service, 1980). The HEP methodology utilizes Habitat Suitability Index (HSI) models to rate the quality of habitat on a scale of 0 to 1 (1 being optimal). The HSI value is multiplied by the number of acres of available habitat to obtain Habitat Units (HU), the HSI and acreages are then projected into the future. One HU is equivalent to 1 acre of optimum habitat. HUs are then averaged annually across the Project's 50-year period of analysis, referred to as Average Annual Habitat Units (AAHU). By comparing the AAHUs of the No Action alternative to each of the action alternatives, the benefits can be quantified (net gain in AAHU). The base year (the year when a proposed project is expected to be operational or, in this case, when construction is complete and benefits begin accruing) considered for this study is 2033, and the period of analysis continued until 2082.

The HEP procedures were used to evaluate the effects of the proposed Project measures on aquatic and floodplain habitat quantity and quality. The PDT used two USACE-approved [per EC 1105-2-412] habitat evaluation methodologies in their analyses:

- Migratory Habitat Model for Diving Ducks in the Upper Mississippi River System (Devendorf, 1995) was used to assess the quality and quantity of aquatic vegetation available to diving duck species during their migration. Aquatic vegetation serves as a critical food source for these species, providing them with the energy necessary to migrate thousands of miles in the spring and fall.
- Floodplain Forest Model (USACE, 2021) was used to assess existing floodplain forest conditions as well as the expected changes under the proposed alternatives. This model was designed to assess all critical aspects of floodplain forest, including species composition, structural diversity, and invasive species prevalence.

Table 7 documents the net AAHUs for each alternative using the diving duck and floodplain forest models.

Table 7. Net Gain in AAHUs for All Alternatives

Alternative	Diving Duck Net AAHUs	Floodplain Forest Net AAHUs	Net Annual AAHUs
No Action	0	0	0
Maximum	625	184	809
Efficient	535	176	711
SAV Objective	625	0	625

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See Appendix A, *Environmental,* for a detailed discussion of the HEP analysis conducted for this project.

5.1.2 Cost Estimates

Table 8 provides a breakdown of costs for each alterative in the final array. The USACE planning team used parametric costs, or rough order of magnitude costs, at FY22 price levels to estimate costs for construction, monitoring and adaptive management (MAM), and Operations, Management, Repair, Rehabilitation, and Replacement (OMRRR). Standard percentages for Pre-construction Engineering & Design (PED) as well as Construction Management were used (Appendix F, *Cost Engineering*). An abbreviated risk analysis was performed to inform a contingency amount for each alternative and Interest During Construction (IDC) was calculated using base year 2033 and an eight-year construction schedule starting at the middle of the construction using the 2022 2.25% discount rate for all alternatives. The construction and OMRRR costs were annualized over a 50-year period utilizing the Fiscal Year (FY) 22 discount rate of 2.25%. No costs for lands, easement, right of ways, relocations or disposals were identified so were not included in Table 8.

Table 8. Final Array of Economic Cost. Costs are in thousands of dollars (FY 2022 Price Level – 50-year period of analysis using 2.25% discount rate and 8-year construction schedule)

Alternative	Project First Costs				IDC	Annualize Cost	Annualize OMRRR
	Construction	MAM	PED/S&A[1]	Contingency			
1 -No Action	$0	$0	$0	$0	$0	$0	$0
2-Maximum	$32,786	$2,418	$13,059	$23,166	$1,449	$2,470	$9
3-Efficient	$17,808	$1,314	$7,093	$12,583	$635	$1,337	$9
4-SAV	$28,579	$2,108	$11,383	$20,194	$1,140	$2,149	$3

[1] Construction Management is denoted as Supervision and Administration (S&A) costs

5.2 Comparison of Alternatives

5.2.1 Cost Effectiveness and Incremental Cost Analysis

To determine the National Ecosystem Restoration Plan (alternative that reasonably maximizes habitat benefits compared to cost), the average annual habitat units and annualized costs of the considered alternatives, including the No Action, were entered into the IWR-Planning Suite (Table 9), a water resources investment decision support tool for evaluation of actions involving monetary and non-monetary cost and benefits. The purpose of entering the data was to analyze the cost effectiveness of each alternative and perform an incremental cost analysis on the cost-effective alternatives. Cost-effective alternatives are plans that have the greatest benefit of all alternatives for that cost.

A secondary analysis on the subset of cost-effective alternatives identifies superior financial investments, called “Best Buys,” through analysis of incremental costs. Best Buys provide the greatest increase in AAHUs for the least increase in cost. The first Best Buy is the most efficient plan, producing benefits at the lowest incremental cost per unit. If a higher level of benefit is desired, then the next Best Buy is the most efficient plan for producing additional benefit.

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Table 9. Final Array of Alternatives Cost per AAHUs

Alternative	Net Annual AAHUs	Project First Cost	Annualized Cost	Cost Per AAHU
No Action	0	0	0	0
Maximum	809	$71,429,000	$2,479,000	$3,064
Efficient	711	$38,797,000	$1,346,000	$1,893
SAV Only	625	$62,264,000	$2,152,000	$3,443

Table 9 shows the considered alternatives and their cost per habitat unit. All but one alternative, Alternative 4, *SAV Only,* was considered cost effective. This is because more benefit, for less money can be achieved by Alternative 3, *Efficient Alternative*. Figure 18 shows the final array of alternatives differentiated by cost effectiveness. The remaining three alternatives were analyzed to determine which had the lowest incremental cost for each additional increment of output (Table 10).

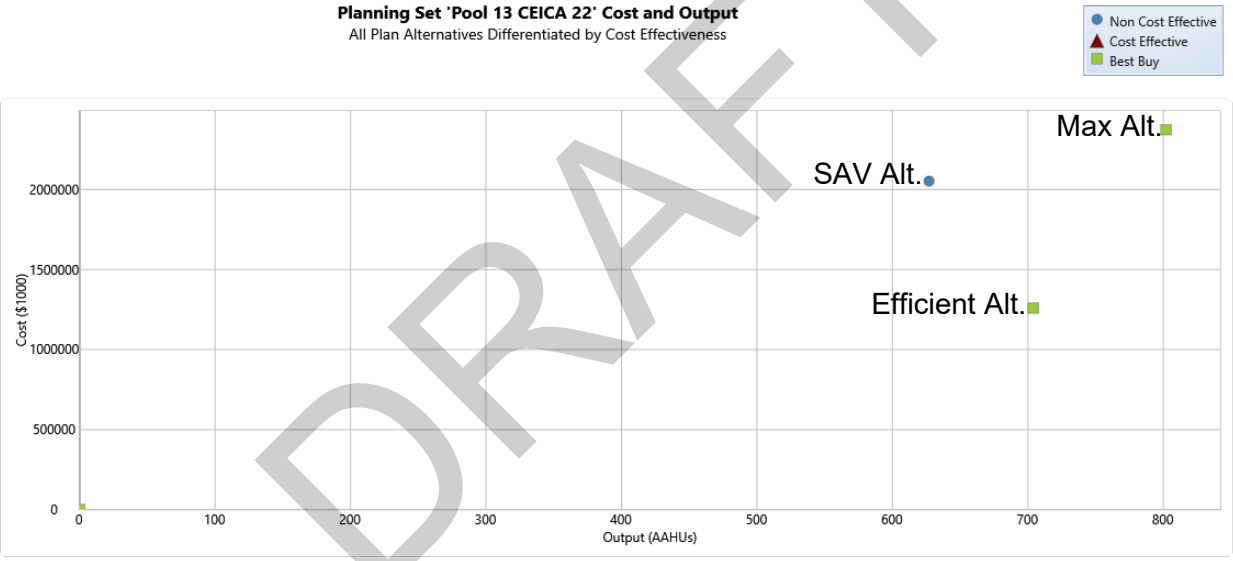

Figure 18. CEICA Plan Alternatives Differentiated by Cost Effectiveness

All three of the remaining alternatives were considered incrementally justified: No Action Plan, Alternative 2, *Maximum Alternative*, and Alternative 3, *Efficient Alternative*. Table 10 and Figure 19 present the best buy alternative's incremental cost and benefit information. The first Best Buy, No Action Plan, is the lowest incremental cost but produces no benefit. The next Best Buy is Alternative 3, *Efficient Alternative* which has a cost of $1,893 per average annual habitat unit, or an incremental cost increase of $1,346,000 for 711 habitat units. The next best buy above Alternative 3, *Efficient Alternative* is Alternative 2, *Maximum Alternative,* which has an incremental cost increase of $1,133,000 to achieve an additional 98 habitat units, or an incremental cost per habitat unit of $11,561.

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Table 10. Best Buy Alternatives Incremental Cost per Output

Alternative	Cost per AAHU	Incremental AAHUs	Incremental Cost Per AAHU
No Action	0	0	0
Efficient	$1,893	711	$1,893
Maximum	$3,064	98	$11,561

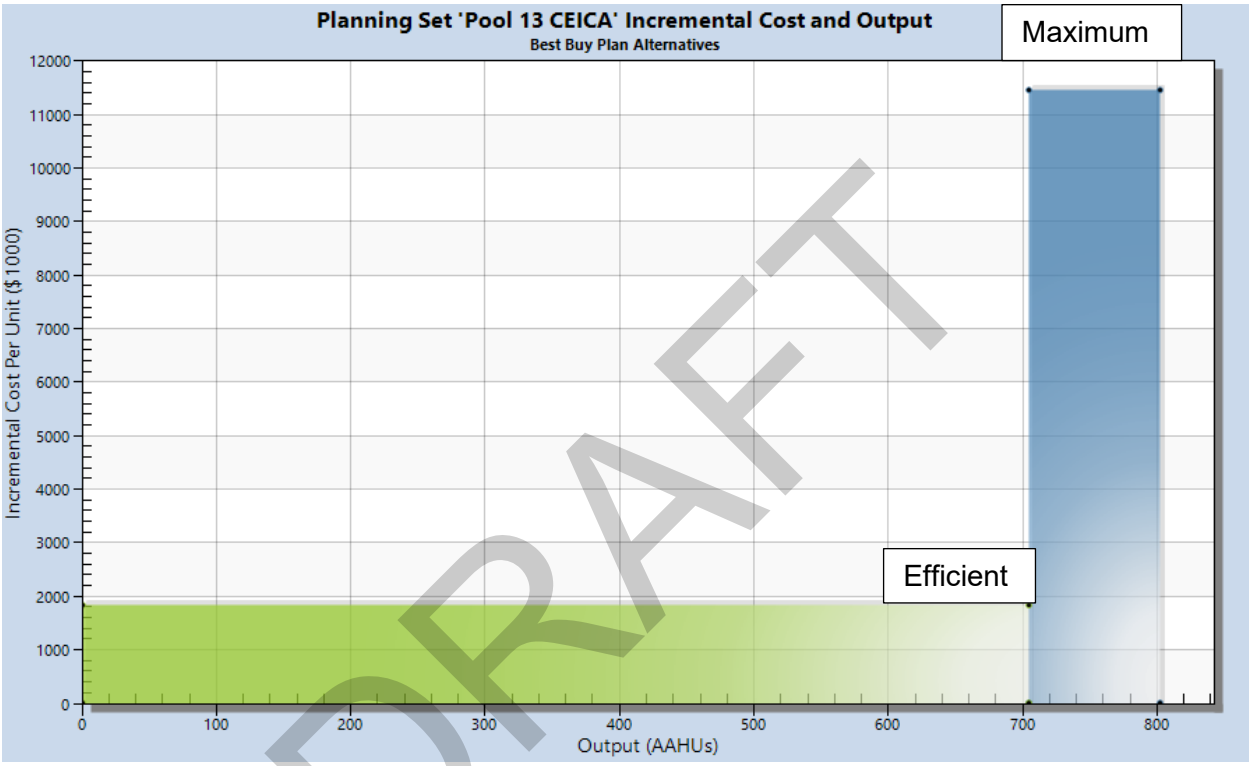

Figure 19. Incremental Cost and Output Results for the "Best Buy" Plans

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5.2.2 Principles and Guidelines (P&G) Criteria

Each alternative in the final array was independently evaluated by metrics for each of the USACE four screening criteria: Completeness, Effectiveness, Efficiency, and Acceptability. A score of "high" signifies the metric was met considerably, a score of "medium" denotes the metric was met moderately, and a score of "low" indicates the metric was minimally met, if at all.

- Completeness. No additional investments, or actions, needed by others to realize the benefits so all alternatives scored high.

- Effectiveness. All the alternatives in the final array provide some contribution to the study objectives.

  The effectiveness with which alternatives met Objective 1, Restore and enhance SAV coverage in the study area over the period of analysis, was measured by the increase in average annual aquatic habitat units achieved by each alternative. If the alternative

contributed over 500 AAHUs, it was given a high score, alternatives that contributed between 100-499 AAHUs were given a moderate score, and all other alternatives were given a low score. All alternatives contributed over 500 AAHUs and therefore all received a high score.

The effectiveness with which alternatives met Objective 2, Restore, and enhance coverage, species richness, and age distribution of the forest community in the study area over the period of analysis, was measured by the increase in average annual floodplain forest habitat units achieved by each alternative. Alternatives that produced over 500 floodplain habitat units were given a high score, alternatives that contributed from 100–499 habitat units were given a medium score, and all other alternatives were given a low score.

- Efficiency. All alternatives in the final array provide net benefits. Outputs from the IWR Planning Suite CE/ICA were used to identify efficient alternatives. Best Buy alternatives were given a high efficiency, cost effective alternatives were given a medium efficiency, and inefficient alternatives were given a low efficiency.

- Acceptability. All the alternatives in the final array are in accordance with Federal law and policy so all alternatives scored high.

5.2.3 Alternatives Ability to Maximize Opportunities

Alternatives were evaluated based on their ability to maximize beneficial use opportunities, reduce re-suspension of sediment, increase pollinator habitat, and improve water clarity in the Lower Pool 13 study area. These opportunities were first described in Section 3.4.

- No Action: This alternative results in no Federal investment. This alternative is the future without project and future conditions to maximize opportunities are low.

- Maximum Plan: This plan includes the most amount and extent of features and associated access dredging. With the largest amount of dredging, the beneficial use opportunity to enhance and create island habitat is high. The project features are designed to enhance SAV coverage which would reduce some re-suspension of sediment and improve some water clarity. The extent of these opportunities was ranked as moderate because modeling was not completed specifically to measure these opportunities.

- Efficient Plan: This plan has less dredging but would still capitalize on enhancing and creating island habitat, so this opportunity was ranked as high. The opportunity to reduce re-suspension of sediment and improve some water clarity are similar to the Maximum Plan and is also ranked as moderate.

- SAV Plan: In this plan, the features are similar in amount and extent to the Maximum Plan and therefore has the same rankings.

Table 11 summarizes the alternative comparison of P&G criteria, effectiveness of meeting project objectives, and maximization of opportunities.

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Table 11. Alternative Comparison of P&G Criteria, Effectiveness of Meeting Study Objectives, and Maximizing Opportunities

				Effective		Maximize Opportunities			
Alternative	**Acceptable**	**Complete**	**Efficient**	**SAV Objective**	**Forestry Objective**	**Beneficial use**	**Reduce Re-suspension**	**Water Clarity**	**Pollinator Habitat**
No Action	High	High	High	Low	Low	Low	Low	Low	Low
Maximum	High	High	High	High	High	High	Moderate	Moderate	High
Efficient	High	High	High	High	High	High	Moderate	Moderate	Moderate
SAV Only	High	High	Low	High	Low	High	Moderate	Moderate	Low

5.2.4 Alternatives Sensitivity to Climate Variability and Change

Since the alternatives are variations of similar features it was ascertained they would be equally affected by climate variability. Table 12 describes the potential risks of climate change to each measure.

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Table 12. Potential Climate Risks to Study Measures

Feature	Timber Stand Improvement Sites		Island, Chevrons, and Rock Mounds	
Trigger	Increased precipitation from larger, slower moving storms	Rising temperatures are anticipated to increase evapotranspiration rates and rates of soil moisture loss	Increased precipitation from larger, slower moving storms	
Hazard	Future flood volumes may be larger than present; large flood volumes may occur more frequently and with longer durations	Future droughts may be more frequent, more intense, and of larger areal extent	Future flood volumes may be larger than present; large flood volumes may occur more frequently and with longer durations	
Harm	Floods that inundate tree roots, particularly floods of longer duration lasting more than 40 days threaten quality and quantity of forest.	Droughts that limit tree roots' access to moisture, particularly droughts of longer duration lasting more than 40 days threaten quality and quantity of forest.	Flood flows create high velocities and high turbidity conditions that are not ideal for Vallisneria growth. Floods of long duration are anticipated to have a more substantial impact.	Flood flows create high velocities with the potential to increase scour at built features, within existing Vallisneria beds, and within sensitive no-work area.
Likelihood	Possible	Likely	Possible	Possible
Mitigation	By improving individual tree vigor and resilience to disturbance events, TSI efforts are likely to lessen the impacts of this hazard.	By improving individual tree vigor and resilience to disturbance events, TSI efforts are likely to lessen the impacts of this hazard.	By improving velocities and turbidity during non-flood periods, chevron and rock mound features are likely to improve the resiliency of Vallisneria and lessen the impacts of this hazard.	Post-TSP feasibility level of design analysis and PED analysis will adjust project features to ensure that they do not increase scour risk and compound climate impacts.

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5.2.5 Comprehensive Benefits

Engineering Regulation 1105-2-100, Planning Guidance Notebook (2000) established accounts to facilitate evaluation and display of effects of alternative plans: National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ) and Other Social Effects (OSE).

The **NED** account displays changes in economic value of the national output of goods and services.

The **RED** account registers changes in the distribution of regional economic activity.

The **EQ** account displays non-monetary effects on significant natural and cultural resources.

The **OSE** account registers effects from perspectives relevant to the planning process but are not reflected in the other three accounts.

In terms of NED effects of the alternatives, all action alternatives would have an economic cost to the nation to achieve the non-monetized environmental output of goods and services provided by the restoration of aquatic and floodplain forest habitats described in the report. While the non-monetized habitat benefits are captured in the EQ account, the NED effects are displayed as the annualized project cost and annualized projected OMRRR. A reduction in project cost is assumed to increase the National Economic Development to the nation therefore alternatives that are less than $1 million annually were considered to have a high NED effect, alternatives more than $1 million annually were considered to have a low NED effect.

Regarding RED, all action alternatives would have a positive impact on the regional economy. A USACE regional economic model, RECONS, was run for all alternatives and while the amount of regional benefits varied, the percentage of Federal expenditure to regional benefits were equivalent and not useful as criteria for comparison. The SAV Objective expenditures total $62,264,000 which supports approximately 620 full-time equivalent jobs, $34,000,000 in labor income, $33,000,000 in gross regional product, and $64,000,000 in economic output in the local impact area. The Maximum expenditures, $71,429,000 support approximately 746 full-time equivalent jobs, $41,000,000 in labor income, $40,000,000 in the gross regional product, and $77,000,000 in economic output in the local impact area. The Efficient expenditures, $38,797,000 support approximately 390 full-time equivalent jobs, $22,000,000 in labor income, $21,000,000 in the gross regional product, and $41,000,000 in economic output in the local impact area. For more information see Appendix B, *Economic and Social Considerations.*

Regarding EQ effects, it is anticipated that all alternatives would have a positive effect on ecological resources. Impacts to threatened and endangered species listed in Section 2.4.4.1 will be avoided to the greatest extent practicable. No known cultural sites have been identified within the study area and aesthetics are expected to be enhanced by all alternatives. All alternatives reduce wind-driven wave action, velocities, and turbidities; thus, it is assumed they will increase aquatic vegetation. Increased acreage of aquatic vegetation will provide improved habitat for many species. Potential temporary adverse effects could result from construction activities (e.g., land disturbance, emissions, tree clearing), but construction BMPs will be strictly adhered to, such that any, and all, adverse effects are temporary and minimal. Consequently, environmental quality of alternatives was ranked on AAHU output. Alternatives that had net

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benefits higher than 500 AAHU scored high, alternatives with net benefits from 100-499 scored moderately, and all other alternatives ranked low. While the SAV alternative would be ranked high due to net higher than 500 AAHU, this alternative only met one objective so was reduced to a moderate ranking.

In terms of OSE, categories of effects include health and safety, economic vitality, social connectedness, identity, social vulnerability and resiliency, environmental justice, and leisure and recreation (USACE, 2013). Ecosystem restoration projects primarily focus on recreation and enjoyment of improved resources. Some of the social effects considered qualitatively in the alternative analysis was safety of boaters near the potential aquatic features and the potential to impede recreational boaters. If the alternative both reduced recreation and safety concerns it scored high in other social effects. If it reduced safety concerns but not recreation it was given a moderate score, and if it did not reduce safety or recreation concerns it was given a low score. All action alternatives rate the same for the enjoyment of improved resources to the project.

Table 13 presents a summary of the comprehensive benefits evaluation across these four categories for each of the alternatives. The NED, RED, EQ, and OSE accounts include a qualitative ranking (high, moderate, low) for the final array of alternatives.

Table 13. Summary of Comprehensive Benefits

Alternative	P&G Accounts			
	NED	**RED**	**EQ**	**OSE**
No Action	High	Low	Low	High
Maximum	Low	Moderate	High	Low
Efficient	Low	Moderate	High	High
SAV Only	Low	Moderate	Moderate	Low

5.2.6 Risk and Uncertainty

Engineering Regulation 1105-2-100, Planning Guidance Notebook (2000) requires risk-based analysis to compare plans in terms of the likelihood and variability of their physical performance, economic success, and residual risks. Risk is defined as the probability or likelihood for an outcome. Uncertainty refers to the likelihood that an outcome results from a lack of knowledge about critical elements or processes that then contributes to risk or natural variability in the same elements or processes. Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made regarding the reliability of estimated benefits and the costs of alternative plans. The remaining uncertainties, and associated risks, with implementing the alternatives are discussed along with risk management strategies.

Federally Listed Threatened and Endangered Species. As mentioned in Section 2.3.4, five T&E species have the potential to occur within the boundaries of the study area. Out of the five species, it was determined that implementation of any of the alternatives had the potential to affect Higgins Eye mussels. There is a high likelihood with a moderate consequence associated with not knowing where, and to what extent, Higgins Eye mussels are present in the area. The risk is similar between the Maximum, Efficient, and SAV alternatives since all three alternatives include access dredging and the construction of chevrons, rock mounds, and an island feature. Under the No Action plan, this species may be adversely impacted due to increased occurrences of drought conditions under certain climate scenarios. To manage this risk a

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mussel survey will be conducted to identify mussel populations in, or near, the tentatively selected plan measure locations during feasibility level design to reduce the risks associated with this uncertainty.

Existing SAV Beds. The study area includes a shallow area with existing SAV (wild celery) beds (refer to Section 2.3.2 for additional detail). It was determined that implementation of any of the alternatives had the potential to negatively affect the existing SAV beds. There is a low likelihood with a high consequence of not knowing how the alternatives affect velocities at various flow regimes. The risk is similar between the Maximum, Efficient, and SAV alternative since all three alternatives include construction of chevrons, rock mounds, and an island feature. To manage this risk further modeling will be completed on the tentatively selected plan during feasibility level design to evaluate the location of measures and the impact to existing vegetative beds particularly during high flows. Existing wild celery beds are expected to decline under the No Action alternative.

I**mpacts to Adjacent Landowners.** All three action alternatives include construction of chevrons, rock mounds, and an island feature. Placement of material in the floodway has the potential to increase flood heights. The uncertainty of increasing flood heights was moderate since the associated consequence was high and the likelihood was unknown. To manage this uncertainty early in the process a preliminary floodplain analysis was conducted on the maximum plan since it had the highest risk of increasing flood heights. To manage this risk further modeling will be completed on any modifications to the tentatively selected plan during feasibility level design to reduce the risk of increasing flood heights.

6. PLAN SELECTION

6.1 National Ecosystem Restoration (NER) Plan

Federal planning for water resources development was conducted in accordance with the U.S. Water Resources Council's 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."

Selecting the NER plan requires consideration of the plan that meets the planning objectives, doesn't violate project constraints, and reasonably maximizes environmental benefits while passing the test of cost effectiveness and incremental cost analysis (CE/ICA). The following documents how the NER plan was identified.

Alternative 3, *Efficient Alternative,* is the first iteration of best buy plans above the No Action plan. It was determined that Alternative 3 is worth the incremental investment above the No Action plan since it provides an acceptable level of restoration (711 AAHUs) for an acceptable average annual cost of $1,346,000. This alternative meets the intent of the Federal objective through improved functionality of portions of the Pool 13 Mississippi River by restoring the floodplain forest and improving shallow open water habitat.

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Alternative 2, *Maximum Alternative,* is the second and last best buy alternative. Alternative 2 differs from Alternative 3, *Efficient Alternative* by adding 3 additional rock mound sites and 1 additional chevron. It provides 809 Average Annual Habitat Units over the No Action plan at an average annual cost per habitat of $3,064. The intent of the Federal objective would be met by improved functionality of portions of the Pool 13 Mississippi River through restoring the floodplain forest and improving shallow open water habitat. After a lengthy comparison to Alternative 2, it was determined that although there would be additional benefits, this addition did not significantly increase the effectiveness of the project (98 AAHUs) while increasing the average annual cost by over approximately $1 million for a total average annual cost of $2,479,000.

SAV, *SAV Only,* Alternative was not cost effective, nor did it sufficiently meet all study objectives.

As a result of this discussion and review of the decision criteria, it was concluded that not only does Alternative 3, *Efficient Alternative,* have the highest net benefits across all four accounts it is also the NER plan since it is the alternative plan that reasonably maximizes the benefits in relation to cost and meets the overall Project objectives. Therefore, it is tentatively selected as the alternative recommended for construction that will be reviewed by the public, stakeholders, state agencies, and Federal agencies.

6.2 Consistency with USACE Campaign Plan

USACE has developed a Campaign Plan with a mission to “Deliver vital engineering solutions, in collaboration with our partners, to secure our Nation, energize our economy, and reduce disaster risk” (USACE, 2022). Alternative 3, *Efficient Alternative*, is consistent with the Campaign Plan by producing lasting benefits for the Nation, by using innovative solutions in pursuit of a sustainable, environmentally beneficial, and cost-effective ecosystem restoration design.

6.3 Consistency with USACE Environmental Operating Principles

USACE has reaffirmed its environmental commitment by formalizing Environmental Operation Principles (EOP) applicable to all of its decision-making and programs. The formulation of alternatives considered for implementation met all of the EOP.

The EOPs:

- foster sustainability as a way of life throughout the organization;
- proactively consider environmental consequences of all USACE activities and act accordingly;
- create mutually supporting economic and environmentally sustainable solutions;
- continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments;
- consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs;
- leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner; and,
- employ an open, transparent process that respects views of individuals and groups interested in USACE activities (USACE, 2002).

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The EOPs were considered during the plan formulation, and the TSP is consistent with the EOPs. The TSP promotes sustainability and economically sound measures by incorporating the most natural and least cost methods for restoring habitat for aquatic plants and bird species.

6.4 Resource Significance

All of the action Best Buy alternatives demonstrate technical, institutional, and public significance as they meet some of the Project objectives. Additionally, they all increase abundance of SAV and coverage and richness of the forest communities within the study area. This area of the UMR, considered part of the Upper Impounded Reach according to the Habitat Needs Assessment II (McCain, *et. al*., 2018), is known for having low total suspended solids concentration, which in turn promotes an abundance of wild celery and other species of SAV. This abundance of SAV is extremely important for many species, including migratory birds. Approximately 30 species of waterfowl migrate through Pool 13 every year, including the canvasback, a USFWS Priority Species and Continental Priority Species according to the North American Waterfowl Management Plan (NAWMP, 2004). Pool 13 provides important stopover habitat for this priority species during migration with an average of over 20,000 canvasbacks during migration (5th most overall in Upper Impounded Reach). It was important that all Best Buy alternatives benefit this important resource.

Large floodplain forests present in the study area are also important features of the landscape. As dynamic habitats exposed to frequent disturbances, they provide scarce resources for many groups of animals, including nesting habitat for neotropical migratory songbirds and tree-roosting bat species. Both of these groups represent USFWS Priority Resources of Concern per the HMP (USFWS, 2019). The contiguous makeup of floodplain forest within the UMR provides a highway for these species to migrate, rest, and breed, making these forests increasingly important as agriculture and developed areas expand.

6.5 Risk and Uncertainty of the TSP

The PDT worked to manage risk in developing measures by expanding on and referencing successful similar work completed by previous HREPs and the Design Handbook. The PDT used that experience and information to identify possible risks and decrease uncertainty in plan formulation. No measures in the TSP are believed to be burdened by significant risk or uncertainty regarding the eventual success of the proposed measures. Significant risk would be avoided by proper design, appropriate selection, and correct seasonal timing of applications.

7. TENTATIVELY SELECTED PLAN

This section discusses the Efficient Plan, the TSP, which will meet the study goals and objectives and includes such measures as:

- Chevrons
- Rock Mounds
- Island Construction
- Timber Stand Improvements

A description of these features is shown in Figure 20 and outlined in Sections 7.1.1.1 through 7.1.1.4.

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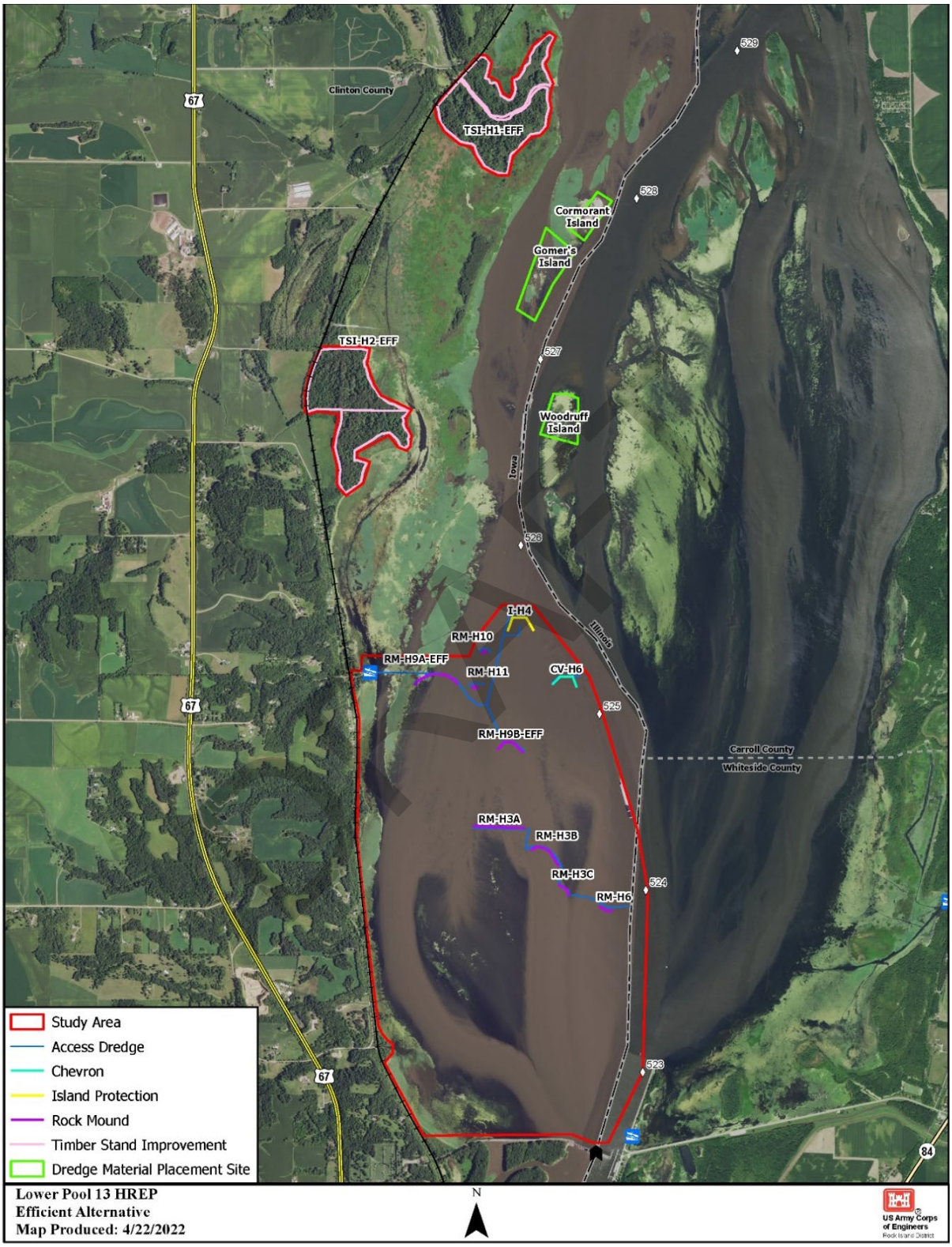

Figure 20. TSP Features and Access Dredging and Dredged Material Placement Sites

7.1 Plan Features

7.1.1 River Training Structures

Features were located to provide optimum conditions for SAV, including a reduction in velocities during the growing season, and providing wave breaks to reduce the resuspension of sediment. Several of these features are in a chevron shape, but others address optimum placement based on bathymetry, wind wave modeling, or velocity modeling. For both chevrons and rock mounds, stone sizes were set as IL DOT RR6 for the feasibility study, however, further design may refine stone sizes.

USACE developed general design criteria to restore optimal submerged aquatic vegetation habitat as follows:

- Optimum Velocity During Growing Season:
  - 10-20 cm/sec
- Water Clarity
  - Turbidity ≤ 20 NTU
  - Secchi disk depth ≥ 0.5 m
  - TSS ≤ 25 mg/l
- Depth
  - 1.5-6 feet

Based on the design criteria selected for velocity, turbidity and depth, along with information regarding velocity and wind driven wave modeling, the team developed a series of potential features to alter the existing conditions to meet the criteria required to restore the submerged aquatic vegetation habitat. These structures were considered to be constructed in various shapes and with different materials. In general, they can be divided into three separate types: islands, rock mounds, and chevrons.

All stonework will be constructed by barge; see Photograph 1 for an example. Typical equipment will include a hopper barge and excavators to place the stone. Areas are very shallow for stone placement, so access dredging will be required to get into each site. Approximately 255,600 CY of excavated material will be transported to dedicated placement sites.

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Photograph 1. Stone Placement in Water by Barge, Beaver Island HREP (June 2019)

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7.1.1.1 *Chevrons*

Chevrons selected for the TSP include CV-H6. Chevron features are often constructed using large riprap to withstand high flow and wind wave action on the Mississippi River. Once the material is placed, it would be shaped to a uniform elevation and side slopes. The chevron top elevations for this Project are dictated by the canvasback priority areas and are at flat pool (582.36 NAVD88). The USFWS canvasback priority area is the portion of the Study Area delineated by the USFWS as being of highest importance for canvasbacks. Canvasbacks and other diving ducks tend to use large expanses of open water and tend to avoid shorelines and tall vertical structures in the areas they use during migration (Devendorf 1995, Korschgen et al. 1988). For this reason, constructed features within the USFWS canvasback priority area will be constructed with a top elevation at or below flat pool elevation so as not to provide a site barrier for this desirable species. Photograph 2 illustrates an example series of chevrons.

7.1.1.2 *Rock Mounds*

Rock mounds selected for the TSP include RM-H3A, RM-H3B, RM-H3C, RM-H6, RM-H9A, RM-H9B, RM-H10, RM- H11. The primary difference between rock mounds and chevrons is the alignment for rock mounds may differ somewhat from the standard chevron shape. These features are often constructed using large riprap to withstand high flow and wind wave action on the Mississippi River. Once the material is placed, it would be shaped to a uniform elevation and side slopes. The rock mound top elevations for this study vary and are dictated by the canvasback priority areas. Within the canvasback priority area, the top elevation is at flat pool (582.36 NAVD88). Outside this area the rock mounds top elevation is 2.5 ft above flat pool (584.86 NAVD88). This height is based on past HREP project success at this elevation and

FWS recommendation. USACE developed general design dimensions for chevrons and rock mounds as follows:

- Top width: 10 feet
- Side slopes: 2:1
- Materials: riprap (IL DOT RR6)



Photograph 2. Series of Chevron Dikes on the Mississippi River
(Source: UMRR-EMP Environmental Design Handbook, 2012)

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7.1.2 Island Construction

There is one island feature, I-H4, selected for the TSP. This feature is located to provide optimum conditions for SAV. The USFWS recommended an earthen island rather than rock to create diverse habitat in this portion of the pool. The total island acreage once constructed will be 4.3 acres.

One potential construction sequence is as follows: The structure would be constructed starting along the main channel. A riprap berm would be placed on the upstream end of the proposed island. Access dredging (AD-CV-H4) for this site would be required. Excavated material for rock placement would be placed on a barge and transported to IP-H4, IP-H5, or IP-H6. Once the rock berm was constructed, sand would be placed on the downstream side. Sand would come from the historic dredge cuts in the navigation channel at approximate RM 529, thereby reducing potential environmental impacts to freshwater mussels. Approximately 55,400 CY of material would likely be excavated and transported to the site by barge.

Additional dredging (AD-I-H4) will occur on the downstream end of the island, and the excavated material would be placed as a 1-foot cap along the top of the island. Dredged material from access dredging will be placed in the most efficient and cost-effective manner to maximize the opportunity for island habitat creation.

USACE developed general design dimensions for island construction as follows:

- Top width: 150-foot with 1-foot cap
- Island protection: 10-foot wide rock layer on upstream side
- Upstream slope (against rock face) 2 horizontal to 1 vertical
- Downstream slope 6 horizontal to 1 vertical

Additional benefits of the feature were provided by the USFWS and are included below:

- In addition to addressing the project problems, opportunities, and objectives an earthen island would provide the following additional secondary benefits that would not be achieved with a rock mound, some of which are unquantifiable. An earthen island is anticipated to transition through different habitats throughout its 50-year design life.

- This type of feature would be more natural looking than a rock mound and is more consistent with the NWFR's Comprehensive Conservation Plan (CCP) which includes the goal, "We will strive to maintain and improve scenic qualities and wild character of the Upper Mississippi River Refuge" and the guiding principles for habitat management programs (USFWS, 2006). An earthen island, including shorelines protected with rock, would balance the NWFR's CCP goal and guidelines with the need to provide meaningful and effective protection of important habitat.

- An earthen island with sloping sides would provide feeding and loafing habitat for shorebirds and turtles at the edges of the island and in the shallow waters adjacent to the edges. Rock slopes are not easily accessible for some wildlife such as turtles which can become trapped in the rock voids. During some flow conditions, an earthen island may also provide some turtle nesting habitat.

- Willows, during times when they are established on the island, will provide additional wind fetch protection which in turn will benefit submerged aquatic vegetation. Feature design would include some willow and grass mix to be planted following construction to provide additional stability to the island.

- Wildlife habitats on the earthen island will be dynamic and are expected, and will be allowed to, transition to various habitats over the I-H4 feature's 50-year design life. Some examples of expected habitats for an earthen island in this location include the following:
    - Willows and grasses would provide nesting habitat for waterfowl
    - If colonial nesting waterbirds such as American white pelicans, double-crested cormorants, ring-billed gulls, and possibly great blue herons and great egrets extensively use the earthen island, then the willow and grass habitat would likely be replaced by areas of little to no vegetative cover which would provide

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nesting and loafing habitat for those types of waterbirds.
- An earthen island at this location could complement previous and future island enhancement, protection, and restoration (such as Pelican, Woodruff's, and Cormorant Islands) and associated habitats just upriver from this location.

7.1.3. Timber Stand Improvement (TSI)

The forest inventory identified two main areas for TSI (TSI-H1-EFF and TSI-H2-EFF). Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment. The target for tree thinning is to release good form understory trees and increase light by cutting stressed and poor in growth form understory and midstory trees (Photograph 3). Thinning will be uneven; some areas require no thinning due to open canopy conditions. Trees cut during thinning treatment will be left where they fall. Tree plantings will focus on increasing species and age diversity in areas where gaps in the canopy exist. Shrub plantings target positive impacts to pollinator species and migratory bird use during fall migration. Tree and/or shrub planting efforts are primarily intended to be conducted using containerized stock. Invasive species treatment will include fall and spring season herbicide application to reed canary grass in canopy gaps. Additional details on TSI features and treatment descriptions can be found in Appendix E, *Engineering* and Appendix A, *Environmental*, Attachment F, *Forest Inventory Data & Prescription.*

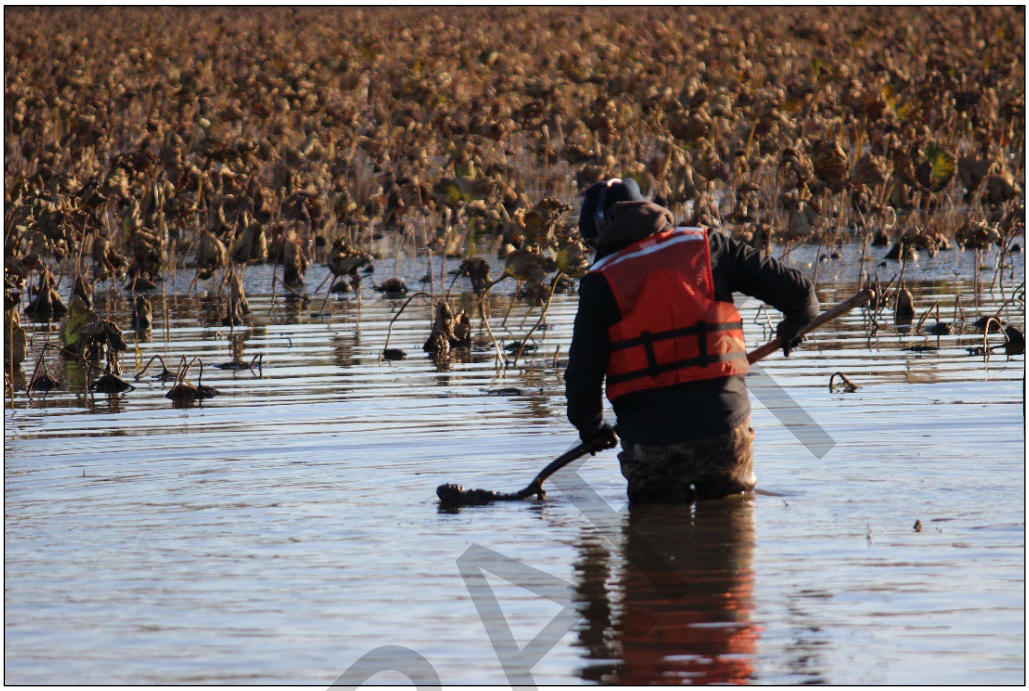


Photograph 3. Thinning Treatment at Beaver Island HREP, May 2022

7.2 Access Dredging

Access dredging is necessary for construction of the project features. Photographs 4, 5, and 6 show example dredging activities. The minimum bottom elevation for access dredging is 574.36

ft (NAVD88). Dredge cuts are designed with a bottom width of 50 ft, side slopes of 4H:1V, at least 25 ft from the toe of the constructed features. Material is assumed to consist of a mixture of clay and silt and will be barged to the disposal sites upstream. Geotechnical investigations will be complete during design of the project.



Photograph 4. Shallow Water Requiring Access Dredging (October 2020)



Photograph 5. Excavator Removes Material and Places in Hopper Barge (Beaver Island 2019)

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Photograph 6. Material is Lifted from Hopper Barge and Placed at Final Placement Site (Beaver Island HREP, October 2020)

7.3 Dredge Material Placement Sites

The three placement sites identified (Cormorant Island, Gomer's Island, and Woodruff Island) as desirable locations for access dredge material placement would also maximize the opportunity and secondary benefit as island habitat for colonial nesting birds and in restoring historic island footprints. See Photograph 7 for an example of island placement and nesting habitat and Photograph 8 for an example of island shrub habitat.



Photograph 7. Nesting Bird Habitat on Islands that have Received Dredged Material in Lower Pool 13 (October 2020)



Photograph 8. Buttonbush on Dredged Material Islands, Lower Pool 13 (October 2021)

The dredge material will be placed on the disposal sites to a top elevation of 586.00 NAVD88 (corresponding to a 0.2 AEP). This is similar to the design elevation of Pelican Island which has

been successful in providing nesting habitat for both waterfowl and colonial nesting birds. Side slopes were set at 1V:4H for stability and to prevent sloughing. Dredged material placement sites will be designed further during PED, ensuring that once the material is placed it will not migrate off site. Slopes may be flattened and/or protection of slopes may be required based on further analysis. Dredge disposal site capacity is 858,600 CY. Total anticipated access dredging quantity is 255,600 CY for the TSP. The site footprints as identified in early iterations to match historic island footprints and sites will be refined during design.

An inter-agency mussel survey of potential disposal sites at Woodruff's and Gomer's Islands was conducted on July 21, 2022. Survey data will be used to refine the size and shape of placement areas in order to avoid and minimize impacts to freshwater mussel species.

Double-crested cormorants (*Phalocrocorax auritus*) & American white pelicans (*Pelicanus erythrorhynchos*) are the two species of colonial nesting birds that are most likely to utilize these islands for nesting (example nests shown in Photograph 9). Ring-billed (*Larus delawarensis*) and herring gulls (*Larus smithosonianus*) are also likely to use these islands for nesting habitat. Pelicans are a ground-nesting species and cormorants will nest on the ground when suitable trees are not available. Over time, if trees are able to establish, egret and heron species may also utilize these islands.



Photograph 9. Nests on Cormorant Island (October 2021)

7.4 Design Considerations

7.4.1 Location

Locations of features were selected as outlined in Appendix E, *Engineering*, Attachment B, *Civil and Environmental Engineering*. Location of features may be modified during the feasibility level

of design based on mussel surveys, cultural resource surveys, and floodplain analysis. Feature locations may be further modified during the design stage based on geotechnical analysis and updated bathymetric surveys.

7.4.2 Survey Data

Information on existing survey data is provided in Appendix E, *Engineering*. Additional survey will be required at access dredge cuts and at structure locations prior to construction.

7.4.3 Access

Access to the site will be by river. Personnel access and staging will likely be from Bulger's Hollow Boat Ramp within the work limits. Proposed access dredge cut locations are shown in Appendix G, *Plates*, and may be modified based on mussel surveys, cultural resource survey, and updated bathymetric surveys. More information is available in the Appendix E, *Engineering*.

7.4.4 Excavated Material

Material excavated from access dredge cuts will be placed at Cormorant Island, Gomer's Island or Woodruff Island.

7.4.5 Historic Properties

Historic properties are addressed in Sections 2 and 8 of this report. The USACE anticipates the Maximum Plan would have no effect to historic properties; however, investigations and consultation need to be completed.

7.4.6 Hazardous, Toxic, and Radioactive Waste

As described in Section 2.5.8, one historic recognized environmental concern (REC) is present near the study area. This area of the Historic REC has been designated as a No Work Zone in regard to HREP measures, and therefore no construction activities will occur there. No other REC's, real or potential HTRW issues are present in the study area. Additional information is provided in Appendix E *Engineering*, Attachment H, *Hazardous Toxic and Radioactive Waste* Documentation report.

The Environmental Protection specification section will 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, work will stop and the steps outlined in ER 1165-2-132 will be followed.

All construction equipment will be clean and free of soil residues, plant, pests, noxious weeds and seeds. No soils can be removed from site unless tested.

7.4.7 Public Access and Security

Public access and security during construction will be controlled through a construction contract. Staging areas would be in generally remote locations, and equipment would need to be secured when there is no oversight in these locations.

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Following construction, access will be typical of other landforms in the river as managed by the NWFR.

7.4.8 Real Estate

The USFWS is acting as the Federal Sponsor, and all the project features are on lands owned by the United States and are part of the Upper Mississippi River NWFR (see Appendix C, *Real Estate Plan* Figure C-1). There are no proposed Public Law 91-646 relocations, as there are no acquisitions required. See Appendix C, *Real Estate Plan* for more detail.

7.5 Construction Considerations

Detailed construction procedures will be developed in the design stage. The Construction contractor will develop high water action plans and construction methods to address designing in variable river stages.

7.5.1 Permits

Laws of the United States and the States of Iowa and Illinois have assigned USACE, IADNR, ILDNR, and the Illinois Environmental Protection Agency (IL EPA) with specific and different regulatory roles designed to protect the waters within and on the State boundaries. Protecting Iowa and Illinois waters is a cooperative effort between the applicant and regulatory agencies.

The basis for USACE regulatory functions over public waterways was formed in 1899 when Congress passed the Rivers and Harbors Act of 1899. Until 1968, the Rivers and Harbors Act of 1899 was administered to protect only navigation and the navigable capacity of this Nation's waters. In 1968, in response to a growing national concern for environmental values, the policy for review of permit applications with respect to Sections 9 and 10 of the Rivers and Harbors Act was revised to include additional concerns (fish and wildlife, conservation, pollution, aesthetics, ecology, and general welfare) besides navigation. This new type of review was identified as a "public interest review." USACE's 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, administered by the IADNR and the IL EPA, should not be confused with USACE'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 USACE to regulate the nonpoint source discharges of dredged or fill material into waters of the United States.

The IADNR is the State agency created by consolidating all previous duties of the IADNR of Water, Air, and Waste Management; the Conservation Commission; the Energy Policy Council; and the Iowa Geological Survey. The IADNR administers permit programs for conserving and protecting Iowa's water, recreational and environmental resources, and for the prevention of damage resulting from unwise floodplain development. Initial 1D hydraulic rise modeling has been completed to determine floodplain impacts for the TSP. The PDT intends to complete further analysis during FLD prior to public review of the feasibility study to ensure the design meets State and local standards. The IADNR also has jurisdiction over sovereign lands and

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waters and certain fee title lands of the State (Iowa Code, Chapters 106 and 111). On meandered streams and lakes, sovereign State property is that land below the ordinary high water mark.

Section 10/404 Permit. The Project will need to show compliance with Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. The District will meet the conditions laid out in Nationwide Permit (NWP) #27 (Aquatic Ecosystem Restoration) in order to be compliant with Section 404 of the CWA. Section 401 Water Quality Certification conditions have already been coordinated and documented as a part of the NWP. This Project will abide by all conditions of the NWP and Water Quality Certification permits, including testing of placement material to ensure compliance with state water quality standards.

Sovereign Lands. USACE/Rock Island District will not apply for an Iowa Sovereign Lands permit due to Federal sovereign immunity.

National Pollutant Discharge Elimination System (NPDES). The Contractor is responsible for obtaining the NPDES Storm Water Permit prior to initiating construction. A storm water discharge or NPDES permit for construction activities will be required. Effective March 10, 2003, the NPDES storm water discharge permit is required when a construction activity disturbs more than one acre. The construction contract for the Project will trigger the need for the contractor to apply for this permit. With or without the permit, USACE requires an environmental protection plan that addresses contaminants as well as erosion control measures. Working near a river requires extra care and erosion control measures. Contract requirements should require the use of an erosion control mat or fence to control erosion and sediment deposition of soil prior to establishing vegetative cover. The contractor would be required to prepare an erosion control plan to ensure that unprotected soil is not allowed to leave the Project site work limits. The contractor would be required to comply with all local codes and permit requirements.

Refuge Special Use Permit. During design, USACE will apply for this permit, issued by the USFWS Refuge Manager for each construction contract.

No other construction requirements are known at this time; however, the PDT will coordinate with the Sponsor and appropriate regulatory agencies during design and construction to ensure requirements are met.

7.5.2 Construction Materials

Only common construction materials are required and can likely be obtained from local sources. Stone will be used for the majority of the constructed features, with gradations refined during the design phase. Material for I-H4 will consist of excavated material from a navigational dredge cut and/or an access dredge cut. Plants and trees will be obtained through approved nurseries using native species.

7.5.3 Construction Sequence / Schedule

Design work will be conducted for 12-18 months prior to proposed construction award dates. Timber Stand Improvement will be the first contract awarded, and features will be constructed.

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The remaining features will likely be divided into three construction contracts based on historic funding availability for the UMRR program as shown in Table 14. A more detailed schedule broken out by stage is provided in Appendix E, *Engineering*.

Table 14. Probable Construction Sequence

TSP	Start	Finish
Construction Phase	10/1/25	1/27/33
Stage I - Forest Management	10/1/25	11/10/28
Stage II - Chevrons and Island	1/1/27	3/29/29
Stage III - Upper Rock Mounds	1/1/29	11/12/30
Stage IV - Middle Rock Mounds	1/1/31	1/27/33

7.5.4 Construction Schedule Constraints

Scheduling of construction would depend on availability of funds, and based on expected funding, it is likely that the Project would be awarded in at least four construction contracts. Considerations in the schedule will include the following:

- No clearing of trees shall be allowed between April 1 and September 30 to avoid impacts to bat roosting trees.
- Coordination with USFWS personnel is required prior to working during the seasonal waterfowl and deer hunting seasons. During peak hunting weekends or dates, all construction activities may be required to cease for a short period of time.
- No clearing of trees where roosting or occupied nests exist shall be allowed when bald eagles or red-shouldered hawks are present in the area. Although there are known nest sites, currently, none are known to exist within 660 feet of the selected measures. If any nesting activity is observed, no construction activities within 660 feet of the nest shall be allowed.
- In accordance with Executive Order 13186, take of migratory birds protected under the Migratory Bird Treaty Act should be avoided or minimized, to the extent practicable, to avoid adverse impact on migratory bird resources.
- Trees and shrubs shall be planted during optimum times for each species. Final planting dates will be coordinated during the design phase.

7.6 Operation, Maintenance, Repair, Rehabilitation, and Replacement

Operation, maintenance, replacement, repair and rehabilitation (OMRR&R) responsibilities of the USACE and USFWS are addressed in the proposed Memorandum of Agreement for the project located in Appendix A, *Environmental* Attachment G, *Memorandum of Agreement*.

7.6.1 Operation and Maintenance

Operation and maintenance (O&M) of UMRR HREPs is similar to that undertaken by the Sponsor and/or partner agencies in day-to-day management of parks, boat ramps, wildlife management areas, and other public use areas. The purpose of assigning O&M costs to the Project Sponsor is to ensure commitment and accountability. HREPs are designed and

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constructed to operate for 50 years with proper maintenance. O&M is the responsibility of the Sponsor in accordance with Section 107(b) of WRDA 1992, Public Law 102-580 which states 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.

The Project was designed to reduce overall operation costs and are limited to low annual maintenance requirements. In general, maintenance includes routine inspections of the rock mound, chevron, and island structures to ensure performance and identify any necessary repairs, replacements, or rehabilitations. Estimates of O&M costs are included in Appendix E, *Engineering* Attachment F. These quantities and costs may change during final design. A complete list of operation and maintenance needs would be provided in an O&M manual following construction completion and preparation of as-built drawings, and prior to transferring the project to the USFWS.

Table 15 includes estimated USFWS operation and maintenance costs for the Project.

Table 15. USFWS Operation and Maintenance Costs

	Quantity	Unit	Unit Price	Annual Costs
Operation	-	-	-	-
Maintenance (years 1 through 50)				
USFWS Annual Site Inspections (all constructed river structures)	32	Hours	$100	$3,200
			Total Annualized Cost at 2.25%	$3,200

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7.6.2 Repair, Rehabilitation and Replacement

Repair, rehabilitation, and replacement considerations may extend outside of the typical 50-year period of analysis, as the USFWS is expected to maintain the HREP as outlined in the Memorandum of Agreement (MOA) found in Appendix A, *Environmental* Attachment G, *Memorandum of Agreement*. Rehabilitation cannot be accurately measured during design or construction phases. Rehabilitation is the reconstructive work that significantly exceeds the annual O&M requirements and is needed because of major storms or flood events. Portions of the rock structures will be replaced every 75 years. Estimates of these costs will be included in the operation and maintenance manual.

7.7 Project Performance Assessment Monitoring

Monitoring includes the systematic collection and analysis of data that provides information useful for assessment of project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain benefits. The UMRR Program integrates long term monitoring, research, modeling, and data management to provide critical knowledge about the UMR's health and resilience. This provides a solid foundation upon which to base management actions, habitat restoration, and policy. With long term data

collected over more than 25 years, the UMRR's database is one of the most extensive and comprehensive on any large river system in the world. Pool 13 is considered a "trend pool" for data acquisition and analysis in the UMRS, and has a significant data set available dating back to 1988 for water quality and 1991 for aquatic vegetation.

Water quality monitoring in Pool 13 is accomplished with a combination of Fixed Site Sampling (FSS) and Stratified Random Sampling (SRS). For FSS, a relatively small number of nonrandomly-selected fixed sites are monitored repeatedly at intervals ranging from once every two weeks to once every two months. Water quality SRS occurs at a larger number of randomly selected locations at seasonal (quarterly) intervals. Some of the data available for review include water clarity, velocity, TSS, total nitrogen and phosphorous, and chlorophyll.

Vegetation monitoring was conducted using transects prior to 1998, when the current SRS protocol was implemented. Data are collected on the distribution, frequency of occurrence, and relative abundance of aquatic vegetation within the pool, including the following aquatic vegetation types: submerged, rooted floating-leaf, emergent, algae, and duckweeds. Both water quality and vegetation data collected through LTRM was used extensively for this study. Future monitoring of study features should integrate seamlessly with current LTRM data collection standards and methods.

This section summarizes the monitoring and data collection aspects that are not associated with MAM). Post-Project performance assessment will commence following the MAM stage, or approximately 10 years post construction. Post-Project performance assessment monitoring will help determine if the goals and objectives are being achieved by the constructed measures. Information regarding the MAM are provided in Appendix A, *Environmental,* Attachment B, *Monitoring and Adaptive Management Plan*.

Table 16 presents overall types, purposes, and responsibilities for monitoring and data collection. A detailed project monitoring schedule is currently being developed and refined. Table 17 presents a post construction evaluation plan.

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Table 16. Overall Types, Purposes and Responsibilities of Monitoring and Data Collection

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

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Table 17. Post Construction Evaluation Plan

Enhancement Measures	Measurement	Location	Year 1 w/ Alt	Year 25 w/ Alt	Year 50 Target w/ Alt	Method	Annual Field Observations by Manager.
TSI	Forest Metrics – timber inventory and stand summary	All TSI areas	>90% Silvicultural Treatment Target Threshold	>60% Silvicultural Treatment Target Threshold	>40% Silvicultural Treatment Target Threshold	Standard Timber Inventory Protocol	Visual Observations
SAV – Rock Mounds & Chevrons	Percent cover of SAV	SW Area of Pool	>20% cover; >60% of veg is wild celery	>30% cover; >60% of veg is wild celery	>30% cover; >60% of veg is wild celery	Aquatic Vegetation Survey (LTRM Protocol)	Visual Observations
	Velocity		< .5 ft/s	< .5 ft/s	< .5 ft/s		

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7.8 Monitoring and Adaptive Management

Section 1161 of WRDA 2016 requires that when conducting a feasibility study for ecosystem restoration, the proposed project includes a plan for monitoring the success of the ecosystem restoration. The primary incentive for implementing an adaptive management plan is to increase the likelihood of achieving desired project outcomes given the identified uncertainties which may include incomplete description and understanding of relevant ecosystem structure and function, imprecise relationships among project management actions and corresponding outcomes, engineering challenges in implementing project alternative, and ambiguous management and decision-making processes.

> The National Research Council defines Adaptive Management as:
> "*Adaptive management promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a "trial and error" process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders."*

Rock structure modification measures may require adjustment to their design to include adjustment of heights and locations. Timber stand improvement management response actions would involve additional tree plantings and/or additional management measures.
This monitoring and adaptive management plan will be further developed with input from the Federal resource agencies. The monitoring schedule is summarized in Table VII-9. Details on performance indicators, monitoring targets, time of effect, frequency of monitoring, adaptive management triggers, and responsibilities of monitoring and data collection are detailed in Appendix A, *Environmental,* Attachment B, *Monitoring and Adaptive Management Plan.*

7.8.1 Monitoring and Adaptive Management Costs

Per Section 1161 guidance, monitoring costs (not to exceed 10 years after project construction is complete) were considered as part of project costs. Any monitoring conducted after 10 years would not be part of the total project cost and will be 100% Federal Sponsor costs. The estimated adaptive management costs are outlined in Table 18. These costs are preliminary and will be updated as adaptive management and monitoring plan is refined.

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Table 18. Estimated Performance Monitoring and Adaptive Management Costs (March 2022 Price Level)

				Post-Construction Years										
Objective	**Work Category**	**Activity**	**PED**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Floodplain Forest Diversity	Monitoring and Analysis	Forest Plot Survey	-	$10,000	-	$10,000	-	$10,000	-	$10,000	-	$10,000		$50,000
														Floodplain Forest Diversity Subtotal: $50,000
SAV Cover	Monitoring, Analysis, Reporting	Site Inspection	$44,000	$15,000	$15,000	$15,000	-	-	-	-	$15,000	-	-	$104,000
		ADCP Data Collection												
	AM: Riprap/Chevron Rock Install/Remove		-	-	-	-	-	$500,000	-	-	$500,000	-	-	$1,100,000
	AM: Veg Planting							$50,000			$50,000			
														SAV Cover Subtotal: $1,204,000
Flow Diversity	Monitoring, Analysis, Reporting	Mussel Survey	-	-	-	-	-	-	-	-	$60,000	-		$60,000
		Data Analysis												
														Mussel Habitat Subtotal: $60,000
														TOTAL $1,314,000

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7.9 Cost Estimates

Cost estimates for the TSP were completed using the MII 4.4.3. a detailed description can be found in Appendix F, *Cost Engineering*. The following sections document the components of the project.

7.9.1 Total Project Cost

The project first cost for the TSP is $38.797 million at a FY 2022 price level (March 2022). The costs expressed as Project First Costs and include LERRDS, construction, contingencies, monitoring and adaptive management, engineering, pre-construction, design, and construction management.

The more refined cost estimate also involved an Abbreviated Risk Analysis to determine contingencies, Micro-Computer Aided Cost Estimating System, and Total Project Cost Summary to determine present value costs. Table 19 shows the estimated cost by account. The project first cost fully funded amount is ($38.797 million), which is the project first cost escalated to the mid-point of construction. The detailed estimate of the project design and construction costs are provided in Appendix F, *Cost Engineering*, however due to the sensitivity of providing this detailed cost information, this material will be omitted in the public documents. Quantities and costs may vary during final design.

Table 19. Project Design and Construction Cost Estimates (March 2022 Price Level)

Account	Measure	Project First Cost
01	Lands and Damages	$0[1]
06	Fish and Wildlife Facilities	$822
09	Channels and Canals	$9,306
16	Bank Stabilization	$7,679
30	Planning, Engineering and Design	$4,816
31	Construction Management	$2,277
	Monitoring and Adaptive Management	$1,314
	Contingency	12,583
	Project Cost Estimates	**$38,797**

[1] Project features are on Federal lands and managed as a national wildlife refuge; therefore 100% Federally funded.

7.9.2 Cost Risk Analysis

The following documents the cost risk analysis, which was completed in 2022. An abbreviated risk analysis (ARA) was performed in accordance with ER 1110-2-1302. An ARA was used for the development of contingency for estimating total project cost. Contingencies represent allowances to cover unknowns, uncertainties, and/or unanticipated conditions that are not possible to adequately evaluate from the data on hand at the time the cost estimate is prepared. The continency must be represented by a sufficient cost to cover the identified risks.

The ARA indicated the appropriate total project cost contingency rate was 48 percent. A complete description of this analysis can be found in Appendix F, *Cost Engineering*.

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7.10 Compliance with Environmental Laws and Regulations

A summary of compliance with the major environmental laws and regulations follows and is summarized in Table 20.

Table 20. Relationship of 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.	Pending[2]
Bald and Golden Eagle Protection Act, 16 U.S.C 668-668c	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
USACE Planning Guidance Handbook (ER 1105-2-100)	Full Compliance
Endangered Species Act of 1973, as amended, 16 S.C. 1531, et seq.	Pending
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
Executive Order 13985, *Advancing Racial Equity*	Full
Executive Order 13990, *Protecting Public Health and Environment*	Full
Executive Order 14008, *Tackling Climate Crisis*	Full
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
Migratory Bird Treaty Act, 16 U.S.C. 703-712	Full Compliance
National Environmental Policy Act, 42 U.S.C. 321, et seq.	Pending[2]
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Pending[2]
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 or Project does not contain resources applicable to the law.
[2] The Project will be in full compliance with NEPA once the Finding of No Significant Impacts is signed.

8. ENVIRONMENTAL CONSEQUENCES

Compliance with the Endangered Species Act (ESA) is pending results from a mussel survey of potential feature locations. Once data on listed mussel species is obtained, determinations of impacts and, if necessary, formal consultation will occur, thus satisfying the ESA in its entirety.

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Sections 2 and 3 identified the existing conditions, drivers, and stressors affecting the habitat resources, and the FWOP condition for the Lower Pool 13 HREP study area. In accordance with National Environmental Policy Act (NEPA), this section evaluates the effects on social, economic, and natural environment that would result from implementation of the considered alternatives identified in Chapter 5, *Formulation of Alternatives.* This section fulfills the NEPA requirements by evaluating the consequences of the considered alternatives, a subset of the final array of alternatives, including the No Action Alternative. Each resource from Section 2 was evaluated for effects (also called impacts) on each considered alternative. Pursuant to NEPA, this chapter addresses the impacts in proportion to their significance (40 Code of Federal Regulations [CFR] § 1502[b]). Significance requires consideration of context and intensity (40 CFR § 1508.27). The depth of analysis of the alternatives corresponds to the scope and magnitude of the potential environmental impact. This chapter provides the scientific and analytic basis for the comparisons of the alternatives and describes the probable consequences (impacts, effects) of each alternative on the selected environmental resources. The purpose of characterizing the environmental consequences is to determine whether the resources, ecosystems, and human communities of concern are approaching conditions where additional stresses will have an important cumulative effect (CEQ, 1997).

The considered action alternatives would result in positive long-term ecosystem benefits for the study area. The considered action alternatives would not result in conversion of land cover types. During construction of any considered action alternative, short-term decreases in water quality, air quality, aesthetics, public use and temporary disturbance to wildlife in the area are anticipated. Long-term benefits would far outweigh the short-term impacts. Some short-term impacts to freshwater mussels are likely under any of the action alternatives, including impacts to the Federally endangered Higgins eye pearlymussel, however, no long-term negative impacts to this species or other Federally-listed species are anticipated. No negative impacts to man-made resources, community resources, availability of public facilities and services, employment, tax income and value losses, property value losses, displacement of people, business and industrial growth, community growth or regional growth are expected. No impacts to life, health, safety or energy are expected. No impacts to historic and cultural resources are anticipated.

Assessing potential significant effects requires consideration to the potentially affected environment (physical, ecological, and socioeconomic aspects) and degree to which the resources of the human environment are affected both short and long-term. Short-term effects include those impacts that would occur during implementation of any reasonable alternative, as well as transient ecological effects that can be expected to occur during the first 1 to 3 years. Long-term effects that can be expected to occur during and beyond the first 1 to 3 years. For purposes of this analysis, significance definitions (e.g., unaffected, less than significant, and significant) have been developed to assess the magnitude of effects for all of the affected resource categories resulting from implementing any of the reasonable alternatives.

- Unaffected: a resource was not affected, or the effects were not appreciable, changes were not of any measurable or perceptible consequence.
- Less than significant: effects on a resource were detectable, localized, small and short-term.

- Significant: effects on a resource were readily detectible and obvious, localized or regional, large and long-term.

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- Beneficial: positive effects on a resource that are localized or regional, large and long-term.

The environmental consequences discussion forms the scientific and analytic basis for comparing the alternatives and the significance of those impacts on the following alternatives:

- Maximum Alternative
- No Action Alternative

This section does not explicitly discuss the effects of the Efficient and SAV Alternatives because the Maximum Alternative contains all the measures included in the Efficient and SAV alternatives. It was assumed the effects would be similar for the Efficient and SAV alternatives, just in a slightly smaller amount and degree. The degree to which the Efficient Alternative impacts are less than the Maximum Alternative is difficult to quantify, as this relates heavily to where T&E mussel species are located. Therefore, only the effects of the Maximum Plan and No-Action Alternative are discussed in detail below. Due to the integrated format of this document, the benefits of the alternatives were assessed in Section 5 through the development, evaluation, and selection process. Projected impacts are summarized in Table 22.

8.1 Upper Mississippi River – Pool 13

Impacts of the No-Action Alternative – Climate change literature and analysis suggests that peak flow magnitude has the potential to change over the project life. Increases in winter and spring flows followed by decreases in summer flows are likely.

Impacts of the Maximum Plan – Climate change impacts are anticipated to be the same for the Maximum Plan as they are for the No-Action Alternative. Project features are anticipated to alter flow directions and velocities within the study area. Project features may cause minor changes to water surface elevations adjacent to proposed features, but the Project would comply with all State and local floodplain standards.

8.2 Tributaries

Impacts of the No-Action Alternative – Climate Change literature and analysis suggests that peak flow magnitude has the potential to change over the project life. Increases in winter and spring flows followed by decreases in summer flows are likely.

Impacts of the Maximum Plan – Climate Change impacts are anticipated to be the same for the Maximum Plan as they are for the No-Action Alternative. Alternatives are not anticipated to impact tributary hydrology. Please see Appendix E, *Engineering,* Attachment A, *Hydrology and Hydraulics* for additional information.

8.3 Bathymetry and Sedimentation

Impacts of the No-Action Alternative – Over the 50-year project life, approximately 1.6 feet of sediment deposition is anticipated throughout the study area. Temporal and spatial variability of this deposition is expected to be substantial, but typical water depths in the study area are anticipated to be roughly 2.4 – 4.4 feet in 50 years.

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Impacts of the Maximum Plan – The Maximum Plan is not anticipated to substantially alter the total quantity of sediment deposition that occurs in the study area over the 50-year project life; however, proposed features are intended to alter flow paths and velocities. Therefore, features are likely to alter spatial patterns of deposition within the study area. While not quantified in this study, field observations of previous HREP features suggest that scour immediately downstream of each feature, followed by deposition immediately downstream of the scour location is likely. Additionally, if proposed features succeed in increasing the presence of wild celery in the study area, field observations within Lower Pool 13 suggest that the vegetation itself would shift patterns of deposition.

8.4 Water Quality

Impacts of the No-Action Alternative – Under the No Action Alternative, turbidity would increase within the study area as SAV vegetation declines and the pool shifts from a mostly vegetated state to a turbid state. Sediment input from upstream tributaries would continue to negatively impact the water clarity of the study area.

Impacts of the Maximum Plan – The Maximum Plan would reduce turbidity within the study area. Construction of chevrons and rock mounds would reduce the height and energy of wind-driven waves, reducing the likelihood of sediment resuspension in shallower areas. The expected increase in SAV acreage would also likely increase water clarity. No alternative would impact or reduce upstream sediment inputs into the study area.

8.5 Hydraulics and Hydrology

Impacts of the No-Action Alternative – Under the No Action Alternative, SAV is expected to disappear over the next 50 years. Observed data indicates the structure of the aquatic vegetation impacts existing hydraulics substantially, and as this vegetation disappears, changes to flows within the study area are likely.

Impacts of the Maximum Plan – The Maximum Plan contains chevrons and rock mounds that would alter the hydraulics of the study area in order to increase cover of SAV. These features would create areas of reduced velocity immediately upstream and downstream of the feature footprint, with areas of increased velocity likely occurring and the margins of the features. Increased cover of SAV is also likely to change the hydraulics of the study area. Changes to regional hydrology are not anticipated.

8.6 Geology and Soil Substrate

Impacts of the No-Action Alternative – Under this alternative, there would be no actions to restore floodplain soils or remove sediments, so there is no impact on geology and soils.

Impacts of the Maximum Plan - Temporary minor impacts to geology soils would likely occur due to construction activities under the Maximum Plan. Floodplain soils would experience minor impacts due to equipment used during forest restoration activities. These activities would be minor and short-term, allowing for a more diverse and balanced flora and hence improved microbial and nutrient communities. Sediment thicknesses and extents within the study area would be impacted by dredging and placement activities, and some sediment deposition areas would be modified based on flow characteristics around rock mounds and berms. Required

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access dredging would impact fluvaquent soils temporarily, but it is expected that these dredge cuts would fill in quickly and would not result in a long-term change to the area. No prime or unique farmland exist within the study area and therefore no effects to this resource are anticipated under any alternative.

8.7 Hazardous, Toxic, and Radioactive Waste

Impacts of the No-Action Alternative - With this alternative, USACE would not implement any action and no changes to any recognized environmental concerns are anticipated.

Impacts of the Maximum Plan – There is one Historic recognized environmental concern (REC) present near the study area. This area of the historic REC has been designated as a No Work Zone in regard to HREP measures, and therefore no construction activities would occur there. No other REC's, real or potential HTRW issues are present in the study area. No impacts to REC's or other potential HTRW sites are anticipated under any alternative.

8.8 Floodplain Habitat

Impacts of the No-Action Alternative – Floodplain forest, wetlands, and aquatic resources in the study area have been adversely affected by altered hydrology, climate change, and land use changes, resulting in increased frequency and duration of flooding, wave action, increased water velocities, and subsequent declines in water quality. Under the No-Action Alternative, these stressors are expected to continue to degrade existing habitat.

Mature silver maple and cottonwood trees are approaching the end of their life expectancy and will die off over the next 50 years, leaving large canopy gaps in the forest. With very limited natural regeneration and desirable understory species, it is assumed that invasive species would colonize and dominate these newly created canopy gaps. Invasive-dominated canopy gaps would prevent future natural regeneration of both native trees and shrubs, resulting in very degraded floodplain forest habitat. This area will struggle to support Neotropical migratory songbirds and tree-roosting bat species, both of which require a forest with a healthy diversity of tree species and structure.

Submerged aquatic vegetation is also expected to continue to degrade throughout the 50-year planning timeframe. Wind-driven wave resuspension of sediments and the associated increased turbidity, coupled with high velocities within the pool, have led to reduced aquatic plant acreage and diversity and habitat quality for migrating waterfowl. If current trends continue, it is likely that SAV will be lost from the study area by the year 2055.

Impacts of the Maximum Plan – The Maximum Plan seeks to reverse the negative trends in floodplain forest and aquatic vegetation laid out in the previous section. To accomplish this, timber stand improvement (TSI) actions are proposed across the 535 acres of floodplain forest included in the study area. Approximately 270 of the 535 acres (~50%) would require active TSI measures, including thinning the forest of overmature and undesirable tree species and planting trees and shrubs in the newly created canopy gaps. While most tree cutting would target mulberry (*Morus alba*) and American elm (*Ulmus americana*), some areas require removal of a portion of canopy trees. In these areas, a maximum of 14% of canopy trees would be removed to increase sunlight availability for planted trees and shrubs. While these thinning activities are expected to have a minor negative impact on the forest, this impact would be temporary and

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would result in long-term beneficial impacts to the system. For a detailed description of TSI actions included in the TSP, see Appendix A, *Environmental,* Attachment F, *Forest Inventory Data and Prescription*.

The islands, rock mounds, and chevron features included in the Maximum Plan are expected to reduce current velocities, break up wind-driven waves, and improve water clarity within the study area. This would benefit multiple species of SAV, including wild celery, resulting in increased cover of SAV. In some areas these features would cause increased velocity outside of the tolerable range for wild celery and other species of SAV, resulting in a loss of SAV coverage in that area, however these areas are likely small and negligible considering the overall benefit of the features. Additionally, these areas of increased velocity would provide flow diversity in a system that is otherwise relatively constant, likely benefiting native species of fish and mussels. Any impacts to existing aquatic resources due to construction of features and access dredging are expected to be minor and temporary when compared to the benefits over the 50-year lifespan of the project.

8.9 Invasive Species

Impacts of the No-Action Alternative – If no action is taken, existing levels of invasive species within the floodplain are expected to increase. The number and size of canopy gaps within the forest would increase as overmature silver maples and cottonwoods die and succumb to wind throw. These canopy gaps would quickly be colonized by reed canary grass and other prominent invasive species. Aquatic invasive species presence is not expected to increase under the No Action Alternative.

Impacts of the Maximum Plan – The Maximum Plan would restore ecosystem structure and function for native species and habitats. With this, native plants and animals should be able to compete better with existing invasive species and make the ecosystem less susceptible to future invasions. TSI measures would reduce invasive species presence and increase recruitment of native tree and shrub species. The increased diversity and structure of understory and midstory vegetation would work to shade out invasive vegetation and prevent its spread. During construction, best management practices would be implemented to reduce invasion while the sites are being disturbed.

The Maximum Plan would also seek to reduce wind fetch across the lower portion of Pool 13, thus reducing turbidity and creating a more favorable environment for the growth of submergent and emergent aquatic vegetation. This increase in abundance of aquatic vegetation would positively impact water quality, providing more desirable habitat for native fish and mussels and creating a robust system that is resilient to invasions by exotic species.

8.10 Fish and Wildlife

Impacts of the No-Action Alternative – Fish and wildlife species in Pool 13 would be negatively impacted through the continued degraded state of ecosystem structure and function within the study area. The continued decline of floodplain forest would reduce available nesting and breeding habitat for Neotropical migratory birds and tree-roosting bat species. Increased invasive species presence would reduce the existing understory and shrub layer within the forest, thereby reducing available nesting habitat for many species of migratory and resident birds. The decline and eventual loss of submerged aquatic vegetation would render the

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impounded area of Pool 13 unsuitable for many species of migratory waterfowl. These species rely on SAV for energy during both fall and spring migrations and without it declines in these populations are likely. The presence of SAV within the impounded area of Pool 13 also provides habitat for multiple species of fish, mussels, and macroinvertebrates. As SAV declines and disappears, the loss of flow and habitat diversity provided by the aquatic vegetation would result in lower numbers of native fish utilizing the area.

Impacts of the Maximum Plan – The Maximum Plan would improve both the aquatic resources and floodplain forest health over the life of the project. This alternative would benefit a wide variety of wildlife within the study area. Birds and bats would benefit from improved forest health, structure, and diversity. During implementation of TSI measures, short-term impacts to wildlife are anticipated, but these short-term impacts would be outweighed by the long-term improvements of ecosystem structure and function. During construction, best management practices would be implemented to avoid and minimize impacts to wildlife resources, including tree cutting outside of roosting season for tree-roosting bat species. To minimize impacts to bald eagles, the USFWS guidelines would be adhered to during construction if any nests are observed. The proposed low-elevation rock mounds, chevrons, and island features would protect existing areas of SAV and encourage SAV growth in currently unoccupied sites, providing migrating waterfowl with much-needed, high-energy food. Construction of these features is likely to negatively impact existing native mussel resources within the area. A mussel survey within and around feature footprints would allow for minimization and avoidance of areas with high mussel densities. Any unavoidable impacts would be coordinated with USFWS and state agencies and are expected to be minor and temporary. Over the long-term, flow diversity created by these structures would provide habitat for native fish and mussel species.

8.11 Endangered Species

Impacts of the No-Action Alternative – Threatened and endangered species listed in Chapter 2 are likely to experience adverse impacts if no action is taken. Anticipated declines of floodplain forest due to forest age, invasive species, and climate change would negatively impact species of tree-roosting bats, including the NLEB and Indiana bat. Increased invasive species within the floodplain would also reduce the prevalence and diversity of native shrubs, directly impacting the monarch butterfly. Listed mussel species may be adversely impacted due to increased occurrences of drought conditions under certain climate scenarios, however this group is the least likely to be impacted under the No-Action Alternative.

Impacts of the Maximum Plan – In accordance with the Endangered Species Act (ESA), USACE obtained a list of Federally threatened and endangered animals and plants from the USFWS, satisfying the “request for species list requirements” for ESA Section 7 Consultation (Chapter 2). USACE will prepare a Biological Assessment documenting conservation measures for listed freshwater mussel species and effects determination for the Federally listed species in coordination with USFWS. Table 21 summarizes the USACE’s effects determination for the Federally listed species potentially occurring within the study area.

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Table 21. Federally-listed Species Effects Determinations for the Maximum Plan

Effects Determination	Species	Category
May Affect, Likely to Adversely Affect	Higgins Eye	Mussels
May Affect, Not Likely to Adversely Affect	Sheepnose	Mussels
	Northern Long-eared bat	Mammals
	Indiana Bat	Mammals
No Effect	Monarch Butterfly[1]	Insects
	Eastern Prairie Fringed Orchid	Flowering Plants
	Western Prairie Fringed Orchid	Flowering Plants

[1]Candidate species

It is expected that the NLEB and Indiana bat would benefit from TSI measures included the Maximum Plan. Required tree cutting would occur between October 1 and March 31, outside of the designated summer maternity and roosting period for tree-roosting bats. Tree cutting is also expected to occur on less than 20% of TSI treatment area. Suitable roost trees will remain for these species, and the number standing dead trees, or snags, per acre is expected to increase over the life of the project, benefiting these tree roosting bat species. Because of this, the Maximum Plan, and by extension the TSP, is Not Likely to Adversely Affect the NLEB or the Indiana Bat.

Determinations on listed freshwater mussel species will be confirmed or revised following study area mussel survey.

The Maximum Plan would include invasive species removal and plantings of native shrubs. Both of these actions provide benefits to native pollinators like the monarch butterfly. No adverse impacts to this species are anticipated under the Maximum Plan, therefore USACE made a determination of No Effect for the monarch butterfly. Neither the eastern prairie fringed orchid nor the western prairie fringed orchid is likely to occur in or near the study area, therefore USACE made a determination of No Effect for both species.

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8.12 Air Quality

Impacts of the No-Action Alternative – The No-Action Alternative would have no impacts to air quality.

Impacts of the Maximum Plan – Minor, temporary increases in airborne particulates are anticipated as a result of mobilization and use of construction equipment. Frequent inspections of construction equipment would be made during construction to ensure they are properly functioning and do not release unnecessary amounts of emissions. Burning of cut trees would not occur, reducing impacts to air quality.

8.13 Noise

Impacts of the No-Action Alternative – No change in noise levels would be expected. Noise from recreational boating, hunting, fishing, and barge traffic is expected to continue at existing conditions levels.

Impacts of the Maximum Plan – The construction of the project would generate a temporary increase in noise levels associated with heavy equipment. Chainsaw use during TSI implementation would contribute noise to floodplain forest, impact species utilizing this habitat. This may lead to temporary displacement of some wildlife species and decrease recreational use; however, this would not impact long-term value of the area.

8.14 Cultural Resources

Impacts of the No-Action Alternative - No impact to historic properties would be expected.

Impacts of the Maximum Plan – The USACE anticipates the Maximum Plan would have no effect to historic properties; however, investigations and consultation need to be completed. The USACE reviewed available information and no historic properties were identified in the Study Area. The USACE identified the area of potential effects (APE) for Section 106 of the National Historic Preservation Act to include the physical effects of constructing project features and the potential visual and audible effects during and/or post construction. Physical effects are limited to the surface and shallow subsurface areas where project features are located. Chevron, island protection, and rock mounds would result in minor displacement of existing shallow subsurfaces, specifically the immediate 1-2 inches of the surface in areas where firm sand material is present and extending to an approximate depth of 1-2 feet in areas where soft clay is present. For timber stand improvements, the vertical APE would extend to an approximate depth of 1-2 feet in areas for tree planting. For access dredging required for construction of project features, the vertical APE would be approximately 6 feet deep.

No historic properties are known to exist within the proposed disposal sites and disturbance has occurred at varying degrees within each disposal location. Cormorant Island is an approved dredged material placement site that last received material in late 2019. Less information is known regarding Gomers and Woodruff Island. No records indicate placement at either location. Additional review a potential survey of these two locations will be completed prior to approval of the Recommended Plan.

Visual and audible effects related to the construction activity was limited to the shoreline at water level on each side of the river. Given the distance, vertical differentiation, vegetation, and existing infrastructure, the upland areas adjacent to the Study Area were not included in the APE for potential visual effects. Construction would result in temporary increases in noise levels where equipment is actively implementing the project. Equipment would likely include barges, bulldozers, and dump trucks. The USACE assessed approximately ¼ mile as the distance from the construction footprint sufficient to displace much of the sound associated with construction activities or limit the noise from being separately distinguishable to other noises in the vicinity. Timber stand improvement activities would not require construction equipment to have an audible effect. As a result, the upland areas adjacent to the Study Area were not included in the APE.

8.15 Socioeconomic Setting

Impacts of the No-Action Alternative – Minor long-term adverse effects to socioeconomic resources would be expected. Human recreational use of the study area through hunting, fishing, and boating would likely decline due to the continued degradation of ecosystem resources. The continued decline of wild celery abundance and the low aquatic plant diversity

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overall would affect the number and diversity of fish and waterfowl utilizing the area which would impact the number of hunters and anglers that use the area. Declines in aesthetics are also likely under the No Action Alternative, resulting in decreased recreational visitation to the study area.

Impacts of the Maximum Plan – The considered alternatives have no measurable impacts on community cohesion, property values, industrial growth, life, health and safety, or privately owned farms. Increased recreational use within the study area is expected under the Max Plan which could increase community, regional, and business growth as well as tax revenues. USACE has not received any public opposition to the considered action alternatives. In the long-term, habitat improvement would increase wildlife and fish populations and diversity. Increased outdoor recreational opportunities including bird watching, hunting, fishing and boating with any of the considered action alternatives are expected. In the short-term, construction activities would likely disturb recreational activities within the study area but could also create short-term employment opportunities.

8.16 Recreation and Aesthetics

Impacts of the No-Action Alternative – Recreational boating would likely continue under the No-Action Alternative. Over the long-term, a decline in recreation and aesthetics may occur due to the continued degraded state of habitat and wildlife populations. This decline in use would likely be visible in the numbers of individuals that hunt waterfowl and bird watch in this part of the river.

Impacts of the Maximum Plan – Short-term impacts to the aesthetic resources would occur with construction equipment and soil disturbance. In the long-term, recreational and aesthetic resources would improve as a result of a more diverse aquatic plant community (emergent and submergent), more diverse and resilient forest, and increased populations of waterfowl and waterbirds utilizing the area during spring and fall migration. Increased bird use of the area would enhance birdwatchers' experiences in this part of the river. Additionally, interest in waterfowl hunting would increase in the area as more birds utilize the additional habitat and aquatic food resources. These improvements would make the study area more aesthetically pleasing to many visitors; therefore, the considered action alternatives would have a positive effect on scenic or aesthetic resources.

8.17 Environmental Justice

USACE has determined that the ***No Action alternative*** and the ***Maximum Plan*** are not anticipated to disproportionally affect environmental justice areas of concern. The in-water and TSI activities are outside of a low-income population and potential impacts from these activities are minimized by the fact that residential areas are not generally located immediately adjacent to the river channel or forest management areas. Maximum Plan features are not expected to impact areas in the floodplain. In addition, the previously described social and economic benefits of the Maximum Plan (e.g., recreation and aesthetics) would benefit environmental justice areas of concern. Additional details on environmental justice can be found in Appendix B, *Economic and Social Considerations*.

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8.18 Climate Change & Greenhouse Gas Emissions

Impacts of the No-Action Alternative — The No Action Alternative should have no effect on climate change. Floodplain forest and SAV resources would lack increased resiliency that likely comes with action alternatives.

Impacts of the Maximum Plan— There is strong consensus that air temperature would increase within the study area and many projections forecast an increase in precipitation. See Appendix E, *Engineering*, Attachment A, *Hydrology and Hydraulics* for more information on climate change. Under the TSP, the increase in floodplain forest and aquatic vegetation would have a beneficial impact through the increased sequestration of CO_2. By improving individual tree vigor and resilience to disturbance events, TSI measures are likely to lessen the potential impacts of climate change on floodplain forest resources. Similarly, by improving velocities and reducing turbidities during non-flood periods, chevrons and rock mound features are likely to improve the resiliency of wild celery and other SAV species, lessening the impacts of increased flows or drought conditions. Greenhouse gas emissions due to construction are not expected to have an impact on total emissions within the study area over the 50-year lifespan of the project.

8.19 Relationship to Short-Term Uses and Long-Term Productivity

Under the Max Plan, construction activities would temporarily disrupt fish, wildlife, and human recreational use in the immediate vicinity of a given construction site. Construction activities would likely provide positive, short-term economic opportunities and a few jobs for the surrounding communities. Overall, the long-term health and productivity of the ecosystem is anticipated to increase with implementation of the proposed project. Additionally, the ecosystem benefits served within the study area would increase; therefore, short-term human use impacts would be offset by long-term increases in productivity.

8.20 Irreversible and Irretrievable Commitments of Resources

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

8.21 Probable Adverse Effects Which Cannot Be Avoided

Unavoidable impacts to freshwater mussels and other benthic organisms are likely. Access dredging and rock placement would occur in areas with moderate mussel density. In an effort to avoid and minimize these impacts, a mussel survey is planned for July 2022. Data from this survey would be used to shift and modify features that would impact high density mussel beds. Additionally, alternative access dredging routes have been laid out in the case that one of the primary access routes is unusable due to high mussel densities. All access dredging was minimized to the extent practicable by locating routes in deeper water (>6 feet).

Minor indirect effects to freshwater mussels and other benthic species are possible due to changing velocities. Rock mound and chevron structures would work to reduce flows immediately downstream, altering the existing hydraulic landscape. Smaller areas of increased velocity would also occur near the margins of these features. These immediate alterations in the hydraulic landscape of the Study Area may indirectly impact mussel species downstream,

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however these impacts are expected to be minimal. Additionally, the overall increase in flow diversity is expected to improve habitat for multiple species of mussels over the long-term.

8.22 Relationship of the Proposed Project to Land-Use Plans

The proposed project would not change the use of any floodplain or aquatic resources. Objectives and proposed features are consistent with both the Habitat Management Plan and Comprehensive Conservation Plan of the NWFR. If implemented, USACE does not expect the proposed action to alter or conflict with the Mississippi River Project Master Plan or any other projects. No Environmentally Sensitive Areas (ESA) described in the Master Plan would be impacted by these actions.

8.23 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 13.

8.23.1 Past Actions

The most significant navigation action in Pool 13 was the authorization, construction, and operation and maintenance of the 9-foot Navigation Channel Project. Construction of L&D 13 raised water levels by as much as 7 feet. Floodplains are now inundated more often and for longer durations. Temporarily inundated wetlands were converted to permanently inundated lakes and sloughs. Several fluvial processes were disrupted, which includes 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.

Portions of Pool 13 are periodically excavated to maintain the navigation channel by the District. As a result, several wingdams and closure structures have been constructed in the pool. While these areas provide some level of habitat for aquatic species, they also work to direct flows to the main channel and reduce flows in the secondary and tertiary channels. While construction of wingdams is not very likely in the near future, dredging and O&M of existing structures will continue.

Four other HREP's were constructed within Pool 13 over the last 30 years.

- Potters Marsh HREP is located in Carroll and Whiteside Counties, IL, between RM 522.5 and 526. It encompasses approximately 2,305 acres of aquatic, wetland, and terrestrial habitat. The Definite Project Report was completed in 1992 and construction was completed in 1995.
- Spring Lake HREP is located in Carroll County, IL, between RM 532.5 and 536. It encompasses approximately 3,300 acres of aquatic, wetland, and terrestrial habitat. The Definite Project Report was completed in 1993 and construction was completed in 2002.
- Pleasant Creek HREP is located in Jackson County, IA, between RM 548.7 and 552.8. It encompasses approximately 2,530 acres of bottomland woods. The Definite Project Report was completed in 2000 and construction was completed in 2002.

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- Brown's Lake HREP is located in Jackson County, IA, at RM 545.8. It encompasses approximately 453 acres of deep-water habitat.

8.23.2 Present and Foreseeable Actions.

USACE will continue to operate and maintain the 9-foot Navigation Channel Project. This includes continuation of dredging, placement of dredged material, and construction, operation, and maintenance of river regulating structures (i.e., chevrons, closing structures, and wingdams).

In the foreseeable future, additional habitat restoration actions under the UMRR Program will occur in Pool 13. Features targeting emergent vegetation and overwintering fish habitat are likely, and will work together with proposed features of this Study.

Cumulative impacts of the proposed action are not expected to be significant. The proposed actions should have positive long-term benefits to the fish, wildlife, and other natural resources inhabiting the area. This Study, in concert with the past HREP's listed above and future HREP's within Pool 13, should counter some of the past, current, and foreseeable actions described earlier.

8.24 Summary of Environmental Consequences

The Maximum Plan would result in positive long-term benefits to floodplain forest, waterfowl, and submergent aquatic vegetation in the lower portion of Pool 13. No adverse, long-term impacts to Federally-protected species are anticipated. Construction of the project would likely cause short-term adverse effects to water quality, air quality, native mussels, aesthetics, wildlife habitat, and public use. However, long-term benefits to the study area would far outweigh the short-term impacts. No negative social or economic impacts would result from the project. Table 22 summarizes the environmental impacts of the No Action and the Maximum Plan.

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Table 22. Summary of Environmental Impacts of the No Action and Maximum Plan

Public Interest Category/Measure	No Action	Maximum Plan
Geology, Topography, Soils	o	o
Floodplains	o	o
Water Resources	o	o
Air Quality	o	-
Climate	o	o
Noise	o	-
Hazardous Materials	o	o
Recreation and Aesthetics	--	-/++
Vegetation	--	++
Fish and Wildlife	--	++
Threatened & Endangered Species	--	-
Wetlands	o	o
Invasive Species	--	++
Water Quality, Wetlands, Rivers, and Streams	--	++
Land Use	o	o
Community Growth	o	o
Community Cohesion	o	o
Displacement of People	o	o
Environmental Justice	o	o
Property Value/Tax Base	o	o
Public Facilities and Services	o	++
Employment	o	o
Business Growth	o	o
Farm Displacement	o	o
Transportation	o	o
Utilities	o	o
Safety	o	o
Cultural and Historic Resources	o	o

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\+ Expected moderate short-term environmental or social benefit as a result of alternative implementation.
++ Expected moderate long-term environmental or social benefit as a result of alternative implementation.
o No or minor expected long-term environmental or social benefit or impact as a result of alternative implementation.
\- Expected moderate short-term environmental or social impact as a result of alternative
-- Expected moderate long-term environmental or social impact as a result of alternative

9 COORDINATION, PUBLIC VIEWS, AND COMMENTS

Coordination has been made throughout the planning process with the following State and Federal agencies, local entities, and members of the general public (Appendix D, *Coordination and Public Involvement*):

- U.S. Fish and Wildlife Service
- Iowa Department of Natural Resources

- Illinois Department of Natural Resources
- Illinois State Historic Preservation Office
- Iowa State Historic Preservation Office
- U.S. Geological Survey

Review comments will be summarized in this report. Letters of support provided by the Project Sponsor and partners are provided in Appendix D, *Coordination and Public Involvement*.

9.1 Coordination Meetings

Numerous coordination meetings were held with Project Sponsor and partners to discuss the Project. The following meetings demonstrate ongoing coordination:

- May 14, 2019. Feasibility Kick-off meeting with USACE, USFWS, IADNR, ILDNR, and USGS. Team began the planning process.
- August 23, 2019. Site visit with USACE, USFWS, IADNR, USGS.
- November 14, 2019. Open House held at the Clinton County Administration Building, Clinton, IA.
- June 22-24, 2020. Workshop meeting with USACE, USFWS, IADNR, ILDNR, and USGS. Existing conditions, project objectives and features, water level management, and habitat benefit models were discussed.
- October 4, 2021. Site visit with USACE, USFWS, IADNR, ILDNR and USGS.
- October 22 and 28, 2021. Meeting with USACE and USFWS to refine Project stressors, problems, objectives, and opportunities.
- November 29, 2021. General meeting with USACE, USFWS, IADNR, ILDNR, and USGS to discuss and finalize the array of alternatives to be analyzed.
- May 2, 2022. Meeting with USACE, USFWS, IADNR, and ILDNR to request concurrence on the proposed TSP.

9.2 Coordination by Correspondence

Refer to Appendix D, *Coordination and Public Involvement*, for specific coordination efforts to date.

9.3 Public Views and Comments

An open house was held on November 14, 2019, in Clinton, IA to discuss the initiation of the Feasibility Study and the proposed Project with interested members of the public and to gather public input (see distribution list in Appendix D, *Coordination and Public Involvement)*. Representatives from the USACE, USFWS, IADNR, and ILDNR were present to talk one-on-one with attendees. Displays were placed around the room showing the UMRR program, information about USACE, historic and current imagery of the Project, and recent aerial imagery. Attendees indicated they used the area of wildlife viewing, recreation, fishing, boating, and hunting. Generally, attendees commented on the desire for more island creation and submerged aquatic vegetation beds for diving ducks, dredging out backwater areas that have silted in over the years, creating fish overwintering habitat nearshore and additional public recreational access points, and concern about pelican population limiting fish stability in the pool.

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The Lower Pool 13 HREP Feasibility report would be provided for public comment and input integration. A public meeting is planned for the winter of 2022 to present the TSP to interested members of the public and to gather their input. A summary will be included in the report after the meeting.

9.4 Implementation Responsibilities

This section discusses the implementation responsibilities for the USFWS (Project Sponsor) and USACE. The responsibility for plan implementation and construction falls to USACE as the lead Federal agency. The USFWS would be responsible for OMRRR for lands they manage as part of the project. Performance evaluation, which includes monitoring of physical/chemical conditions and some biological parameters, is a USACE responsibility.

A *Memorandum of Agreement* is the formal agreement that would be entered into by USACE and the USFWS before implementation of the project. The Memorandum of Agreement (MOA) describes obligations for constructing, operation, and maintaining the implemented features of the Lower Pool 13 HREP (Appendix A, *Environmental*, Attachment G, *Memorandum of Agreement)*. This draft MOA is used in lieu of a separate List of Items of Local Cooperation normally used in Specifically Authorized and Cost Shared projects because:

1. This project is 100% Federally-funded (per Section 906(e) of WRDA 1986) because it is taking place on lands managed as a national wildlife refuge.

2. The project has no non-Federal sponsor because the project is 100% Federally-funded.

3. OMRRR is also a 100% Federal cost when the project is located on Federal lands, and therefore, per Section 107(b) of WRDA 1992, OMRRR costs shall be borne by the Federal agency that is responsible for the management activities on such lands.

9.4.1 U.S. Army Corps of Engineers

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

9.4.2 U.S. Fish and Wildlife Service

The USFWS is the Federal Sponsor and has provided technical and other advisory assistance during all phases of the study and will continue to provide assistance during Project implementation. OMRRR will be further specified in the Project OMRRR Manual to be provided by USACE prior to final acceptance of the Project by the Federal Sponsor.

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10. CONCLUSION

Full realization of the potential habitat value in the Lower Pool 13 HREP area has been hindered by increased water levels, sedimentation, wind fetch and erosive forces from the implementation of the UMRS 9-Foot Navigation Channel Project, which has led to suboptimal velocities and poor water clarity. These factors have negatively affected aquatic vegetation as well as reduced recruitment of native tree species. Restoring optimal SAV growing conditions for duck habitat and restoring floodplain areas that would enhance coverage, species richness and age distribution would allow the study area to realize the highest benefit to desirable plant, animal, and fish species.

The restoration measures of the TSP (chevron and rock mound structures, timber stand improvements, and island creation) are designed to meet the Project's objectives (see Section 3, *Problem Identification*).

Assessment of the future with-Project scenario shows definite increases in 711 total habitat units over the 50-year period of analysis, benefitting target species and a majority of other aquatic and floodplain forest dwelling species. These increases represent quantification of the projected outputs: improved habitat quality and increased preferred habitat quantity.

11. RECOMMENDATION

The selected plan is tentative. Once the plan has been vetted through the public, stakeholders, local, state, and Federal agencies, the USACE will evaluate all comments and decide whether to pursue it as the recommend plan to construct.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS,
AND CLINTON COUNTY, IOWA

RECOMMENDATIONS

I have weighed the outputs to be obtained from the full implementation of the Lower Pool 13 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 constructing chevrons, rock mounds, island construction and implementing timber stand improvements.

The total Federal estimated Project cost, including general design and construction management, is approximately $38,797,000.

At this time, I further recommend that funds in the amount of $4,816,000 be allocated for the Project's Planning, Engineering, and Design.

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Date

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Jesse T. Curry, P.E.
Colonel, US Army
Commander & District Engineer

FINDING OF NO SIGNIFICANT IMPACT

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS,
AND CLINTON COUNTY, IOWA

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The U.S. Army Corps of Engineers, Rock Island District (USACE) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. This IFR/EA dated 30 August 2022, for the Lower Pool 13 Habitat Rehabilitation and Enhancement Project addresses ecosystem restoration opportunities and feasibility in the Pool 13, Upper Mississippi River (UMR) river miles (RM) 522.5-529.0. The final recommendation is anticipated to be 1 September 2023.

The Final IFR/EA, incorporated herein by reference, evaluated various alternatives that would 1) maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and 2) maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem in the study area. The Recommended Plan is the National Ecosystem Restoration (NER) Plan and includes:

- chevron and rock mound construction (1992 acres of diving duck habitat)
- timber stand improvement (535 acres)
- mussel and fish habitat incorporation (to be determined in plans & specifications)

In addition to a “No Action” plan, three alternatives were evaluated. The alternatives included distinct combinations of chevron and rock mound construction, island construction, and timber stand improvement. Non-structural measures were considered but not selected for alternative formulation because they were found to be incomplete, ineffective, or not within the scope of the authorized project.

SUMMARY OF POTENTIAL EFFECTS

For all alternatives, the potential effects were evaluated, as appropriate. Table 1 is a summary assessment of the potential effects of the Recommended Plan:

Table 1: Summary of Potential Effects of the Recommended Plan

	Insignificant Effects	Insignificant Effects as a Result of Mitigation	Resource Unaffected By Action
Aesthetics	☐	☐	☒
Air Quality	☐	☐	☒
Aquatic Resources/Wetlands	☒	☐	☐
Invasive Species	☒	☐	☐
Fish and Wildlife Habitat	☐	☐	☒
Threatened/Endangered Species/Critical Habitat	☒	☐	☐
Historic Properties	☒	☐	☐
Other Cultural Resources	☒	☐	☐
Floodplains	☒	☐	☐
Hazardous, Toxic & Radioactive Waste	☐	☐	☒
Hydrology	☒	☐	☐
Land Use	☐	☐	☒
Navigation	☐	☐	☒
Noise Levels	☐	☐	☒
Public Infrastructure	☐	☐	☒
Socio-Economics	☐	☐	☒
Environmental Justice	☐	☐	☒
Soils	☐	☐	☒
Tribal Trust Resources	☐	☐	☒
Water Quality	☐	☐	☒
Climate Change	☐	☐	☒

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All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the Recommended Plan. Best Management Practices as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts.

No compensatory mitigation is required as part of the Recommended Plan.

Public review of the draft IFR/EA and FONSI will be completed in May 2022.

ENDANGERED SPECIES ACT:

Pursuant to the Endangered Species Act of 1973, as amended, Section 7 consultation is ongoing. Official species determinations will be updated following a survey of mussel resources within the project area. Formal consultation and the development of a BA/BO is likely.

NATIONAL HISTORIC PRESERVATION ACT: The National Historic Preservation Act (NHPA) of 1966, as amended by Public Law 96-515 (94 Stat. 2987), established national policy for historic preservation, authorized the Secretary of the Interior to expand and maintain a National Register of Historic Places, and created the Advisory Council on Historic Preservation. Section 106 specifies that Federal agencies, before approval of any expenditure or before issuance of any license, must consider the effect of the action on any property included in or eligible for the National Register of Historic Places. To be in compliance with NHPA, the USACE will initiate consultation with the Iowa and Illinois SHPOs and THPOs for tribes that might attach religious and cultural significance to properties within the Study Area: Ho-Chunk Nation of Wisconsin,

Kickapoo Tribe of Oklahoma, Miami Tribe of Oklahoma, Osage Nation, Sac and Fox Nation of Missouri in Kansas and Nebraska, Sac and Fox Nation, Oklahoma, Sac and Fox Nation of the Mississippi in Iowa, and Winnebago Tribe. This consultation will be completed prior to the approval of the Recommended Plan (Appendix D).

Consultation and Coordination with Indian Tribal Governments (E.O. 13175)
All Federal agencies are required under E.O. 13175 to consult with Indian Tribal Governments when considering policies that will impact Tribal communities. The USACE will initiate consultation with THPOs of X tribes for NHPA purposes (Appendix D).

CLEAN WATER ACT SECTION 404(B)(1) COMPLIANCE:

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the Recommended Plan has been found to be compliant with conditions laid out in Nationwide Permit #27 and section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Appendix A, Attachment C *Clean Water Act Section 404(b)(1) Assessment* of the IFR/EA.
401 WQC: Water quality certification pursuant to section 401 of the Clean Water Act is included with the issuance of Nationwide Permit NO. 27.

OTHER SIGNIFICANT ENVIRONMENTAL COMPLIANCE

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

FINDING

Technical, environmental, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.* All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the Recommended Plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

DRAFT

_____
Date

_____
Jesse T. Curry, P.E.
Colonel, US Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX A
ENVIRONMENTAL

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX A
ENVIRONMENTAL

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ATTACHMENT A
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1. INTRODUCTION

The following sections present an ecological habitat 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 *Pool 13 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 each alternative. The evaluation was conducted by a multi-agency team of biologists from the U.S. Fish & Wildlife Service (USFWS); the Iowa Department of Natural Resources (IADNR); the Illinois Department of Natural Resources (ILDNR); and the U.S. Army Corps of Engineers (USACE), Rock Island District.

2. EXISTING AND FUTURE WITHOUT PROJECT BIOLOGICAL CONDITIONS

2.1. Submerged Aquatic Vegetation

2.1.1. LTRM Data Collection

The Long-Term Ecological Monitoring Element of the Upper Mississippi River Restoration (UMRR) Program integrates long-term monitoring, research, modeling, and data management to provide critical knowledge about the Upper Mississippi River's health and resilience. This provides a solid foundation upon which to base management actions, habitat restoration, and policy. With data collected over more than 25 years, the UMRR's database is one of the most extensive and comprehensive of any large river system in the world. Pool 13 is considered a "trend pool" for data acquisition and analysis in the Upper Mississippi River System (UMRS), and has a significant data set available dating back to 1988 for water quality and 1991 for aquatic vegetation.

Water quality monitoring in the pool is accomplished with a combination of Fixed Site Sampling (FSS) and Stratified Random Sampling (SRS). For FSS, a relatively small number of nonrandomly-selected fixed sites are monitored repeatedly at intervals ranging from once every two weeks to once every two months. Water quality SRS occurs at a larger number of randomly selected locations at seasonal (quarterly) intervals. Some of the data available for review include water clarity, velocity, total suspended solids (TSS), total nitrogen and phosphorous, and chlorophyll.

Vegetation monitoring was conducted using transects prior to 1998, when the current SRS protocol was implemented. SRS data collected from 1998 to present were used to inform existing conditions of the Study Area. Data are collected on the distribution, frequency of occurrence, and relative abundance of aquatic vegetation within the pool, including the following aquatic vegetation types: submersed, rooted floating-leaved, emergent, algae, and non-rooted floating.

Water quality and vegetation data are available for download at https://umesc.usgs.gov/ltrm-home.html.

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2.1.2. LTRM Data & Existing Conditions

Summer water quality data and vegetation sampling data collected by LTRM was used to determine existing conditions within the project area. The percent frequency aquatic vegetation data has been used to create surface maps of the pool for each sampling year, depicting the probability of occurrence for different types of aquatic vegetation. These surface maps indicate the relative probability that a sampling plot was occupied by aquatic vegetation. The dark green represents the highest probability of vegetation and light blue represents the lowest probability of vegetation detections. Areas that are black are either non-aquatic areas or insufficient samples for precise interpolations.

These annual surface maps (Figure A-1) are generated using frequency data obtained from individual sampling locations, whereby presence in a sampling location (pixel) is a probability of 1 and absence is a probability of zero, to interpolate the probability that the species or group of species would be present or absent within intervening pixels where sampling did not occur. The interpolations were halted when hitting stratum boundaries and when distances among sampling points was greater than 150 m. The value used for interpolation is a probability index, which is the sum of six rakes at each sampling location where submerged aquatic vegetation was detected.

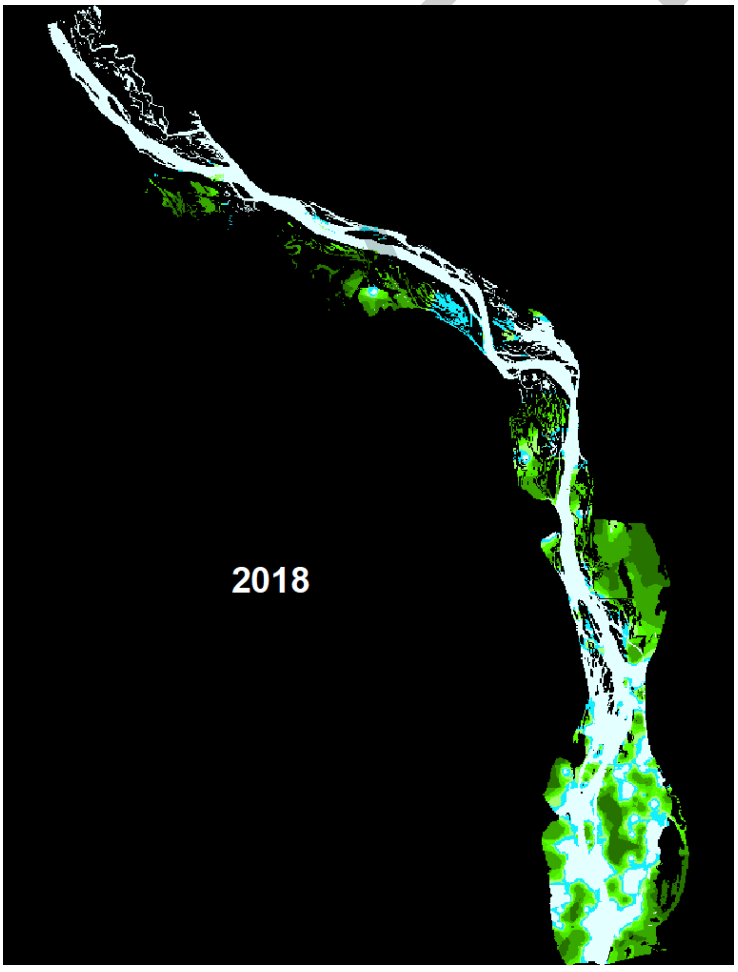

Figure A-1. LTRM Surface Map Showing Probability of Occurrence of Wild Celery in 2018.

Surface maps showing probability of occurrence of wild celery were combined with summer water quality SRS data for each year of sampling. Velocity and turbidity were the two main water quality variables used to assess existing conditions within the pool. Water quality sampling points were deemed suitable for SAV when (1) velocity was between 10-20 cm/s and (2) turbidities were less-than 20 NTU. For additional details on design criteria for wild celery, see Appendix E. Points where optimal velocity and turbidity were observed were given a suitability rating of 2. Points with only one of these parameters meeting the criteria were assigned a suitability rating of 1. Points that met neither velocity nor turbidity requirements were assigned a habitat suitability rating of 0. Points where one or neither of these criteria were met were used to identify areas in need of restored processes. Also, by overlaying these habitat suitability points over wild celery probability of occurrence maps, the team was able to verify these design criteria did correspond with vegetation responses. Habitat suitability maps showing wild celery surface mapping and summer SRS water quality data for 2018 is shown in Figure A-2. Maps were created for all years that water quality and vegetation data was available, dating back to 1998.

Additional data on SAV and associated substrate was gathered through field surveys 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 of this Appendix.

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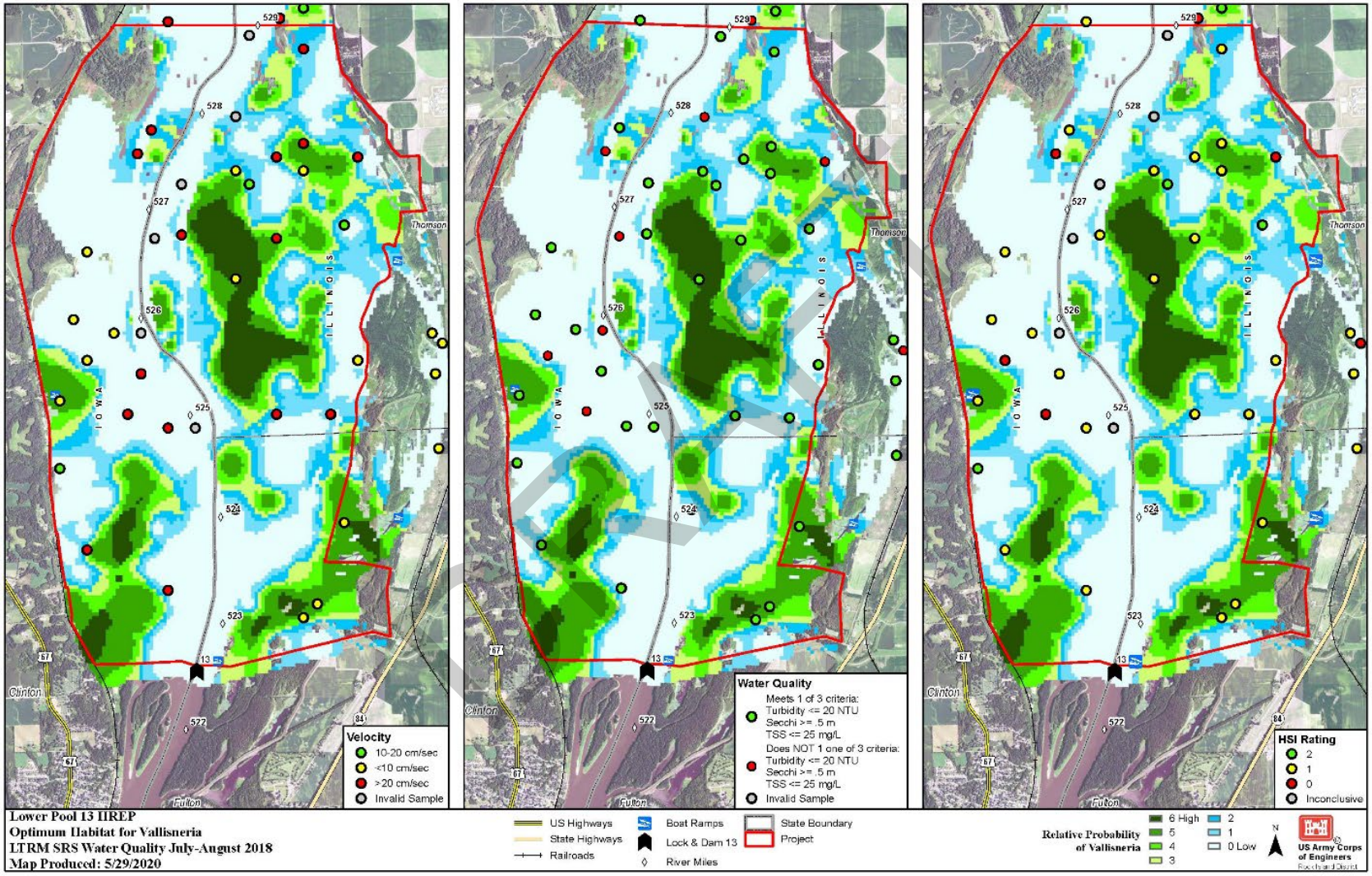

Figure A-2. Habitat Suitability Mapping Showing Summer Water Quality Sampling (Velocity and Turbidity) as Well as Probability Maps for Wild Celery

2.2. Floodplain Forest Habitat

The construction of Lock and Dam 13 severely altered the hydrology of the Project area. Increased water levels significantly altered the hydrology and forest conditions of the study area. Increased inundation during flood events has restricted species diversity of the study area, and many of the mature trees that make up the overstory layer are reaching the end of their lifespan. 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. Detailed data on existing forest conditions were pulled from USACE's Forest Management Geodatabase (FMG) and additional data was collected during stand walks in 2020 and 2021. FMG data is included in Table A-1 and represents a summarization of data from multiple forest inventory plots within each site. This information, combined with LIDAR survey data, GIS analyses, H&H modeling, and consensus of the resource managers was used to predict FWOP conditions and helped inform TSI treatments found in the TSP. Detailed information can be found in Attachment F of this appendix.

Table A-1. FMG Summary Data for TSI Sites 1-4.

SITE	Basal Area	Trees/acre	Species Richness	Overstory Closure (%)	Overstory Height (ft)	Understory Height (ft)	Tree Age (yr)
1	114.4	250.5	7	72.4	75.9	7.2	75
2	136.1	273.0	13	66.1	93.8	9.6	68
3	115.3	362.4	13	84.5	85.3	10.5	77
4	97.4	279.9	10	58.0	83.4	8.5	85

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 USACE and reviewed by a multi-agency team which included representatives from the USFWS, the IADNR, and the ILDNR. Benefits to SAV were quantified through the use of Engineering Circular 1105-2-412, *Assuring Quality of Planning Models* and the *Migratory Habitat Model for Diving Ducks Using the Upper Mississippi River* (Devendorf, 1995). Floodplain forest benefits were quantified through the use of the Corps-certified *Floodplain Forest HSI Model (USACE, 2021).*

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 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 Project 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.

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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 treatment area within a floodplain forest. 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. Acreage differs for future without project and with project alternatives due to the trade-off between unlimiting habitat (ex: wetland) for limiting habitat (ex: aquatic).

- **Capability**. Can be accurately quantified with a high degree of certainty
- **Limitation**. Grossly underestimates the areal extent of ecological benefits from each management measure as 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 of features 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. Potential area of influence is an estimated area that is more consistent with the guidance calling for a systems approach to restoring “degraded ecosystem function” (ER 1165-2-501) and this was critical when assessing benefits to aquatic vegetation. It was difficult to devise consistent rules for defining this area, however hydraulic modeling, aerial imagery, agency input, and best professional judgement were used to develop a consistent rule that could be applied to all alternatives equally. This ensures that any uncertainty and error that

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exists in our assumptions are applied evenly across all alternatives, ensuring the ranking of alternatives remains the same.

- **Capability.** Fully captures the area of ecological benefits of a given management measure

- **Limitation**. Difficult to estimate with a degree of certainty

For this Project, of the three scales considered, using the potential area of influence was most appropriate. In some cases/target years, the potential area of influence was the same as the area of restored process. Use of the potential area of influence became critical when estimating benefits in the Future With Project scenarios. The action footprint approach drastically underestimated benefits provided by features and did not fully measure the impact of the Project.

Table A-2. Habitat Types and Areas Evaluated for this Assessment

Habitat Type	Evaluation Area	Action Footprint[1] (acres)	Area of Analysis (acres)	HSI Model
Aquatic	Southwest Corner	35	1991	Diving Duck
Floodplain Forest	N Elk River (Site 1)	50	120	Floodplain Forest
	S Elk River (Site 4)	91	174	Floodplain Forest
	S Elk River (Site 3)	71	121	Floodplain Forest
	S Elk River (Site 2)	55	120	Floodplain Forest
Total		**302**	**2,526**	

[1]Action footprint describes silvicultural treatment area (floodplain forest) and total feature footprint area (aquatic).

3.1.4. Area of Analysis

While the area of restored process and potential area of influence strategies were used to assess the impacts of features and their associated benefits, the area of analysis represents the overarching boundary within which all features lie. This includes areas that experience improvements from features as well as areas not impacted by feature construction. For the Diving Duck Model, an area of analysis of 1991 acres was used. This was appropriate for two reasons: (1) diving ducks require large, open areas in order to feed, loaf, and rest during migration, allowing them to gather in large numbers and spot potential danger from a long way off, and (2) this area encompassed all potential features evaluated for all alternatives.

3.2. Quality of SAV Benefits

The methodology utilized for evaluating benefits to SAV 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 or groups of species (guilds). 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) represents how suitable a given habitat is, with a value of 1 representing optimal habitat. The index 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.

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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). Habitat units are calculated for select Target Years (TY) (existing, 1, 5, 10, 20, 50) and annualized (using IWR Planning Suite NER Annualizer) over the life of the Project to derive Average Annual Habitat Units (AAHUs). TY 0 reflects the existing conditions of the area in terms of habitat units. TY 1 was used to assess features immediately following the completion of construction. TY 5 represents the year in which SAV is expected to decline below 20 percent cover under the No Action Alternative. TY 10 is when SAV is expected to colonize the Area of Restored Process for each of the action alternatives. TY 20 is when SAV declines to below 10 percent cover within the Study Area under the No Action Alternative. This TY is also when SAV reaches its maximum percent cover under the action alternatives, expanding into the Potential Area of Influence. AAHUs are used as the output measurement to compare the features and alternatives for the proposed Project.

3.2.1 Submerged Aquatic Vegetation (SAV)

USACE approved the *Migratory Habitat Model for Diving Ducks Using the Upper Mississippi River* on November 15, 2021 (per EC 1105-2-412). This model was used to assess benefits to diving ducks through the increase in forage and habitat resulting from construction of rock mounds (RM features), chevrons (CV features), and island IH-4 . SAV is a target food source for many species of diving ducks on the Upper Mississippi River (UMR) and this model best captured the benefits associated with increasing abundance of SAV in the Project area.

The following assumptions were made in applying the Diving Duck Migration Model:

Baseline Condition. Detailed water quality and vegetation data has been collected within the project area since 1998 through the UMRR Long Term Resource Monitoring Program (LTRM). Due to the length of data collection and location, it was assumed that data collected in the “Impounded Area” of Pool 13 was representative of the smaller project area. Vegetation sampling of both emergent and submerged vegetation occurred during the growing season in Pool 13 between July and August. It is assumed that any differences in sampling date across years are negligible. Two of the input variable within the Diving Duck Migration Model are “percent cover of SAV” and “percent cover of emergent vegetation. The LTRM data for SAV is not available as percent cover values, but is instead provided as percent frequency as an index of abundance (i.e., rake scores). For our modeling purposes, it is assumed that percent frequency is an acceptable proxy for percent cover. Percent cover for emergent vegetation is provided by LTRM and was used as an input variable within the model. Baseline conditions were calculated using most recent LTRM vegetation data and did include the use of hydraulic modeling results. The taxonomic identity and abundance of invertebrates is also a diving duck model input variable, and multiple site visits confirmed the present of macroinvertebrates utilizing SAV for food/habitat. It is assumed that the presence of SAV indicates the presence of at least one key taxonomic group of macroinvertebrates.

Future Without Project Conditions. Future conditions of aquatic vegetation were based on trend analysis of LTRM vegetation sampling data (Figure A-3). The key assumption using this data was that SAV will decline to a percent frequency of 0 by the year 2055 (Target Year 20). It is assumed that stressors identified in Section 3.1.1 of the main report are driving this decline. Emergent vegetation presence within the project is expected to remain low to nonexistent. The loss of SAV is assumed to result in the loss of macroinvertebrates that utilize the vegetation. With the loss of SAV and macroinvertebrates it is unlikely that Pool 13 will continue to support migratory waterfowl in large numbers as it does today.

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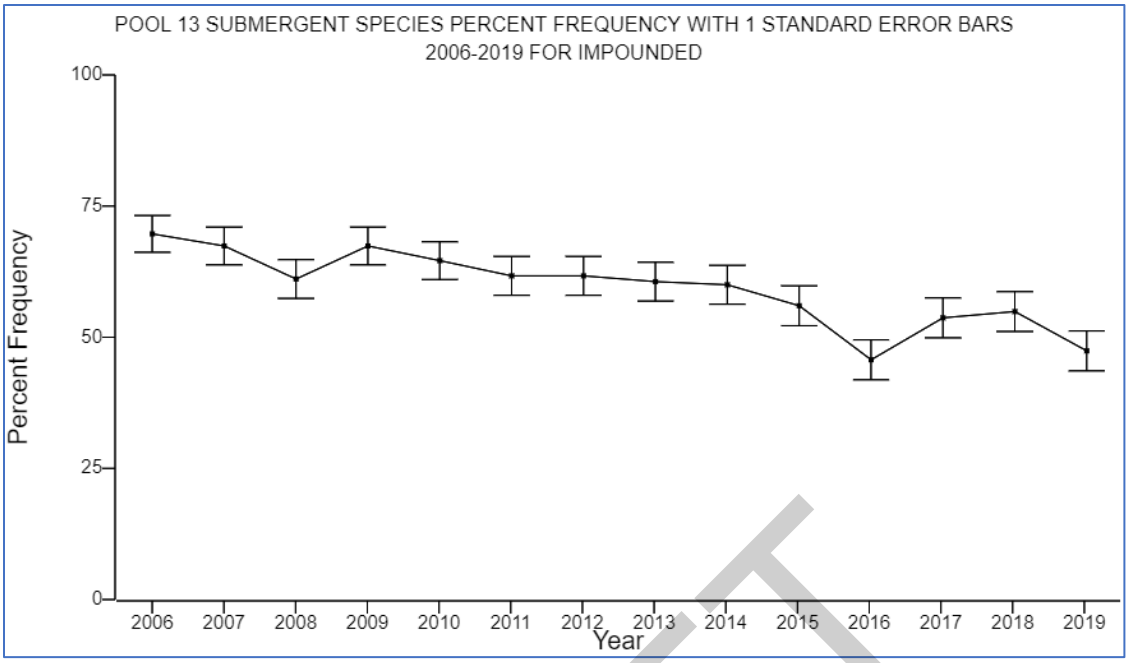

Figure A-3. SAV Percent Frequency Trends From Peak (2006) to Present.

Future With Project Conditions. Creation of islands, chevrons, and rock structures would reduce velocities and wind-driven waves within the project area. Individual SAV species, such as wild celery, require optimal conditions of velocity, depth, and turbidity in order to establish and persist. The rock mounds, chevrons, and island features were designed to provide areas of optimal velocities (15.5 cm/s) and reduced wave action, which would lead to lower turbidities (< 20 NTU) in areas with appropriate depths (1.5-6 ft). Areas deeper than 6 ft are not expected to support SAV as not enough light penetrates the water column. Additionally, the diving duck model utilizes a maximum depth of 6 ft based on the average maximum depth that many species of diving ducks will dive to. Additional details on design criteria for wild celery are included in Appendix E. Hydraulic modeling showed the impact of these features on both velocities and resuspension of sediment due to waves. ST Wave modeling was used to determine wave heights on the leeward side of features. Wave heights were then used to calculate the probability of sediment resuspension for those areas. Model results demonstrated that these low elevation rock structures would create core areas of optimal conditions for SAV species. These core areas have (1) depths between 1.5-6 ft, (2) velocities less-than 15.5 cm/s (.5 ft/s), and (3) protection from sediment resuspension from at least 2 wind directions. These areas represent the Area of Restored Process discussed previously and are quantified using hydraulic modeling. Details on the hydraulic modeling involved can be found in Appendix E. Wild celery and other species of SAV are expected to colonize these areas first. Over time, the establishment and presence of SAV will influence additional acreage nearby through velocity reduction and wave energy dissipation. This area represents the Potential Area of Influence.

To estimate this potential area of influence, hydraulic modeling outputs of velocity and wave heights were compared to aerial imagery and data on known extents of SAV. Existing cover of SAV was approximately 30 percent greater than the areas shown through hydraulic modeling. This is likely due to the limits of hydraulic modeling, as it is unable to incorporate vegetation structure into its modeling framework. The team and agency partners agreed that the additional 30 percent of SAV cover observed likely occurred due to existing vegetation's influence on velocity and wave action. For the purposes of this habitat benefits evaluation, it is assumed that

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vegetation within core areas will increase by a maximum value of 30% due to this potential area of influence. This number was calculated based on the difference between the predicted areas of optimal conditions (baseline) and the actual observed size of aquatic vegetation beds. This assumption was applied equally to all alternatives.

3.3. Quality of Floodplain Forest Benefits

USACE certified the Floodplain Forest HSI Model on August 16, 2021. This model was used to quantify the habitat benefits associated with Timber Stand Improvement (TSI) features.

Baseline Condition. Floodplain forest data was collected during the 2019 and 2020 growing seasons. Four sites representing approximately 535 acres were identified as requiring restoration. Floodplain forest within the project area is comprised of mature forest having well-established trees in the canopy. The primary forest community type is silver maple with very limited natural regeneration and desirable understory establishment. Overall diversity of the area is low. The forest management areas collectively have trees in the canopy that are over 80 years old and will not persist past the life of this project. The chief concern is there is limited or no adequate natural regeneration of trees to replace the expected mortality of trees in the canopy that are reaching expected maximum age of the most prevalent tree species. In addition, there are scattered canopy gaps within the mature and overstocked forest condition inundated with invasive species. These canopy gaps were likely formed by the death of overmature trees or windthrow during storm events. The canopy gaps generally include the invasive species reed canary grass and Japanese hops. Both of these species are shade intolerant and require direct sunlight to grow and persist. Therefore, a method to control and reduce the spread of these invasive species is to densely plant cuttings or container trees to cast shade.

Future Without Project Conditions. It is assumed that the forest will experience severe change over the 50-year lifespan of this project if no action is taken. Mature trees will die throughout the forested area of the project, leaving behind large canopy gaps with little to no understory or natural regeneration of native species. These canopy gaps will then allow for further establishment of invasive species and prevent future regeneration. It is likely that an overall transition to an open canopy structure will occur. There are currently very few hard mast trees across the forested area that could provide a seed source for natural recruitment. Undesirable species such as mulberry and boxelder are likely to take their place. As these mature trees die, diversity is expected to decrease.

Future With Project Conditions. Removal of overmature trees coupled with planting of desirable species will provide the forest with a necessary increase in diversity and age structure. It is assumed that the temporary reduction in canopy cover caused by tree cutting will be back to desired levels (70-80%) by Target Year 25. Thinning of undesirable and overmature trees will reduce stress on desirable tree species, creating a robust midstory and encouraging natural recruitment. Shrub plantings will introduce additional species and structural diversity, providing nesting habitat for both migratory and resident bird species. Additionally, treatment of canopy gaps and planting of trees within these gaps will shade out existing and future invasive species.

4. HABITAT EVALUATION RESULTS

Section 4.1 of the main report describes each potential Project measure in detail. After a lengthy process involving preliminary analysis, identification of compatibility, dependencies, and input

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from resource agencies, the PDT identified a final list of measures to be formulated into alternatives before this habitat quantification exercise

Aquatic Vegetation Benefits. Table A-2 provides the final suitability index (SI), acres for each alternative, habitat units, gross AAHUs, and net AAHUs (lift) for each target year under consideration.

Floodplain Forest Benefits. Table A-3 provides the final suitability index (SI), acres for each alternative, habitat units, gross AAHUs, and net AAHUs (lift) for each target year under consideration.

Table A-3. Benefit Evaluation Results for Aquatic Vegetation Measures Using the Diving Duck Migration Model

				Output		
Alternative	**Year**	**SI**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
No Action	0	0.55	1991.5	1089	685	0
	1	0.55	1991.5	1089		
	5	0.48	1991.5	956		
	10	0.48	1991.5	956		
	20	0.28	1991.5	558		
	50	0.28	1991.5	558		
SAV	0	0.55	1991.5	1089	1310	625
	1	0.55	1991.5	1089		
	5	0.55	1991.5	1089		
	10	0.55	1991.5	1089		
	20	0.67	1991.5	1328		
	50	0.68	1991.5	1354		
Efficient	0	0.55	1991.5	1089	1220	535
	1	0.55	1991.5	1089		
	5	0.55	1991.5	1089		
	10	0.55	1991.5	1221		
	20	0.61	1991.5	1248		
	50	0.63	1991.5	1248		
Max	0	0.55	1991.5	1089	1310	625
	1	0.55	1991.5	1089		
	5	0.55	1991.5	1089		
	10	0.67	1991.5	1328		
	20	0.68	1991.5	1354		
	50	0.68	1991.5	1354		

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Table A-4. Benefit Evaluation Results for Floodplain Forest TSI Measures Using Floodplain Forest HSI Model

				Output		
Alternative	**Year**	**SI**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
No Action	0	0.38	535	203	147	0
	1	0.38	535	203		
	25	0.26	535	140		
	50	0.20	535	107		
SAV	0	0.38	535	203	147	0
	1	0.38	535	203		
	25	0.26	535	140		
	50	0.20	535	107		
Efficient	0	0.38	535	203	323	176
	1	0.45	535	241		
	25	0.65	535	346		
	50	0.68	535	364		
Max	0	0.38	535	203	331	184
	1	0.45	535	241		
	25	0.65	535	349		
	50	0.73	535	390		

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 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.

The results of the habitat analysis support the premise that the functions and values of the study area can be restored by implementing one of the described cost effective alternatives or best buy plans (see Section 5, *Evaluation and Comparison of Alternatives* for a review of CEICA and TSP selection process). The HEP analysis indicates substantial improvements in both aquatic and floodplain habitat within the study area. Existing aquatic vegetation would receive protection from high velocities, wind-driven waves, and increased turbidity while SAV would expand into new areas within the study. Floodplain forest habitat would be greatly improved through the TSI measures described in Appendix A, Attachment F. Diverse plantings and thinning of undesirable species would create structural diversity for multiple species of birds, mammals, and invertebrates. Due to the acreage of the Project floodplain, it is difficult for a single Project to re-create conditions which were present prior to the 9-foot navigation channel implementation. However, the TSP would make great strides in restoring the structure and function those conditions provided.

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ATTACHMENT B
MONITORING AND ADAPTIVE MANAGEMENT PLAN

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Table B-1. Estimated Performance Monitoring and Adaptive Management Costs (March 2022 Price Level) B-9

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1. INTRODUCTION

This appendix presents the feasibility level monitoring and adaptive management plan for the Pool 13 Rehabilitation and Enhancement Project (HREP). This plan identifies and describes the monitoring and adaptive management activities proposed for the Project and estimates associated costs and duration. This plan will be further developed in the pre-construction, engineering, and design (PED) phase as specific design details are made available.

1.1. Authorization

Section 2039 of the Water Resources Development Act (WRDA) of 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 that 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), knowledge gained from monitoring one HREP can be applied to other HREPs. Opportunities for this type of adaptive management are common within the UMRR, which builds upon lessons learned from other HREP projects and Long Term Resource Monitoring (LTRM).

1.2. Procedure: Drafting the Plan

The Upper Mississippi River Restoration Coordinating Committee collaborated to establish a general framework for adaptive management to be applied to all UMRR projects as part of the Implementation Issues Assessment. The framework for adaptive management is consistent with the implementation guidance provided in Section 2039 of the 2007 WRDA. The UMRR adaptive management framework includes systemic, set-up, and implementation phases (Figure B-1).

1.3. Adaptive Management Team Structure

To execute a systemic adaptive management strategy for the UMRR, a communication structure has been identified (Figure B-2). The structure establishes clear lines of communication and data exchange between UMRR Management, HREP Planning and Sequencing Framework Teams, LTRM, Project Delivery Teams (PDT), and stakeholders. Successful implementation will require the right resources being coupled at the right time to support the framework components.

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UMRR HREP AM Planning Flowchart

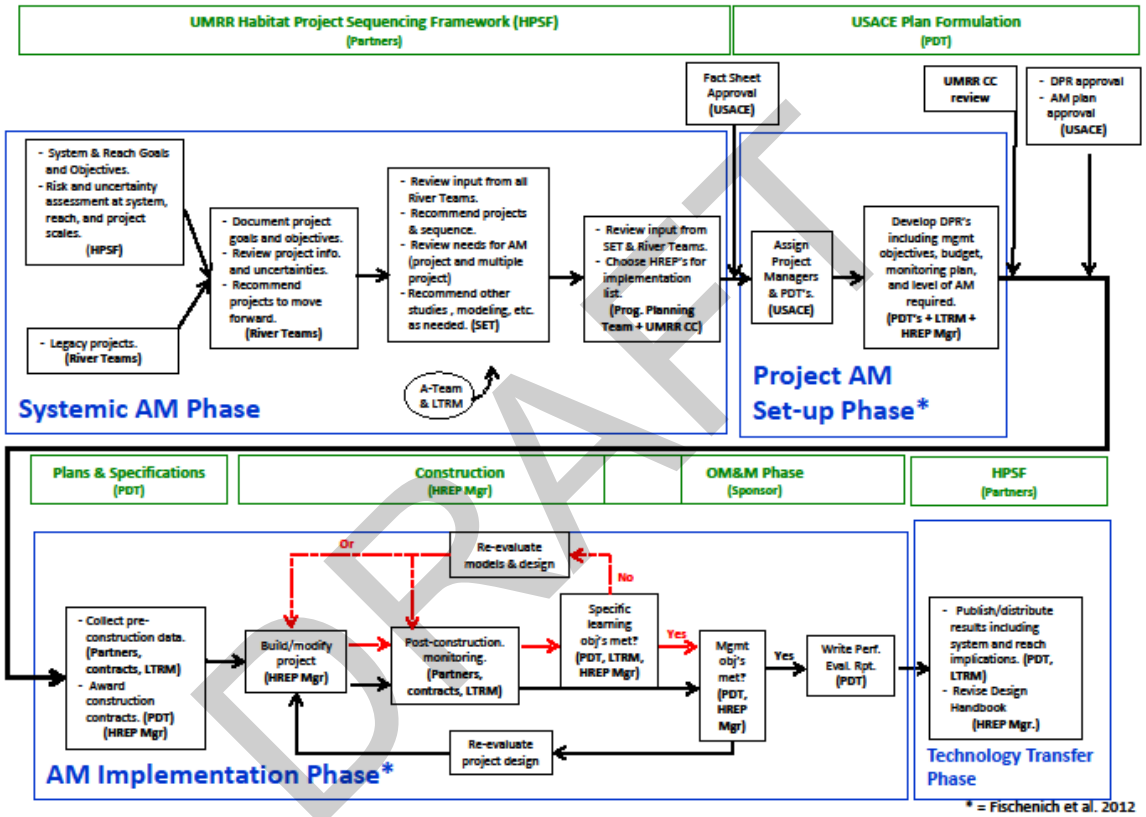

Figure B-1. UMRR HREP Adaptive Management Planning Flowchart

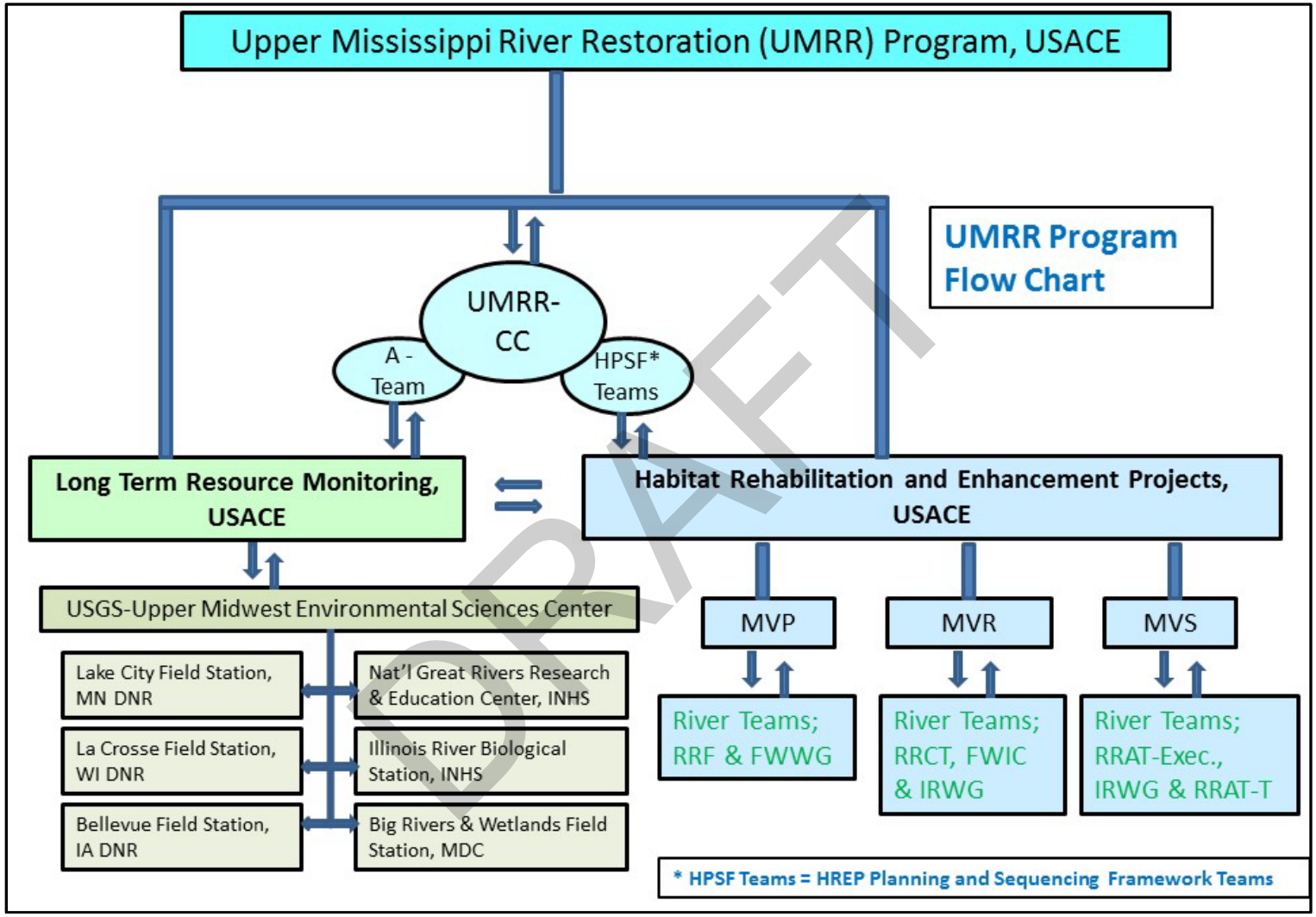

Figure B-2. UMRR Structure

2. PROJECT ADAPTIVE MANAGEMENT PLANNING

The resulting adaptive management plan for the Pool 13 HREP describes and discusses whether adaptive management is needed in relation to the Tentatively Selected Plan (TSP) identified in the Feasibility Study. The plan also identifies how adaptive management would be conducted for the study 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 the identification of performance criteria which specify the conditions that define project success.

The current Adaptive Management Plan for this Project reflects a level of detail consistent with the Project 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. This Section of the Adaptive Management Plan:

- identifies the restoration goals and objectives identified for the Project;
- presents a conceptual ecological model that relates management actions to desired Project outcomes; and
- identifies sources of uncertainty that could be addressed through the use of adaptive management for this Project.

Subsequent sections describe monitoring, assessment, and decision-making in support of adaptive management. 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.

2.1. Project Goals and Objectives

The Pool 13 HREP features target two main project objectives, namely:

1. Restore and enhance submerged aquatic vegetation coverage over the period of analysis, and

2. Restore and enhance coverage, species richness, and age distribution of the forest community over the period of analysis.

The strategic locations and design of the features included for each objective work to restore the missing characteristics of the Project. Low-elevation rock mounds, chevrons, and islands provide areas of optimal velocity, reduced wind-driven wave action, and improved water clarity for establishment and persistence of SAV. These conditions increase the abundance and coverage of SAV which provides important food sources for migrating waterfowl. These features also provide an opportunity for increased flow diversity and improved habitat for native mussels.

Timber stand improvement (TSI) actions address the aging forest structure and overall loss of resiliency, structure, and diversity of floodplain forest. Restoration of species richness and structural diversity of the forest provides improved stopover habitat for neotropical migratory birds, increased roosting, maternity, and foraging habitat for bats, and increased acreage and diversity of pollinator habitat. Restoration and enhancement of aquatic vegetation and terrestrial

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forest communities will benefit a multitude of species prioritized by resource management agencies and valued by the public.

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. Following is a list of uncertainties associated with restoration of aquatic vegetation and floodplain forest habitat in the Pool 13 HREP.

2.2.1. Floodplain Forest

The District evaluated the level of uncertainty and risk associated with TSI actions. It is expected that tree and shrub plantings will experience some level of mortality within the first 10 years post construction. If the level of mortality exceeds that which is reasonable and expected, Adaptive Management measures to supplement plantings may be required. Monitoring will be conducted to monitor mortality and determine project success.

2.2.2. SAV Cover

It is expected that 1) low-elevation rock mound and chevron features will reduce velocities and sediment resuspension due to wave action for species of SAV and 2) SAV will quickly colonize areas where these optimal conditions are created. It is also expected that once SAV is established in areas with newly created optimal conditions, the physical structure of the SAV will further decrease velocities and reduce wave action in its immediate vicinity, providing a shadow effect outside of the immediate area of impact of constructed features. Both of these expectations remain uncertain. If monitoring demonstrates flows have been reduced below optimal and increased flow is required, an adaptive management measure to modify the low-elevation islands will be needed. Additionally, if monitoring shows appropriate velocities and water clarity but no SAV, an adaptive management measure to introduce SAV plantings may be needed.

2.2.3. Flow Diversity

It is expected that implementation of the low-elevation rock mound and chevron features will provide relatively small areas of increased velocities adjacent to the ends of features in addition to the areas of reduced velocities discussed above. This flow diversity is expected to benefit native mussel species occurring within the Study Area, including mussels that may be impacted during project construction. It is expected that mussels will recolonize areas where they may have been displaced during construction of project features, such as within access dredge cuts.

2.3. Conceptual Model

Figure B-3 shows the conceptual ecological model.

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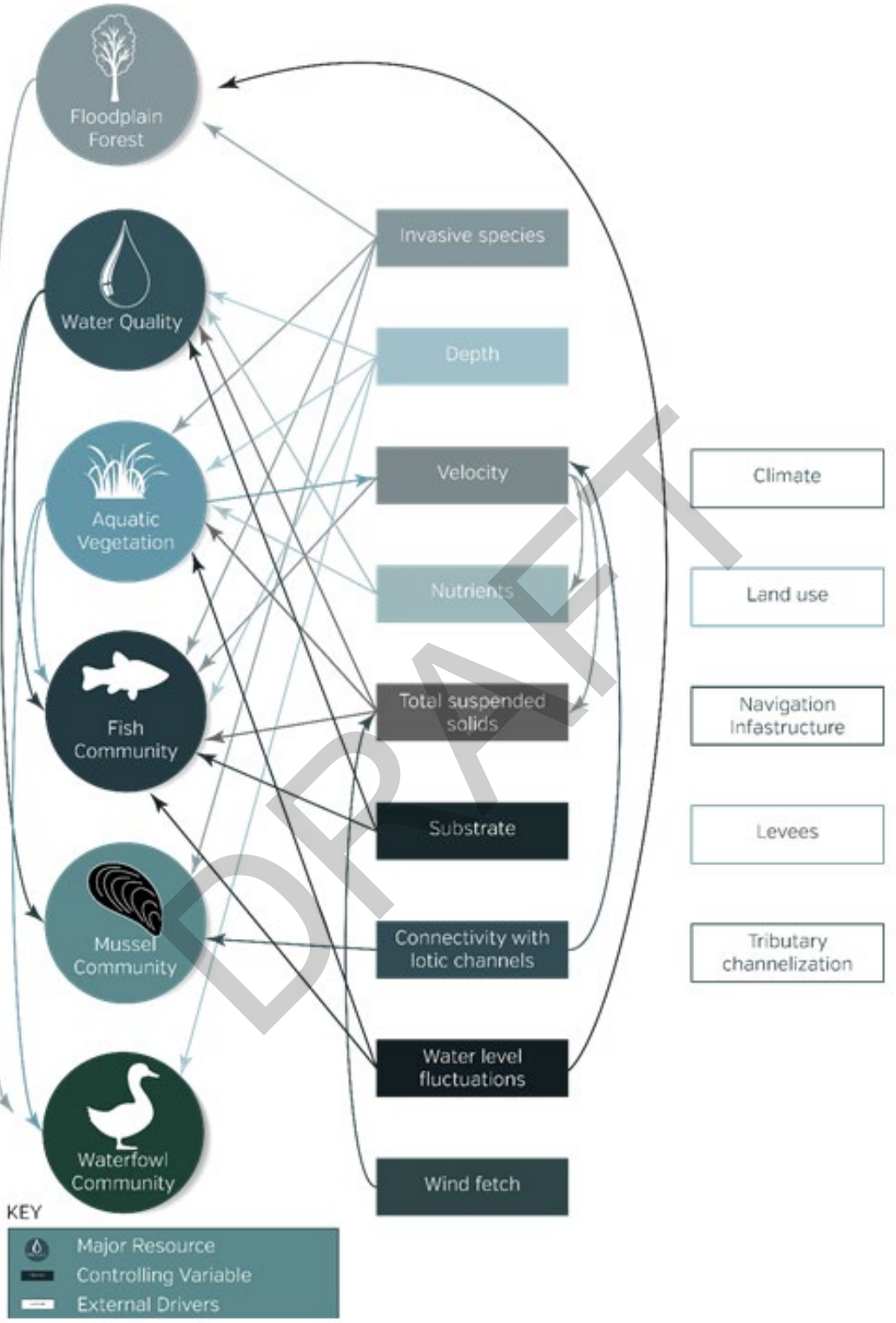

Figure B-3. Lower Pool 13 Conceptual Ecological Model

3. MONITORING OF OBJECTIVES TO DETERMINE PROJECT SUCCESS AND ADAPTIVE MANAGEMENT MEASURES

The power of a monitoring program developed to support determinations of project success and inform adaptive management lies in the establishment of feedback between continued project monitoring and corresponding project management.

3.1. Floodplain Forest

Tree and shrub monitoring will be conducted for seedlings and saplings within the timber stand improvement areas. Sampling will consist of a quantitative, random sampling of the planted trees and shrubs planted per treatment area. Additionally, natural regeneration establishment and stump sprouts will be observed as a qualitative assessment while conducting the random sampling work. Frequency will be bi-annually for the first 10 years post construction.

Planted trees and shrubs will be selected at random from the individual planting locations provided from completed planting efforts in the office. Each species will have 30% of the original planted quantity sampled in a sampling year; the random selection will change each sampling year. Metrics captured when at the planted tree or shrub will be species, health condition, height, and diameter 6 inches above the root collar. In the effort to walk to each randomly selected tree, the forester will observe the growth conditions of other planted trees or shrubs, natural regeneration, and stump sprouts from the coppice cutting treatments. Metrics captured for the qualitative assessment will presence/absence, approximate heights by species, approximate area percentage of desirable stocking for the treatment area.

3.1.1. Success Criteria

Targets for tree density and diversity for each treatment area will be calibrated and validated based on reference forest stand. We assume 60% survival for tree and shrub plantings at year 5 with at least 8 species present.

3.1.2. Adaptive Management Trigger and Measure

If monitoring results indicate tree survival is less than 60% and/or less than 8 species are present at Year 5, supplemental plantings will be required in areas that are underperforming.

3.2. SAV Cover

Vegetation surveys will be conducted both pre and post-construction of the Project. Surveys will be conducted concurrently with construction of features, as construction of the entire Project is expected to occur over an extended period of time. Upon construction of all features, surveys will occur in Years 1-5, followed by Years 8 and 10. Vegetation sampling will follow LTRM Stratified Random Sampling (SRS) techniques utilized in the rest of Pool 13. In addition to vegetation sampling, velocity and turbidity measurements will be collected at each sample point. The results of this study will inform Project success, inform adaptive management triggers and measures, and inform future HREPs by demonstrating the effectiveness of sub-surface islands in stopping wind-driven waves and reducing velocities. This monitoring program will also seek to answer the question of “shadow effect” and inform natural resource managers on how existing vegetation influences hydrology. Water quality data will be collected via sondes annually for the first 5 years post-construction and will be used to determine water clarity, water flow, wave

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heights and temperature throughout the year. Annual vegetation survey data will be compared with pre-project data collected via the LTRM station at Bellevue, IA to aid in determining Project success.

3.2.1. Success Criteria

Aquatic habitat area (approximately 1990 acres) analyzed using the Diving Duck Migration Model supports at least 20% cover of SAV species by Year 5, with at least 60% of SAV cover being wild celery (*Vallisneria americana)* **or** target velocities of less-than .5 ft/s are achieved within the area of influence of features.

3.2.2. Adaptive Management Trigger and Measure

If monitoring results indicate SAV cover is less than 20% of Diving Duck Migration Model area of analysis by year 4 **or** features are not providing target velocities, monitoring data will be used to locate features that are underperforming. If feature(s) is not providing optimal velocities, modification of feature(s) will be necessary. If feature(s) is providing optimal velocities, vegetation planting at these sites may be necessary to kickstart growth.

3.3. Flow Diversity

3.3.1. Rock Mounds & Chevrons

A series of mussel survey methodologies including dive surveys, timed searches, and quadrat surveys will be used to survey project features and access dredge cut locations. This will occur at Year 8 post-construction. Surveys will determine species diversity, age structure, substrate relationships, and density. Data analysis will include simple analyses of mussel diversity, density, age structure, and relationships to river rock size or location. Results of the analyses will be used to inform Project success and to guide future projects in the UMRS.

3.3.2. Success Criteria. Successful recruitment of freshwater mussels will be identified when >4 species of mussels of at least 5 mussels/m^2 are present.

4. DOCUMENTATION, IMPLEMENTATION COSTS, RESPONSIBILITIES, AND PROJECT CLOSE-OUT

4.1. Documentation, Reporting, and Coordination

The PDT will document each of the performed assessments and communicate the results to the HREP program manager and partners designated for the Project. Periodic reports will be produced to measure progress towards the Project goals and objectives as characterized by the selected performance measures.

4.2. Costs

The costs associated with implementing monitoring and adaptive management measures 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 estimated costs in Table B-1 will need refinement in PED during the development of the Detailed Monitoring and Adaptive Management Plans.

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Table B-1. Estimated Performance Monitoring and Adaptive Management Costs (March 2022 Price Level)

				Post-Construction Years										
Objective	**Work Category**	**Activity**	**PED**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Floodplain Forest Diversity	Monitoring and Analysis	Forest Survey	-	$10,000	-	$10,000	-	$10,000	-	$10,000	-	$10,000		$50,000
														Floodplain Forest Diversity Subtotal: $50,000
SAV Cover	Monitoring, Analysis, Reporting	Site Inspection	$44,000	$15,000	$15,000	$15,000	-	-	-	-	$15,000	-	-	$104,000
		ADCP Data Collection												
	AM: Riprap/Chevron Rock Install/Remove		-	-	-	-	-	$500,000	-	-	$500,000	-	-	
	AM: Veg Planting							$50,000			$50,000			$1,100,000
														SAV Cover Subtotal: $1,204,000
Flow Diversity	Monitoring, Analysis, Reporting	Mussel Survey	-	-	-	-	-	-	-	-	60,000	-		$60,000
		Data Analysis												
														Mussel Habitat Subtotal: $60,000
														$1,314,000
														TOTAL

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5. RESPONSIBILITIES

5.1. Floodplain Forest Diversity

Feasibility and PED activities are limited to one pre-construction evaluation of the existing forest characteristics at Pool 13. Monitoring would be conducted annually for the first 5 years and then in years 7 and 10. Responsibility for these features will be with USACE.

5.2. Flow Diversity and Mussel Recolonization

A series of mussel survey methodologies including dive surveys, timed searches, and quadrat surveys will be used to survey project features and access dredge cut locations. This will occur pre-project and at Years 4 and 8 post-construction. Surveys will determine species diversity, age structure, substrate relationships, and density. Data analysis will include simple analyses of mussel diversity, density, age structure, and relationships to river rock size or location. Responsibility for these features will be a coordinated effort between USACE, the IADNR, and the USFWS.

5.3. SAV Cover

Vegetation surveys will be conducted annually for the 3 years leading up to project completion. Surveys will continue annually upon completion of the Project for years 1-10. Vegetation sampling will follow LTRM Stratified Random Sampling (SRS) techniques utilized in the rest of Pool 13. In addition to vegetation sampling, velocity and turbidity measurements will be collected at each sample point. Water quality data will be collected from the site annually for the first 5 years post-construction and will be used to determine water clarity, water flow, and temperature throughout the year. Annual vegetation survey data will be compared with pre-project data collected via the LTRM station at Bellevue, IA to aid in determining Project success. The need for changes will regularly be evaluated. Responsibility for these efforts will be a coordinated effort between USACE, the IADNR, and the USFWS. If necessary, vegetation plantings will be the responsibility of the groups listed above.

6. PROJECT CLOSE-OUT

Close-out of the Project would occur when it is determined that the Project has successfully met the Project success criteria described in Section III, *Monitoring of Objectives To Determine Project Success and Adaptive Management Measures*. 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:

- Success criteria met;
- Continued site inspections to determine continued Project status; and
- Continued O&M into the future

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ATTACHMENT C

CLEAN WATER ACT
SECTION 404 ASSESSMENT
NWP 27 JUSTIFICATION

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1. INTRODUCTION

1.1. Location

The *Pool 13 Habitat Rehabilitation and Enhancement Project* (Project) is located within the impounded area of Pool 13 in the Upper Mississippi River System. The Project is within Clinton County, Iowa and Whiteside and Carroll Counties, Illinois. The Project area lies within the Upper Mississippi River National Wildlife and Fish Refuge (Refuge) between river miles (RM) 522.5 and 529.0.

1.2. General Description

The U.S. Army Corps of Engineers (Corps), Rock Island District (District) proposes to rehabilitate and enhance the Project through construction of measures which will increase acreage of submerged aquatic vegetation **(**SAV), increase floodplain forest vegetation diversity, and improve the overall structure and function of the Project.

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

- Processes such as suboptimal velocities and poor water clarity caused by upstream suspended sediment load and resuspension of bottom sediments due to wind-driven wave action is negatively affecting submerged aquatic vegetation
- The decline in SAV cover within the project area has resulted in reduced food availability for migrating waterfowl species

Increased flooding has reduced the recruitment of native tree species and increased the prevalence of invasive species. These conditions reduce the quality and quantity of forest resources, reduce the acreage, diversity and age structure of the floodplain forest, and result in a loss of forest resiliency which effects the resident and migratory bird and bat communities.

1.3. Authority and Purpose

The Upper Mississippi River Restoration's authorizing legislation is the Water Resources Development Act of 1986 (Public Law 99-662), Section 1103, as amended. The purpose of this Project is to rehabilitate and enhance fish and wildlife habitat. The Project is the result of planning efforts by the State of Iowa, the U.S. Fish and Wildlife Service (USFWS), and the Corps.

1.4 .General Description of Dredged and Fill Material

An estimated total of 255,600 cubic yards (cy) of material will be mechanically excavated within the Project area in order to provide access to TSP feature placement locations. Geotechnical soil borings will be completed during the Design phase of this project. 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 58,000 tons (TN) of clean RR6 riprap will be used to construct rock mounds, chevrons, and the I-H4 island (Appendix G*, Plates*).

1.5. Description of the Proposed Placement Sites

Figure C-1 shows the feature locations and potential placement sites for material excavated

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during access dredging. The proposed dredged material placement sites are historic islands adjacent to the main channel. These island sites represent an opportunity to use excess dredged material to rebuild degraded islands. By placing material at these locations, the Project can increase island habitat and provide suitable nesting locations for multiple species of colonial nesting birds. Details on the placement sites and estimated quantities are provided in Table C-1. The maximum elevation of the placement sites does not exceed an elevation of 586.0.

Table C-1. Dredged Material Placement Site Details.

Dredged Material Placement Sites			
	Cormorant Island	Gomer's Island	Woodruff Island
Surface Area (acres)	15.2	44.9	26.16
Elevation Above Flat Pool (ft)	3.64	3.64	3.64
Side Slope	4:1	4:1	4:1
Quantity (cubic yards)	149,800	504,000	204,800

Surficial soils within the placement sites are generally fluvaquent soils, which is described as an alluvium product in the U.S. Department of Agriculture (USDA) classification system. This series is described as frequently flooded and water table is said to vary between ground surface and 1 foot deep.

1.6. Description of the Placement Method

Mechanically dredged material will be placed directly within the footprint of eroded islands, allowed to dry, and then mechanically shaped to desired dimensions. Material will be handled multiple times. If necessary, riprap will be barged to the site and placed mechanically in order to stabilize the island(s).

1.7. Substrate Elevation and Slope

Flat pool in the Project area is approximately elevation 582.36 NAVD88 (Lock and Dam13, Fulton, IL). Rock mound (RM-H#) and chevron (CV-H#) features are designed to reduce flow velocity downstream and disrupt wind-driven wave action in order to benefit SAV. Maximum elevation of rock mounds will be at flat pool (582.36) in order to reduce visual obstructions to migrating waterfowl. Rock mounds will be constructed of IL DOT RR6 riprap and built on a 2:1 slope. Island feature (I-H4) will be built to a maximum height of 584.86 (2.5 feet above flat pool) and constructed out of IL DOT RR6 at a 2:1 slope. Dredged material acquired from access dredging will be placed downstream of I-H4 in order to create opportunities for nesting. Dredged material will have a 6:1 slope on the downstream end of I-H4. The maximum elevation of the placement sites is at elevation 586. Slopes would be 4:1 on all sides.

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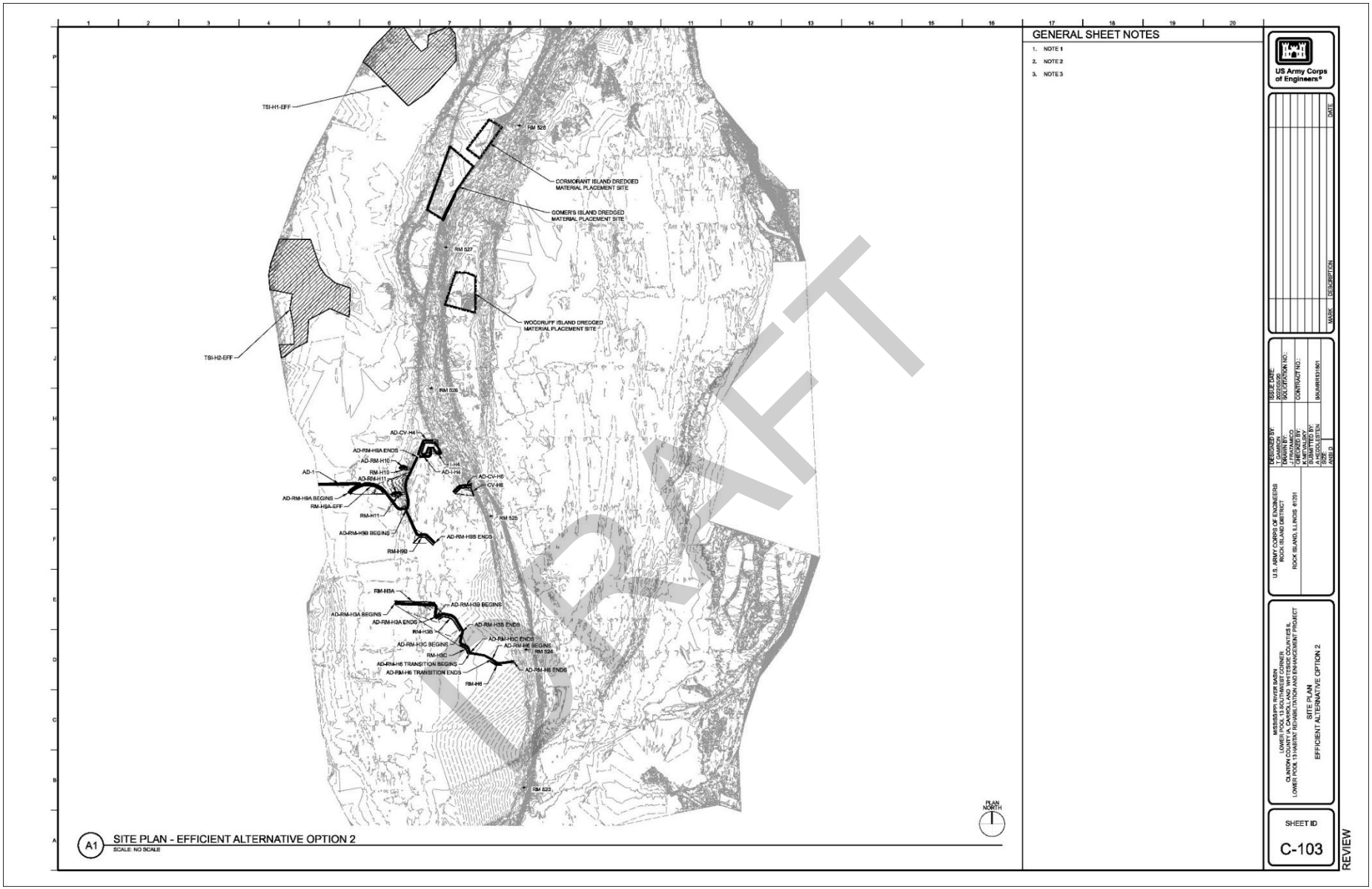

Figure C-1. Feature Layout and Potential Dredged Material Placement Sites for TSP

2. NATIONWIDE PERMIT COMPLIANCE DOCUMENTATION (NWP)

2.1. NWP Requirements

In order to use an NWP, the Project must comply with the following four sets of conditions:

1. General NWP Conditions for NWPs;
2. NWP 27 Conditions;
3. Iowa 401 Water Quality Certification Conditions; and
4. Illinois 401 Water Quality Certification Conditions

Table C-2 shows the 28 general NWP conditions and the District's compliance responses. Table C-3 shows the NWP 27 conditions and the District's compliance responses.

Iowa and Illinois have conditioned Section 401 water quality certification applicable to NWP 27. Department of the Army authorization pursuant to Section 404 of the CWA (33U.S.C.1344) under NWP 27 will be subject to all of the Iowa and Illinois conditions.

Table C-4 shows both the Iowa and Illinois Section 401 Water Quality Certification conditions for NWP 27 and the District's compliance responses.

3. CONCLUSION

The PDT concludes this Project meets the conditions of Section 404 of the CWA by an existing Department of Army NWP for aquatic habitat restoration, establishment and enhancement activities, as described in the January 13, 2021, final rule in the Federal Register (86 FR 2744) for the Nationwide Permits Program under the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, and the Marine Protection, Research and Sanctuaries Act. This final rule announced the reissuance of 12 existing nationwide permits (NWPs) and four new NWPs, as well as the reissuance of NWP general conditions and definitions with some modifications.

The USACE and USFWS realize NWP 27 may be modified, reissued, or revoked prior to project construction. The PDT will remain informed of changes to the NWPs. If construction activities are not completed prior to 12 months from the date of the modifications or revocation of the NWP, the team will reevaluate the Project's 404 compliance status and will coordinate the Project with the District's Regulatory Branch. The Project will be in full compliance with the current CWA regulations prior to any construction and activities.

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Table C-2. General NWP Conditions and Compliance Responses

#	General NWP Condition	Compliance Response
1	Navigation	No navigation impacts expected. Project features would not impact the 9-foot navigation channel. The Project would not impact barge operation, safety, or tow handling.
2	Aquatic Life Movements	Positive impacts expected with increased flow diversity, habitat, and food.
3	Spawning Areas	No impacts to fish spawning habitat are anticipated.
4	Migratory Bird Breeding Areas	Project features avoid and minimize disturbances to existing migratory bird nesting and rookeries. Positive benefits expected due to restoration of nesting island habitat for colony-nesting bird species.
5	Shellfish Beds	Project features will not be located in "areas of concentrated shellfish populations". Increased flow diversity will improve habitat for native freshwater mussels.
6	Suitable Material	Access dredged material is expected to be suitable for construction of I-H4 and placement areas (nesting islands).
7	Water Supply Intakes	No public water supply intakes present in planning/impact area
8	Adverse Effects From Impoundments	The Project will not impound water within or around the project area.
9	Management of Water Flows	Project features would handle fluctuating water levels including fluctuating river levels.
10	Fills Within 100-Year Floodplains	This Project would comply with applicable FEMA approved floodplain management requirements.
11	Equipment	Heavy equipment and barges will be used and operated within the impounded area of Pool 13. However, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity increases, and substrate disturbance. Impact of equipment should be temporary and minimal considering size of the area.
12	Soil Erosion and Sediment Controls	The Project would require standard construction guidelines to avoid erosion and sediment
13	Removal of Temporary Fills	Not Applicable
14	Proper Maintenance	USFWS would maintain Project features over the 50-year Project life
15	Wild and Scenic Rivers	Not Applicable
16	Tribal Rights	Not Applicable
17	Endangered Species	Partial Compliance. See Main Report Section 6 & App A, Attachment E.
18	Historic Properties	The District followed their procedures for complying with the requirements of Section 106 of NHPA. Full Compliance (Attachment 3). In a letter dated DATE, the Iowa SHPO concurred with the District's No Adverse Effect determination.
19	Designated Critical Resource Waters	This Project does not have any designated critical resources.
20	Mitigation	This Project would not require wetland mitigation.
21	Water Quality	This Project would comply with the Iowa and Illinois water quality standards (See Table C-4)
22	Coastal Zone Management	Not Applicable
23	Regional and Case-By-Case Conditions	Not Applicable
24	Use of Multiple Nationwide Permits	The Project PDT requests only NWP 27.
25	Transfer of NWP Verifications	All lands are in Federal ownership
26	Compliance Certification	Full compliance expected
27	Pre-Construction Notification	Full compliance expected
28	Single and Complete Project	The Pool 13 HREP would be a single project.

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Table C-3. Iowa Regional Conditions for 2021 Nationwide Permits.

#	Iowa Regional Condition	Compliance Response
1	Side slopes of a newly constructed channel will be no steeper than 2:1 and planted to permanent, perennial, native vegetation if not armored.	**No channel construction**
2	For projects that impact an Outstanding National Resource Water, Outstanding Iowa Water, fens, bogs, seeps, or sedge meadows, a Pre-Construction Notice in accordance with General Condition No. 32 and an Individual Section 401 Water Quality Certification will be required.	**No listed waters impacted by this project**
3	Any bank stabilization activity involving a method that protrudes from the bank contour, such as jetties, stream barbs and/or weirs, will require a Pre-Construction Notice in accordance with General Condition No. 32.	**No bank stabilization**
4	Beyond what is described in General Condition # 6, suitable fill material shall consist of clean materials, free from debris, trash, and other deleterious materials. If broken concrete is used as riprap, all reinforcing rods must be cut flush with the surface of the concrete, and individual pieces of concrete shall be appropriately graded and not exceed 3 feet in any dimension. Asphalt, car bodies, and broken concrete containing asphalt, and liquid concrete are specifically excluded.	**All riprap will be clean and approved**
5	No non-native, invasive or other plant species included on the Corps "Excluded Plant List" shall be planted for re-vegetation or stabilization purposes, with the exception of any species that hold particular cultural or traditional significance to the Meskwaki Nation (the Sac and Fox Tribe of the Mississippi in Iowa). The plant list can be found on the Corps website at: http://www.mvr.usace.army.mil/Missions/Regulatory.aspx. To prevent the spread of non-native and/or invasive plant species, the permittee shall ensure that equipment to be utilized in Waters of the United States is cleaned before arriving on site. Wash water shall not be discharged into any wetland, waterway, or any other surface water conveyances.	**No non-native/invasive plants will be planted for this project**
6	All authorizations requested by applicants other than the Tribal Authority for use within lands under the jurisdiction of the Sac and Fox Tribe of the Mississippi in Iowa require preconstruction notification to the District Engineer and coordination with the Tribal Authority.	**N/A**
7	For Nationwide Permit 14, all proposed projects that result in the loss of greater than 300 linear feet of streambed located within Waters of the U.S., as defined in the definitions contained in the Nationwide Permits, require a Pre-Construction Notice in accordance with General Condition No. 32 to the District Engineer.	**N/A**

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Table C-4. Nationwide Permit #27 Conditions and Compliance Responses

#	NWP 27 Condition	Compliance Response
1	Project Intent. Does it meet the intent of aquatic habitat restoration, establishment, and enhancement activities?	This Project's goals and objectives (Main Report) focus on aquatic habitat restoration.
2	Tidal Areas	This Project does not include any tidal areas
3	Net increase in aquatic resource function and services.	Features will protect and increase acreage of SAV, provide food for migrating waterfowl, and improve floodplain forest habitat over the 50 year lifespan of the project. In the absence of our Project, this area would lose SAV and no longer support migrating waterfowl which demonstrates a net increase in aquatic habitat value.
4	Project features meet the NWP intent	The proposed project features work together to cumulatively provide significant benefits to SAV, water clarity, migrating waterfowl, colonial-nesting bird species, and island habitat.
5	Alteration of a stream or natural wetlands is	The proposed Project would not alter any stream or areal quantity of wetland habitats.
6	Reversion	USACE requires perpetual O&M through an MOA between the USFWS and USACE.
7	Reporting	The USFWS and USACE would comply with all pre-construction reporting requirements.
8	Notifications	The USFWS and USACE would comply with all pre-construction notification requirements.

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Table C-5. Iowa and Illinois Section 401 Water Quality Certification for NWP 27 Conditions

#	Iowa Section 401 Water Quality Certification for NWP 27	Compliance Response
1	For projects that impact an outstanding national resource water, outstanding Iowa water, fens, bogs, seeps, or sedge meadows, an individual Section 401 Water Quality Certification will be required.	Mississippi River is not an ONRS or Outstanding Iowa Water
2	For nationwide permits when the Corps District Engineer has issued a waiver to allow the permittee to exceed the limits of the nationwide permit, an individual Section 401 Water Quality Certification will be required.	Not applicable.
3	Heavy equipment shall not be used or operated within the stream channel. If in-stream work is unavoidable, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity increases, substrate disturbance, bank disturbance, and riparian vegetation impacts. This condition does not further restrict otherwise authorized drainage ditch maintenance activities.	Heavy equipment will be used and operated within the stream channel. However, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity increases, substrate disturbance, bank disturbance, and riparian vegetation impacts, as evaluated earlier.
#	**Illinois Section 401 Water Quality Certification for NWP 27**	**Compliance Response**
1	For NWP 12, 57, and 58: pre-construction notification is required in accordance with General Condition 32 for the following activities; (a) activities that involve mechanized land clearing in a forested wetland for the utility line right-of-way; (b) utility lines placed within, and parallel to or along a jurisdictional stream bed.	Not applicable.
2	For Nationwide Permit 14, all proposed projects that result in the loss of greater than 300 linear feet of streambed located within Waters of the U.S., requires a Preconstruction Notice in accordance with General Condition No. 32.	Not applicable.
3	Any bank stabilization activity involving a method that protrudes from the bank contours, such as jetties, stream barbs, and/or weirs, will require a pre-construction notification in accordance with General Condition 32.	Not applicable.

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ATTACHMENT D
FISH AND WILDLIFE COORDINATION ACT REPORT

(To be added when FWCA Report is complete)

DRAFT

ATTACHMENT E
BIOLOGICAL ASSESSMENT

(To be added when BA is complete)

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APPENDIX A
ENVIRONMENTAL

ATTACHMENT F
FOREST INVENTORY DATA & PRESCRIPTION

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AUGUST 5-6 FLOODPLAIN FOREST STAND WALK DATA SHEETS

U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: Ben/Lauren Date: 05 Aug 20

Pool: p13 Compartment: c002 Unit: u002 Site: st01 Stand:

# of Plots: 16 # Age Plots: 3 Walk Acreage: 120 Inventory Year: 2019 Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
108	108	13"	85%	70'	70%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
0	0	0	0	5'-10'	3

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
1947	0	9	Stressed	025	1

Size Class Distribution (TPA)

Polesize (8"-12")	56
Sawtimber (12"-18")	30
Mature (18"-24")	19
Overmature (24"+)	7

Top 3 Understory Species

Species 1	SAIN3
Species 2	CEOC2
Species 3	SANI

Top 3 Ground Species

Species 1	PHAR3
Species 2	LACA3
Species 3	LEOR

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH	Target TPA	Target BA
ACSA2	42	64	16"		
SANI	18	20	14"		
FRPE	16	13	12"		
SAIN3	20	4	6"		
ACNE2	6	3	9"		

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c002 u002 sr01

Stand Recon Details

Presc Detail Yr: 2020

Access: L / W Optimal Mgmt: Even / Uneven / Mult

Merch: N / L / M / H

DWD: N / L / M / H SCav: X LCav:

Hlth: V / S / SD / D

Yrs Thin/TSI: <10 / 10-30 / > 30 Yrs Rgn Hvst: <10 / 10-30 / > 30

TSIType: LT / CT / DT / GT / FT / S PreC?: Y / N

Regen: N / L / M / H W. Inv: N / L / M / H H. Inv: N / L / M / H

Planting: Full / Fill-In

Planting Density: N / L / M / H Priority: N / L / M / H

Volume, dot tally, BAF 10 plots,

Avg Logs: Volume/ac	SpCode	Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
	Tot Trees									
	Tot Logs									

Plot tally:

Year	Treatment
1	Thinning → reduce canopy trees where dense no cutting where large gaps exist → min 4 o max 6 canopy tree >40' crown total of 15 canopy trees/ac cut max ~10% of area no cutting needed at least 10 trees <12" coppice per acre target canopy to cut stressed/SD >30% crown dieback, heart rot, sig. lean, unbalanced crown Favor to release (growing space) to best in form canopy trees
2	Planting at 20 container trees/ac 2x cluster of 15 shrubs/ac 60% QUBI, JUNI, CAIL2, QUPA2, DENI > container 4' hgt min at 20' from planted, 35' from any tree >12" dbh 40% CASP8, ACSA2, PODE3, GYDI, PLOC, TIAM COSES, COAM, CECA4, EVAT5, CRVI, SAMBU > container 3' hgt min 2 spp per cluster (min 5 per spp)
Notes	Stand canopy & understory in decline → no sustainable regen or understory tree to replace canopy Site conditions indicate well drained & suitable to restore diverse tree species

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U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: BV & LN Date: 06 Aug 20

Pool: p13 Compartment: c002 Unit: u003 Site: st02 Stand:

# of Plots: 28 # Age Plots: 5 Walk Acreage: 120 Inventory Year: 2019 Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
144	128	12"	105%	95'	70%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
1	2	14"	<10%	5'-10'	8

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
1954	0	7	Stressed	146	2

Size Class Distribution (TPA)

Polesize (8"-12")	97
Sawtimber (12"-18")	18
Mature (18"-24")	11
Overmature (24"+)	8

Top 3 Understory Species

Species 1	CORNU
Species 2	ACNE2
Species 3	FRPE

Top 3 Ground Species

Species 1	LACA3
Species 2	PHAR3
Species 3	VITIS

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH	Target TPA	Target BA
PODE3	10	40	26"		
ACSA2	27	33	14"		
FRPE	21	13	10"		
ACNE2	33	12	8"		
ROPS	16	6	8"		

Target Threshold

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1002u003st02

Stand Recon Details Presc Detail Yr: 2020

Access: L / W Optimal Mgmt: Even / Uneven / Mult

Merch N / L / M / H

DWD: N / L / M / H SCav: 7 LCav: 0

Hlth: V / S / SD / D

Yrs Thin/TSI: <10 / 10-30 / > 30 Yrs Rgn Hvst: <10 / 10-30 / > 30

TSIType: LT / CT / DT / GT / FT / S PreC?: Y / N

Regen N / L / M / H W. Inv N / L / M / H H. Inv N / L / M / H

Planting: Full / Fill-In MOAL PHAR3 IHJSA

Planting Density: N / L / M / H Priority: N / L / M / H

Volume, dot tally, BAF 10 plots,

	Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
Ave Logs: Volume/ac	SpCode								
	Tot Trees								
	Tot Logs								

Plot tally:

Year	Treatment
Notes	Eastern + central portion of ACSA2 canopy (SANI) areas spliting away from st02 summary → no action for these areas → GPS locations of areas transition from PODE3 canopy → only PODE3 community dominant in canopy for Lower 13
1	Thinning NW target MOAL, ACNE2, CLEOC, ULAM, FRPE to cut 75-80% of poor form → flatter, forked, dead top, >20% lean, heart (<12" dbh) Southern same s/l target to cut 50% → same descriptive to condition MOAL → 24" stump hgt w/ herbicide treatment → all others s/p 3" stump hgt no herbicide → intent for coppice
2	Planting → containerized min 6' hgt for QUBI, QUPA2, PODE3 rate 16 tpa, POBE3 at 60% quantity 4' hgt for JUNI 2' hgt for CALA21 → 20' from any planted 15' from any coppice stump 30' from any canopy or >18" dbh tree Shrub cluster of 15 for every 6 ac @ 300' spacing between cluster AMAR, SAMBU, CRUS, EAUS

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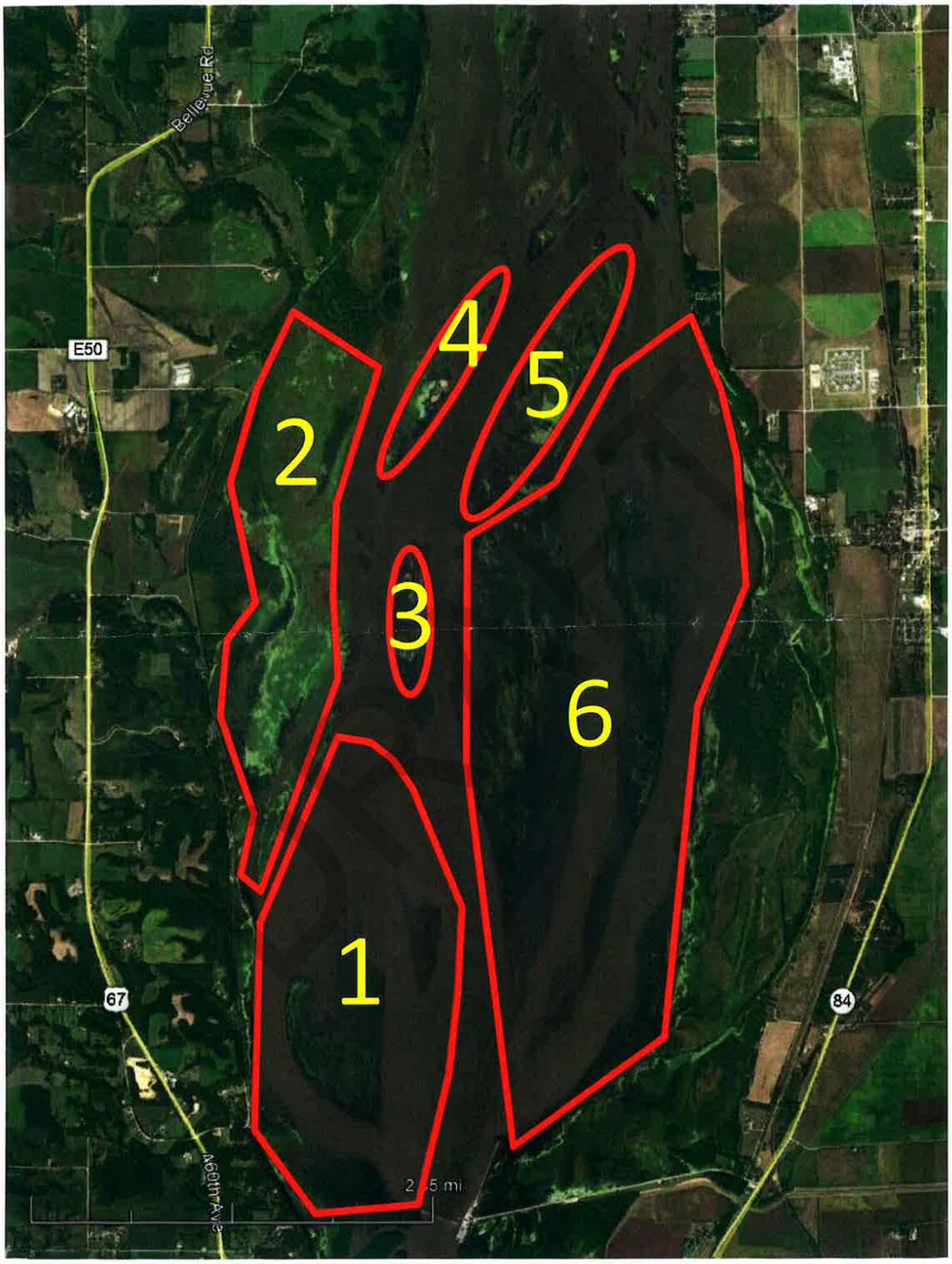
Bellevue Rd
E50
4
5
2
3
6
1
67
84
460th Ave
2.5 mi

U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: LM & BU + Kirk Hansen IA DNR Date: 4/19/21

Pool: p13 Compartment: c002 Unit: u003 Site: st04 Stand:

# of Plots: 40 # Age Plots: 8 Walk Acreage: 174 Inventory Year: 19/20 Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
122	103	12"	80%	80'	60%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
0	0	0	0	5'-10'	22

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
1942	0	10	Stressed	055	1

Size Class Distribution (TPA)

Polesize (8"-12")	68
Sawtimber (12"-18")	17
Mature (18"-24")	6
Overmature (24"+)	6

Top 3 Understory Species

Species 1	SAIN3
Species 2	FRPE
Species 3	ULAM

Top 3 Ground Species

Species 1	PHAR3
Species 2	LACA3
Species 3	ASTER

* also present: clumps of dogwood

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH	Target TPA	Target BA
ACSA2	25	32	15"		
SANI	43	26	10"		
PODE3	11	19	17"		
ACNE2	10	7	11"		
ULAM	13	6	9"		

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Stand Recon Details Presc Detail Yr:

Access: L / W | Optimal Mgmt: Even / Uneven / Mult

Merch: N / L / M / H

DWD: N / L / M / H | SCav: | LCav:

Hlth: V / S / SD / D

Yrs Thin/TSI: <10 / 10-30 / > 30 | Yrs Rgn Hvst: <10 / 10-30 / > 30

TSIType: LT / CT / DT / GT / FT / S | PreC?: Y / N

Regen: N / L / M / H | W. Inv: N / L / M / H | H. Inv: N / L / M / H

Planting: Full / Fill-In

Planting Density: N / L / M / H | Priority: N / L / M / H

Volume, dot tally, BAF 10 plots,

Avg Loss: Volume/ac	SpCode	Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
		Tot Trees								
		Tot Logs								

Plot tally:

Year	Treatment
0-1	• Clear reed canary grass & duff in existing canopy gaps. (spray 20' buffer for creek) • Time duff clearing for optimal seed catch of cottonwood, silver maple, & willow.
0-1 (cont.)	• Plant willow cuttings in gaps, 80 TPA. • Plentiful source of willow cuttings along outskirts of site. • Plant sycamore, river birch, cottonwood,
0-1 (cont.)	swamp white oak, bur oak, pin oak, and black walnut, 10 TPA.
	• No treatment for southern "willow island" chunk of site.

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U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: LM & BV + Kirk Hansen IA DNR Date: 4/19/21

Pool: p13 Compartment: c002 Unit: u004 Site: st01 Stand:

# of Plots: 1 # Age Plots: 0 Walk Acreage: 21 Inventory Year: 2020 Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
37	80	19"	55%	90'	50%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
0	0	0	0	10'-15'	7

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
0	0	0	Stressed	004	5

Size Class Distribution (TPA)

Polesize (8"-12")	0
Sawtimber (12"-18")	10
Mature (18"-24")	10
Overmature (24"+)	8

Top 3 Understory Species

Species 1	SAIN3
Species 2	
Species 3	

Top 3 Ground Species

Species 1	LEOR
Species 2	PIPU2
Species 3	IMCA

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH
ACSA2	8	40	28"
BENI	10	20	18"
ULAM	10	10	13"
MORU2	7	10	16"

Target Threshold

Target TPA	Target BA

DRAFT

Stand Recon Details Presc Detail Yr:

Access: L / W | Optimal Mgmt: Even / Uneven / Mult

Merch: N / L / M / H

DWD: N / L / M / H | SCav: | LCav:

Hlth: V / S / SD / D

Yrs Thin/TSI: <10 / 10-30 / > 30 | Yrs Rgn Hvst: <10 / 10-30 / > 30

TSIType: LT / CT / DT / GT / FT / S | PreC?: Y / N

Regen: N / L / M / H | W. Inv: N / L / M / H | H. Inv: N / L / M / H

Planting: Full / Fill-In

Planting Density: N / L / M / H | Priority: N / L / M / H

Volume, dot tally, BAF 10 plots,

Avg Logs: Volume/ac	Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
	SpCode								
	Tot Trees								
	Tot Logs								

Plot tally:

Year	Treatment
	• No treatment

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U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: LM, TS + Rebekah Anderson IL DNR Date: 4/20/21

Pool: p13 Compartment: c003 Unit: u006 Site: st01 Stand:

# of Plots: 12 # Age Plots: 3 Walk Acreage: 36 Inventory Year: 2020 Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
321	116	8"	105%	50'	50%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
0	0	0	0	10'	35

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
1980	0	8	Stressed	004	2

Size Class Distribution (TPA)

Polesize (8"-12")	256
Sawtimber (12"-18")	22
Mature (18"-24")	6
Overmature (24"+)	<1

Top 3 Understory Species

Species 1	SAIN3
Species 2	SANI
Species 3	ACSA2

Top 3 Ground Species

Species 1	ASTER
Species 2	PIPU2
Species 3	BIDEN

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH	Target TPA	Target BA
SANI	269	84	7"		
ACSA2	35	28	12"		
ULAM	13	3	6"		
CEOC	<1	4	6"		

Target Threshold

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Stand Recon Details Presc Detail Yr:

Access: L / W | Optimal Mgmt: Even / Uneven / Mult | Merch: N / L / M / H

DWD: N / L / M / H | SCav: | LCav:

Hlth: V / S / SD / D

Yrs Thin/TSI: <10 / 10-30 / > 30 | Yrs Rgn Hvst: <10 / 10-30 / > 30

TSIType: LT / CT / DT / GT / FT / S | PreC?: Y / N

Regen: N / L / M / H | W. Inv: N / L / M / H | H. Inv: N / L / M / H

Planting: Full / Fill-In

Planting Density: N / L / M / H | Priority: N / L / M / H

Volume, dot tally, BAF 10 plots,

Ave Logs: Volume/ac.	Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
SpCode									
Tot Trees									
Tot Logs									

Plot tally:

Year	Treatment
	• No Treatment

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U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: LM, TS + Rebekah Aberson, IL DNR Date: 4/20/21

Pool: p13 Compartment: c003 Unit: u006 Site: st02 Stand:

# of Plots: 5 # Age Plots: 2 Walk Acreage: 31 Inventory Year: 2020 Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
193	106	10"	90%	65'	50%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
0	0	0	0	10'-15'	<1

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
1958	0	8	Stressed	014	4

Size Class Distribution (TPA)

Polesize (8"-12")	152
Sawtimber (12"-18")	29
Mature (18"-24")	8
Overmature (24"+)	1

Top 3 Understory Species

Species 1	SAIN3
Species 2	MORU2
Species 3	CEOC2

Top 3 Ground Species

Species 1	ASTER
Species 2	LACA3
Species 3	BOCY

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH	Target TPA	Target BA
SANI	120	54	9"		
ACSA2	36	40	14"		
SAIN3	35	6	5"		
PODE3	<1	4	37"		
ULAM	<1	2	20"		

Target Threshold

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Stand Recon Details Presc Detail Yr:

Access: L / W Optimal Mgmt: Even / Uneven / Mult

Merch: N / L / M / H

DWD: N / L / M / H SCav: LCav:

Hlth: V / S / SD / D

Yrs Thin/TSI: <10 / 10-30 / > 30 Yrs Rgn Hvst: <10 / 10-30 / > 30

TSIType: LT / CT / DT / GT / FT / S PreC?: Y / N

Regen: N / L / M / H W. Inv: N / L / M / H H. Inv: N / L / M / H

Planting: Full / Fill-In

Planting Density: N / L / M / H Priority: N / L / M / H

Volume, dot tally, BAF 10 plots,

	Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
Avg Logs: Volume/ac	SpCode								
	Tot Trees								
	Tot Logs								

Plot tally:

Year	Treatment
0-1	• Low thinning of understory mulberry throughout largest island of this site midstory & • thinning will include poor in form trees, diameter range 2"-20". • pile slash in interior of island.
1-2	• Plant in existing gaps & higher light condition areas after thinning. • Planting density 10-15 TPA. • species include: sycamore, cottonwood, river birch, and northern catalpa.

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U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: LM, BV + Kirk Hansen IADNR | Date: 4/19/21

Pool: p13 | Compartment: c002 | Unit: u003 | Site: st03 | Stand:

# of Plots: 38 | # Age Plots: 8 | Walk Acreage: 121 | Inventory Year: 2019 | Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
139	108	11"	90%	85'	80%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
1	3	18"	<10%	10'-15'	9

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
1945	1935	9	Stressed	156	2

Size Class Distribution (TPA)

Polesize (8"-12")	93
Sawtimber (12"-18")	22
Mature (18"-24")	7
Overmature (24"+)	6

Top 3 Understory Species

Species 1	CORNU
Species 2	FRPE
Species 3	BENI

Top 3 Ground Species

Species 1	LACA3
Species 2	PHAR3
Species 3	TORA2

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH	Target TPA	Target BA
PODE3	8	33	27"		
ACSA2	46	22	9"		
ACNE2	16	15	12"		
FRPE	23	12	9"		
ULAM	12	7	10"		

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Stand Recon Details Presc Detail Yr:

Access: L / (W) Optimal Mgmt: (Even) / Uneven / Mult

Merch N / (L) / M / H

DWD: N / L / (M) / H SCav: LCav:

Hlth: V / (S) / SD / D

Yrs Thin/TSI: <10 / 10-30 / (> 30) Yrs Rgn Hvst: <10 / 10-30 / > 30

TSIType: LT / CT / DT / GT / FT / S PreC?: Y / (N)

Regen N / (L) / M / H W. Inv N / (L) / M / H H. Inv N / (L) / M / H

Planting: (Full) / Fill-In

Planting Density: N / (L) / M / H Priority: N / L / (M) / H

Volume, dot tally, BAF 10 plots,

	Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
Avg Logs: Volume/ac	SpCode								
	Tot Trees								
	Tot Logs								

Plot tally:

Year	Treatment
0-1	• Plant 20 TPA, no thinning treatment. • 15 gallon container size, [redacted] • 5 TPA cottonwood, 15 TPA hard mast species mix.
0-1 (cont)	• 100 Ft. spacing from other planted trees. ↳ hard mast [redacted] & planted cottonwood. • 15 ft. minimum spacing from existing cottonwood trees. • Coppice trees DBH under 12" w/ trunk,
0-1 (cont)	crown, or branches within 15ft. of the planted trees. (Low stumps to encourage stump sprouting) • Coppice dogwood within 5 ft. from any planted tree.

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U.S. Army Corps of Engineers: *Stand Walk Recon Field Sheet*

Forester: LM, TS + Rebekah Anderson ILDNR Date: 4/20/21

Pool: p13 Compartment: c003 Unit: u005 Site: st01 Stand:

# of Plots: 39 # Age Plots: 3 Walk Acreage: 127 Inventory Year: 19/20 Dominant Soil Type:

Stand Summary Data

Trees Per Acre	Basal Area	QM DBH	Stocking	Canopy Height	Canopy Closure
184	128	11"	105%	80'	50%

Hard Mast TPA	Hard Mast BA	Hard Mast QM DBH	Hard Mast Stocking	Understory Height	Snag TPA
1	3	18"	<10%	10'-15'	24

Stand Age	Hard Mast Age	Growth	Stand Health	Species Richness	Regeneration Rate
1945	0	6	Stressed	276	2

Size Class Distribution (TPA)

Polesize (8"-12")	114
Sawtimber (12"-18")	28
Mature (18"-24")	11
Overmature (24"+)	5

Top 3 Understory Species

Species 1	CORNU
Species 2	FRPE
Species 3	CEOC2

Top 3 Ground Species

Species 1	PHAR3
Species 2	LACA3
Species 3	TORA2

Top 5 Overstory Species

USDA Code	Avg. TPA	Avg. BA	QM DBH	Target TPA	Target BA
ACSA2	68	43	10"		
BENI	42	40	13"		
FRPE	23	13	10"		
ULAM	27	10	8"		
PODE3	2	10	30"		

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Stand Recon Details Presc Detail Yr:

Access: L W | Optimal Mgmt: Even / Uneven / Mult | Merch: N / L / M / H

DWD: N / L / M / H | SCav: | LCav:

Hlth: V / S / SD / D

Yrs Thin/TSI: <10 / 10-30 / > 30 | Yrs Rgn Hvst: <10 / 10-30 / > 30

TSI Type: LT / CT / DT / GT / FT / S | PreC?: Y / N

Regen: N / L / M / H | W. Inv: N / L / M / H | H. Inv: N / L / M / H

Planting: Full / Fill-In

Planting Density: N / L / M / H | Priority: N / L / M / H

Volume, dot tally, BAF 10 plots,

		Logs (16, 11") Plots:	0.5	1	1.5	2	2.5	3	3.5	4
Ave Logs:	Volume/ac	SpCode								
		Tot Trees								
		Tot Logs								

Plot tally:

Year	Treatment
0-1	• Thin poor in form elms in overstory & midstory. • Thin mulberry (large diameter & light blocking understory trees). • Combined thinning rate of 5-10 TPA.
1	• Plant 5 gallon container size pin oak, black walnut, northern pecan, bitternut hickory, shellbark hickory, bur oak, swamp white oak. (10 TPA)
2-3	• Follow up free thinning treatment 1 growing season after planting.
	• Note: No treatment to the smaller chunks w/in the site; accessibility issues and younger stand dynamics.

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STAND WALK RECON SUMMARY AND TSI FEATURE DESCRIPTION FOR TSP

General Information

- Timber Inventory collected: 2019 & 2020 growing season
- Data summarized to: 8 forest management areas (Site level)
- Acres included within HREP: 740 acres – Elk River Bottoms, Gomer's Lake, Iowa Islands, & Illinois Islands
- Acres identified for features: 355 acres – overview map included
- Silvicultural Feature count: 7 prescriptions within 6 Sites
- No action determination: 2 Sites
- Stand Walk Recon: August 2020 (2 days), April 2021 (2 days)
- Foresters on Recon: Ben Vandermyde, Lauren McNeal, Tate Sattler
- Assisting with Recon: Nate Williams, Kirk Hansen, Rebekah Anderson

Areas included in the stand walk recon area located in Pool 13, Compartment 2, and are in Units 2 (Elk River Bottoms), 3 (Gomer's Lake), and 4 (Iowa Islands). Areas included in the stand walk recon are also located in Pool 13, Compartment 3, and are in Units 5 (Lock & Dam Road), and 6 (Illinois Islands). The silvicultural prescriptions are written to the Site or Stand level (subdivisions of Unit) for recommendation to project features. All 7 recommendations for timber stand improvements include a thinning treatment to achieve a forest growth response to meet desirable forest health, diversity, and resilience best suited for that area based on current environmental and forest conditions. All 7 silvicultural prescriptions include containerized trees and/or shrubs, or willow cuttings for planting efforts to achieve forest growth response. 1 silvicultural treatment includes invasive species treatment.

Areas identified during the stand walk recon to have low or no risk to having no feature development of implementing timber stand improvements are not included in this summary. Only areas that will degrade or continue to degrade for the next 50 years without action (implemented silvicultural prescription) are described in this summary.

The entire stand walk recon area in general is comprised of mature forest having well-established trees in the canopy. The primary forest community types are silver maple and mixed silver maple with very limited natural regeneration and desirable understory establishment. Overall, the summarized forest management areas collectively have trees in the canopy that will not persist past life of this HREP project. The main consideration of concern is that there is limited or no adequate stocking of trees to replace the expected mortality of trees in the canopy that are reaching expected maximum age of the most prevalent tree species.

In addition, there are scattered canopy gaps within the mature and overstocked forest condition inundated with invasive species. These canopy gaps were likely formed by the death of overmature trees or windthrow during storm events. The canopy gaps generally include the invasive species reed canary grass and Japanese hops. Both of these species are shade intolerant and require direct sunlight to fully establish. Therefore, a method to control and reduce the spread of these species is to densely plant cuttings or container trees to cast shade.

For life of this project, in general, there is the expectation that the forest structure dynamics will alter greatly with reduction in forest canopy at unpredictable rates and patterns. This is primarily a result of the overall condition of the forest being well past overstocked tree densities. The effect of areas being well past overstocked is negative to new, developing, and mature trees alike. The condition of overstocked forest should be considered as a measure that represents a

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chronic condition not providing adequate growing space to promote natural recruitment and to the healthy establishment of trees below the forest canopy. The only corrective option to alter long term impacts of an overstocked forest is through reduction of trees by thinning treatments or timber harvest. For multiple considerations, thinning treatments are the recommended option to provide adequate growing space and to increase tree health, structural diversity, and sustainable longevity.

Most prescriptions will require the contractor to first mark trees to cut and/or mark trees to save prior to any actual tree cutting occurs to meet the prescription targets. Following approval of tree cutting selection, the contractor will then be capable to proceed with the actual tree cutting. Prescriptions that specify that the government will mark trees will be done so by project forester and PDT members prior to contract award. Tree planting varies by species, stock type, and density depending on identified area capability, priority considerations to forest growth, and anticipated risk to natural regeneration limitations.

All tree cutting for thinning treatments is intended to only occur outside the bat tree roosting season; from October 1st to March 31st. The anticipated method of tree cutting is to be conducted by hand crews and chainsaw operation. Areas that are anticipated to have use of heavy equipment during tree thinning efforts will be addressed specifically. Otherwise, the general assumption is that work will be conducted by hand crews to implement the silvicultural prescription.

Tree and/or shrub planting efforts are primarily intended to be conducted using containerized stock. In general, containerized stock is expected to be at minimal height of 4 feet tall from the root collar to the terminal leader. Species that are known to not reach this height at the nursery include species of hickory, walnut and Kentucky coffeetree – for these species, the minimum intended tree height is 14 inches. All containerized tree planting is expected to occur from middle of October up to one week prior to frozen ground conditions – most years this would be the first week of December. Trees and shrubs are likely to only have a soil disturbance of a depth of 14 inches at the maximum. If conditions are anticipated to be different or different planting stock is used, that will specifically be addressed for that prescription. Otherwise, the general assumption is to be that tree and shrubs will be containerized and planted in the fall planting season. Utility vehicles are likely to be used to transport trees and shrubs.

Area summary information provided below is further details specific to that described area beyond what has been addressed under the general information. Current forest condition descriptions are to be considered to be reflective to the overall general information discussed thus far if not otherwise expressed per summarized area.

Silvicultural Prescriptions – Timber Stand Improvement (TSI) Features

Unit 2 – Northern Elk River Bottoms

Site 1 (TSI-H1) **p13c002u002st01**

I. Current Forest Condition **120 acres**

- The canopy at this site is on the extreme end of average stand age for the recon areas. The canopy age on average is just over 80 years old.
- The understory is a random mixture of trees that are suppressed and in decline. These understory trees will not successfully replace the canopy trees.

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- Scattered canopy gaps are currently existing without any significance to natural tree regeneration success. Lighting conditions appear to be collectively too low for recruitment due to abundance of invasive species in gaps.
- The timber inventory only captures 7 tree species (none are hard mast) in this stand, so the tree species diversity is very low even though the area has indicators that it is well drained and supportive to a diverse range of tree species.

II. Risk to Forest without TSI Feature

- There are currently no hard mast trees within this area that could provide a seed source to recruitment of naturally established hard mast seedlings. This area has suitable areas for establishment of hard mast trees. Without planting hard mast tree species, species diversity will remain low within this area.
- Native shrubs are in decline across all forested areas within pool 13. Conditions are not favorable for natural establishment of native shrubs with the current pattern of canopy closure and invasive species coverage. Without planting native shrubs, they are unlikely to establish in the area.
- Mature trees are likely to die unpredictably throughout the area. Specifically, mature silver maple trees adjacent to large canopy gaps that are at risk to windthrow. This will open up the gaps and allow for further establishment of invasive species.

III. Silvicultural Prescription (1 Rx including 50 acres maximum)

- Free Thinning with tree and shrub planting
- Government marked – project forester with PDT members
- Thinning will focus on reducing canopy trees where dense. Intent is to cut trees that have poor structural development, declining health condition, and major defect. There will be no cutting where large gaps exist. Intent of selection to cut will be to favor trees with good form and development, in good health condition, and likely to respond to available growing space. Poor in form midstory trees will be coppiced to allow for stump sprouting. Selection of trees below the canopy layer to keep will be based on overall tree vigor and structural development. Target is to retain only the best in form.
- Maximum of 15 canopy trees/acre will be cut. Minimum of 10 <12” dbh midstory trees/acre will be coppiced to allow for stump sprouting. Approximately 10% of the area will require no thinning.
- Fill-in planting in existing and created canopy gaps after thinning will focus on increasing species and age diversity.
- Maximum 20 container trees/acre to plant. Container trees must be 4’ tall minimum. Minimum spacing 20’ from any other planted tree, and 35’ from any existing tree >12” dbh. Approximately 60% of planting stock: QUBI, JUNI, CAIL2, QUPA2, BENI. Approximately 40% of planting stock: CASP8, ACSA2, PODE3, GYDI, PLOC, TIAM.
- Shrub species will be planted in clusters to promote pollinator habitat and increase success.
- Container shrubs will be planted in 2 clusters of 15 shrubs for a total of 30 shrubs/acre. Container shrubs must be 3’ tall minimum. Each shrub in a cluster should be approximately 2-4’ from the other shrubs. Minimum spacing 20’ from any other planted tree, and 35’ from any existing tree >12” dbh. Each shrub cluster will consist of 2 species. Shrub species list: COSES, COAM, CECA4, EUAT5, CRVI, SAMBU.

IV. Measurement of Impact

- A total of 50 acres is to be included in the treatment implementation.
- Tree densities vary across entire site due to canopy gaps. The average trees per acre across the site is 108 TPA. Cutting will include up to 14% of canopy trees or an

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average of 15 TPA: total of no more than 750 canopy trees will be cut across the entire treatment area.
- All suppressed trees less than 12 inches diameter breast height will be coppiced. This will vary by the acre, in total, no more than 1,500 trees under 12 inches dbh are anticipated to be cut.
- Tree cutting will include trees of all diameter sizes.
- Areas outside of the patch thinning areas may require limited clearing of small diameter trees for contractor access to and from each cutting area for planting efforts. Intent will be to utilized routes that are the most open to minimize need for clearing for access paths.
- Maximum of 1000 container trees will be planted throughout the treatment area. The maximum depth to dig to plant will be 10 inches.
- Maximum of 1,500 container shrubs will be planted throughout the treatment area. The maximum depth to dig to plant will be 10 inches.

Unit 3 – Southern Elk River Bottoms / Gomer's Lake

Site 4 (TSI-H1) **p13c002u003st04**

I. Current Forest Condition **174 acres**

- The canopy at this site is on the extreme end of average stand age for the recon areas. The canopy age on average is just over 80 years old.
- Midstory trees consist of poor in form undesirable species that are blocking sunlight and will be detrimental to further growth of understory trees.
- Scattered large canopy gaps are currently existing without any significance to natural tree regeneration success. These gaps are inundated with invasive species which limits natural regeneration success of tree species due to competition for resources.
- The timber inventory only captures 10 tree species (none are hard mast) in this stand, so the tree species diversity is very low even though the area has indicators that it is well drained and supportive to a diverse range of tree species.

II. Risk to Forest without TSI Feature

- There are currently no hard mast trees within this area that could provide a seed source to aide in recruitment of naturally established hard mast seedlings. Without planting hard mast tree species, species diversity will remain low within this area.
- Mature trees are likely to die unpredictably throughout the area. Specifically, mature silver maple trees adjacent to large canopy gaps that are at risk to windthrow. This will open up the gaps and allow for further establishment of invasive species.
- Poor in form midstory trees will continue to block light and suppress good form understory trees, as well as reduce natural recruitment.
- Invasive species and canopy gaps will continue to grow and spread without tree plantings to increase shade cover.

III. Silvicultural Prescription (2 Rx including a combined 91 acres maximum)

- Free thinning, target is to release good form understory trees and increase light by cutting stressed and poor in growth form understory and midstory trees. Maximum 81 acres, will cut 5 TPA on average. Thinning will be uneven; some areas require no thinning due to open canopy conditions. Target is to mostly cut mulberry and American elm. Other species may be cut as well depending on growth form.
- Invasive species treatment, Fall and Spring season herbicide application to reed canary grass in canopy gaps, maintaining a 20' buffer from creek. Maximum 10 acres

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will be sprayed throughout the treatment area, only areas with the densest inundation of reed canary grass in open canopy gaps will be treated.

- Late Spring/early Summer duff clearing of canopy gaps; timed accordingly with cottonwood, silver maple, and willow natural seed release timing. Maximum 10 acres will have duff clearing, same footprint as herbicide application.
- Fall planting of willow cuttings; pole size and smaller cuttings are easily accessible on edges of treatment area. Maximum 10 acres planted, same footprint as herbicide application and duff clearing. Approximately 80 TPA planted, with the same maximum TPA of willows cut.
- Fall or early spring planting of diverse container tree species, maximum planting 10 TPA a mix of sycamore, river birch, cottonwood, and a hard mast mix of swamp white oak, bur oak, pin oak, and black walnut. These trees will be planted throughout the total 91 acres.

IV. Measurement of Impact

- A total of 91 acres is to be included in the treatment implementation.
- Tree density is relatively uneven throughout the site due to canopy gaps; average TPA is 122. Maximum number of trees cut would be 450 in the 81 acre thinning treatment area.
- Tree cutting will include trees of all species, targeting mostly mulberry and elm for the free thinning up to 20” dbh.
- A total of 10 acres of canopy gap areas will be sprayed with herbicide according to manufacturer recommendations.
- A total of 10 acres of canopy gap areas will have the duff layer cleared to expose bare soil using small equipment (Bobcat).
- Tree cutting for will cutting stock will include all willow species in the diameter range of 2”-12”. Multiple cuttings may be gathered from trees on the higher end of the diameter range. Maximum of 300 willow trees will be cut to produce 7’ tall willow cuttings to be planted. Willow stumps will be cut clean for coppice. Willow at the targeted size selected for creating willow cuttings are very viable and very likely to stump sprout.
- Tree cuttings will be planted at a maximum rate of 80 TPA over 10 acres for a total of 800 cuttings planted. Maximum depth to dig to plant will be 20 inches.
- Container trees will be planted throughout the 91 acres at a maximum rate of 10 TPA, approximately 910 container trees. Maximum depth to dig to plant will be 10 inches.

Site 3 (TSI-H2) **p13c002u003st03**

I. Current Forest Condition **121 acres**

a. The tree species diversity for this site includes black walnut at a very low rate and older than the average canopy tree. Cottonwood is the most dominant tree species at this site with a high quadratic mean dbh, followed by silver maple with a polesize quadratic mean dbh. In total, there were 12 tree species captured in the timber inventory.
b. The canopy at this site is on the extreme end of average stand age for the recon areas. The canopy age on average is just over 75 years old.
c. Due to the high abundance of cottonwood, there is a relatively high amount of sunlight making it to the forest floor. This amount of sunlight could encourage further natural regeneration given the right conditions.
d. The understory is currently a random mixture of trees that are suppressed and in decline.
e. Dogwood and river birch are in the top 3 understory species, and are mostly growing in clumps in areas of the site with higher light conditions.

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f. Suppressed and stressed/significant decline boxelder is one of the top overstory species, which suggests the area could potentially support black walnut growth.
g. There are currently patches of the invasive species reed canary grass in canopy gaps and high light availability areas.

II. Risk to Forest without TSI Feature

a. The average tree in the canopy is expected to continue to be under stress and collectively the rate of mortality will increase within the next 20 years. Cottonwood and Silver maple average life expectancy is 100 years. Without planting trees or coppicing regeneration currently growing in poor form, we can expect this area to begin to transition to a more open canopy structure with large canopy gaps.
b. Tree species diversity is currently high; 12 tree species currently known to occur and more may be present. Without planting to boost success of already occurring natural regeneration, there is low expectation that species distribution will continue naturally or expand upon current tree distribution and evenness. Cottonwood in particular is not naturally regenerating at a rate to eventually replace canopy trees as they begin to senesce.
c. Tree planting will be needed to ensure maximum success of treatment. The majority of the slower growing tree species require ample sunlight and space for natural establishment. Without planting, there is the expectation that only a minimal recruitment of slower growing species will occur prior to fast growing tree species filling in any available growing space. The risk without planting also includes an opportunity missed to increase the actual evenness of tree species throughout the site.
d. Without planting, invasive species presence is expected to continue and further expand due to higher availability of sunlight.

III. Silvicultural Prescription (1 RX including 71 acres maximum)

a. Full low density tree planting of currently occurring tree species as well as a hard mast mix throughout the treatment area.
b. Target is to plant trees into naturally occurring canopy gaps and areas of higher light availability.
c. A total of 20 TPA will be planted throughout the treatment area, to include 5 TPA cottonwood and 15 TPA a hard mast mixture of swamp white oak, pin oak, bur oak, black walnut, Kentucky coffeetree, northern pecan, and bitternut hickory.
d. Planted trees are to be no closer than 15 feet from the main stem of any cottonwood tree and 30 feet from the main stem of any other existing tree over 18” dbh. Additionally, each container tree must be planted at least 50 feet away from any other planted tree. Species are to be distributed evenly throughout the treatment area.
e. Planting is to focus in the small canopy gaps throughout the site. In the absence of a true canopy gap, trees will be planted in the areas with the highest available light.
f. Coppice of existing trees under 12” dbh within 15’ from any planted tree will occur to provide additional growing space and stump sprout protection to the planted tree.
g. Coppice of shrub dogwood within 5’ from any planted tree will occur to provide additional growing space and stump sprout protection to the planted tree.

IV. Measurement of Impact

- A total of 71 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 139.
- There will be no thinning other than coppice of small diameter trees and shrubs. On average, a range of 2 to 4 trees or shrubs will be required to be cut per planted tree. Maximum number of trees/shrubs cut will be 6,000 and

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- Maximum 20 TPA will be planted across the 71 acres, a total of 1,420 trees. Maximum depth to dig for planting will be 14 inches.

Site 2 (TSI-H2) **p13c002u003st02**

I. Current Forest Condition **120 acres**

a. The average canopy tree is around 65 years old and will be approaching over maturity by the end of the project.
b. There are currently 12 species captured by the inventory in the site, including 1 hard mast species. This is relatively diverse.
c. Isolated hard mast trees are present; however, these trees are mature and very few individuals. There are no quality hard mast regeneration, saplings, or pole size trees; no hard mast tree exists below the canopy that are not suppressed and stressed.
d. Cottonwood is the primary tree species in the canopy for this stand, followed by silver maple. This is one of the only cottonwood dominant communities in the pool. The average cottonwood tree in the overstory is overmature, while the average silver maple in the overstory is sawtimber size.
e. Few trees in the understory exist, none of which are cottonwood. Trees that are present are in very poor development form and are stressed.
f. Parts of the eastern and central portion of the site have a younger silver maple stand dynamic with black willow throughout. These areas are not included in the treatment, and have no prescribed treatment.
g. In areas with higher light availability, non-native herbaceous vegetation is thriving and outcompeting first and second year tree seedlings.

II. Risk to Forest without TSI Feature

a. Cottonwood trees in the canopy are very old and very large. These individuals in the canopy have been unable to successfully naturally regenerate due to invasive herbaceous vegetation and poor form midstory trees. Without action, this stand is very unlikely to remain in forest cover.
b. None of the trees below the canopy are capable to replace trees that will die out of the canopy. Without management, this stand will continue to degrade.
c. The establishment of non-native herbaceous vegetation and scraggly mulberry is very likely to occur as a natural succession to the area. Rate of change is expected to be unpredictable and the duration of transition to a lessor forested condition is difficult to foresee.
d. Without planting of a diverse mix of species, the site will not continue as a relatively diverse site. No desirable species are currently able to naturally regenerate, including cottonwood.

III. Silvicultural Prescription (1 RX including 55 acres maximum)

a. Geometric Thinning with tree planting and shrub cluster planting.
b. Target to cut 50-75% of the mulberry, boxelder, hackberry, American elm, and green ash under 12” dbh that is in poor form. Poor form includes flattened crown, forked tops, dead top, >20% lean, and heart rot. The goal is to create greater light to the forest floor to promote natural regeneration and the growth of planted trees.
c. Mulberry will be cut with a stump height of 24” and treated with herbicide to reduce stump sprouting.
d. All other species will be coppiced with a maximum stump height of 3” to promote stump sprouting.
e. Trees and shrubs will be planted 1 year post thinning treatment.
f. Containerized trees will be planted at a rate of 16 TPA throughout the prescription area.

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g. Species include swamp white oak, pin oak, and cottonwood with a minimum stock height of 6'. Other species include black walnut with a minimum stock height of 4' and bitternut hickory with a minimum stock height of 2'. Cottonwood will make up approximately 60% of the trees planted.
h. Trees will be planted a minimum of 20' from any other planted tree, minimum 15' from any coppiced stump, and a minimum of 30' from any canopy tree \ tree greater than 18" dbh. Maximum depth to plant will be 10 inches.
i. Shrubs will be planted in clusters of 15, at the rate of 1 cluster for every 6 acres. There will be 9 clusters total planted. Each cluster will need to a minimum of 300' from any other planted shrub cluster. Maximum depth to dig to plant will be 10 inches.
j. Species planted are to include false indigo bush, elderberry, green hawthorn, and eastern wahoo. There will be at least 3 individuals of each species within each cluster. Individuals of the same species are to be placed adjacent to each other within the clusters to encourage natural regeneration and spreading.

IV. Measurement of Impact

a. A total of 55 acres is to be included in the treatment implementation.
b. Tree density is variable across Site 2; however, the majority of the treatment area reflects the site average of 144 TPA. The maximum number of trees to cut would be 4,000 across the 55 acre treatment area; this equates to an estimate of 53% of living trees.
c. The treatment is targeting the suppressed trees in the understory, trees less than 12 inches in diameter at breast height.
d. All cut mulberry would be treated with herbicide. All other tree species are to be allowed to stump sprout; coppice.
e. Tree planting will be at a rate of 16 TPA, therefore 880 trees will be planted throughout the treatment area.
f. Shrub planting will include 9 total clusters with 15 individual plants per cluster, adding up to a total of 135 individual shrubs planted. The clusters will be planted at the rate of 1 cluster for every 6 acres.

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Unit 5 – Lock & Dam Road

Site 1 **p13c003u005st01**

I. Current Forest Condition **127 acres**

- The canopy at this site is on the extreme end of average stand age for the recon areas. The canopy age on average is just over 75 years old.
- The understory conditions are marginal. The overall condition of trees below the canopy are for the most part in significant decline and suppressed. These trees are not favorable to replace and establish into the canopy.
    a. There are currently 15 species captured by the inventory in the site, including 2 hard mast species. This is relatively diverse.
    b. Isolated hard mast trees are present; however, these trees are mature and few individuals. There is little to no quality hard mast regeneration, saplings, or pole size trees; few hard mast trees exist below the canopy that are not suppressed and stressed.
    c. Existing hard mast species are concentrated near the SW corner of the treatment area.

d. Dogwood is in the top 3 understory species, and are mostly growing in clumps in areas of the site with higher light conditions.
e. There are currently patches of the invasive species reed canary grass in canopy gaps and high light availability areas.
f. Areas of highest tree health decline/mortality are generally lower elevation adjacent to interior sloughs.

II. Risk to Forest without TSI Feature

a. None of the trees below the canopy are capable to replace trees that will die out of the canopy. Without management, this stand will continue to degrade.
b. The establishment of non-native herbaceous vegetation and scraggly mulberry/elm is very likely to occur as a natural succession to the area. Rate of change is expected to be unpredictable and the duration of transition to a lessor forested condition is difficult to foresee.

- Without planting of a diverse mix of species, the site will not continue as a relatively diverse site. No desirable species are currently able to naturally regenerate, including hard mast species.
- Without a reduction of light blocking poor in form midstory and canopy trees to create available growing space, there is no expectation that conditions for the understory will improve evenly across the site. Without available growing space and adequate sunlight to the forest floor, conditions will not be favorable for the establishment of advanced natural regeneration to a sustainable population density.

III. Silvicultural Prescription (1 RX including 82 acres maximum)

- Free thinning to target poor form elm and mulberry in the overstory, midstory, and understory. Trees will be targeted to cut by their poor and/or light blocking form: i.e., significant lean, sweeping crown, flattened crown, heart rot.
- Trees thinned will have a diameter range of 4”-20”. 5-10 trees per acre in this category will be cut.
- Plant a hard mast mixture after thinning in existing canopy gaps and created higher light areas.
- 5 gallon container stock will be used, species include: pin oak, black walnut, northern pecan, bitternut hickory, shellbark hickory, burr oak, and swamp white oak. 10 trees/acre will be planted.
- Follow up free thinning treatment 1 growing season after planting to ensure available light is still adequate.

IV. Measurement of Impact

- A total of 82 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 184. Tree cutting will include up to 10 TPA. Maximum trees cut will be 820.
- Reduction of mulberry and elm will include trees in the diameter range of 4”-20”.
- Maximum amount of container trees planted will be 10 TPA, or a maximum of 820 trees throughout the treatment area.
- A total of 45 acres will not have any tree cutting conducted. This area includes the smaller “islands” of forest off of the main chunk that do not have the same stand dynamics. These areas are much younger and the dynamics are not concerning for the project duration.

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Unit 6 – Illinois Islands

Site 2 **p13c003u006st02**

I. Current Forest Condition **31 acres**

- This site consists of 4 islands adjacent to the channel. The islands mostly consist of pole size stands of willow with some pole size silver maple mixed in.
- The largest of the islands has a slightly older dynamic and does include larger diameter silver maple, elm, mulberry, and cottonwood. This island also has a dense thicket of dogwood in the understory around the edges of the island. There are also scattered clumps of dogwood in the interior of the island.
- This site has only 5 overstory species documented in the inventory, mostly due to the early successional stage of these islands. There are 2 additional species captured in the understory category. All of the species are typical, there is no hard mast component to these islands.

II. Risk to Forest without TSI Feature

a. In the established more mature portion of the largest island, there is no good form regeneration to replace canopy trees as they senesce. The regeneration that is occurring is poor in form and will likely fall out before they hit the canopy.
b. The establishment of non-native herbaceous vegetation and scraggly mulberry/elm is very likely to occur as a natural succession to the area. Rate of change is expected to be unpredictable and the duration of transition to a lessor forested condition is difficult to foresee.

- Without a reduction of light blocking poor in form midstory and canopy trees to create available growing space, there is no expectation that conditions for the understory will improve evenly across the site. Without available growing space and adequate sunlight to the forest floor, conditions will not be favorable for the establishment of advanced natural regeneration.
- Without planting a diverse mix of species, it is unlikely that this site will be able to maintain or increase the diversity it currently has.

III. Silvicultural Prescription (1 RX including 6 acres maximum)

- Low thinning to target poor form mulberry in the midstory and understory. Trees will be targeted to cut by their poor and/or light blocking form: i.e., significant lean, sweeping crown, flattened crown, heart rot.
- Trees thinned will have a diameter range of 2”-20”.
- Plant a mixture of species after thinning in existing canopy gaps and created higher light areas within the mature stand.
- 3-5 gallon container stock will be used, species include: sycamore, cottonwood, river birch, and northern catalpa. 15 trees/acre will be planted.

IV. Measurement of Impact

- A total of 6 acres is to be included in the treatment implementation.
- Tree density is relatively uneven throughout the site; average TPA is 193, but TPA in the treatment area is closer to 90. Tree cutting will include up to 10% of trees or an average of 9 TPA. Maximum trees cut throughout the treatment area is 54.
- Reduction of mulberry will include trees in the diameter range of 2”-20”.
- A total of 25 acres will not have any tree cutting conducted. This area includes the smaller islands of younger willow dominated forest. These areas are much younger and the dynamics are not concerning for the project duration.
- Maximum of 90 container trees will be planted throughout the treatment area.

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APPENDIX A
ENVIRONMENTAL

ATTACHMENT G
MEMORANDUM OF AGREEMENT

(To be added when MOA is complete)

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APPENDIX A
ENVIRONMENTAL

ATTACHMENT H
CULTURAL RESOURCES

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1. INTRODUCTION

The U.S. Army Corps of Engineers, Rock Island District (USACE) is proposing to construct the Lower Pool 13 Habitat Rehabilitation and Enhancement Project (HREP) located between river miles 522.5 and 529.0 in the southernmost portion of Pool 13 on the Upper Mississippi River in Clinton County, Iowa and Carroll and Whiteside Counties, Illinois. The proposed project features in the Study Area are located in Iowa (T82N R7E Sections 4-9, 16-18 and 20-21 and T83N R7E Sections 20-21 and 28-32) and Illinois (T22N R3E Sections 3-4 and 9-10 and T23N R3E Sections 21, 33, and 28).

This attachment contains existing information available from previous investigations and recorded archaeological sites and historic standing structures. The proposed Study Area covered in this attachment includes the descriptions provided in the Feasibility Report and Integrated Environmental Assessment for the Lower Pool 13 Habitat Restoration and Enhancement Project (HREP).

2. PREVIOUS INVESTIGATIONS AND KNOWN HISTORIC PROPERTIES

The Pool 13 locality has a long history of archaeological investigations. The earliest systematic archaeological work in the Iowa was completed by Keyes and Orr in the 1920s; however, studies have predated his work. The Bureau of American Ethnology was actively researching mounds in the 1880s at the same time as the Northwestern Archaeological Survey which extended into Minnesota, Wisconsin and Iowa. Orr focused his work in Iowa which included excavations of mounds, camps, villages, and rock shelters. These early investigations in the 1800's and early 1900's mapped upland sites and excavated burial mounds. Focus on upland areas continued until the 1970s when surveys started to shift focus to floodplain areas.

With the passage of the National Historic Preservation Act of 1966 (NHPA), preservation in the United States became formalized and professionalized. There had been previous measures for preservation (e.g., Antiquities Act of 1906, Historic Sites Act of 1935); however, the NHPA was to be the most influential. Federal projects, or projects with Federal funding, were now subject to Section 106 review in which Federal agencies were required to consider the impact of their actions on historic properties. The NHPA would change how the USACE would review projects on the Mississippi River and with it, the focus of studying upland areas started to shift to floodplain areas. The majority of surveys completed in the 1970s by the USACE on the Mississippi River were for dredge placements sites or dredge cuts; however, some surveys were connected to the development of recreation areas and the construction of flood control projects. By the 1980s, surveys by the USACE continued for these types of projects but expanded to geomorphology studies and the preservation and management of known cultural sites.

The USACE identified the area of potential effects (APE) for Section 106 of the National Historic Preservation Act to include the physical effects of constructing project features and the potential visual and audible effects during and/or post construction. No known archaeological sites from Iowa or Illinois have been identified within the APE. Within this stretch of the river, several known historic properties have been identified within the state of Iowa and Illinois; however, they are not within the area of proposed project features and are outside the visual and audible effects.

The Historic Indian Location Database (HILD) project uses overlooked historical sources to map Native American sites in Iowa from the era of the earliest European explorers to the modern period. Its goal is to change Iowa's map from a blank landscape to one populated with villages,

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camps, and other locations, revealing map that is alive with events and encounters. The Timber Stand 1 location overlaps with HILD # 637 - Elk River Indian Camp dated 1835. Review of General Land Office plat maps from the 1830s until the 1880s, an eastern expansion of the Iowa land can be seen until it was submerged after the 1930s. The approximate location of this village site may be located within Timber Stand 1.

3. FUTURE ARCHAEOLOGICAL AND GEOMORPHOLOGICAL INVESTIGATIONS

The USACE anticipates the Maximum Plan would have no effect to historic properties; however, investigations and consultation need to be completed. It is anticipated this investigation would be completed in 2023. Summary of the results will be included in this section.

4. CONCLUSIONS AND RECOMMENDATIONS

The USACE anticipates the Maximum Plan would have no effect to historic properties; however, investigations and consultation need to be completed. The USACE reviewed available information and no historic properties were identified in the Study Area. Limited previous investigations have been completed within the Study Area including those completed for USACE developed picnic and boating areas. The USACE determined a field investigation was needed to consider potential effects to historic properties. Additional identification efforts would also include consultation with the Iowa and Illinois State Historic Preservation Offices (SHPO) and Tribal Historic Preservation Offices of Ho-Chunk Nation of Wisconsin, Kickapoo Tribe of Oklahoma, Miami Tribe of Oklahoma, Osage Nation, Sac and Fox Nation of Missouri in Kansas and Nebraska, Sac and Fox Nation, Oklahoma, Sac and Fox Nation of the Mississippi in Iowa, and Winnebago Tribe.

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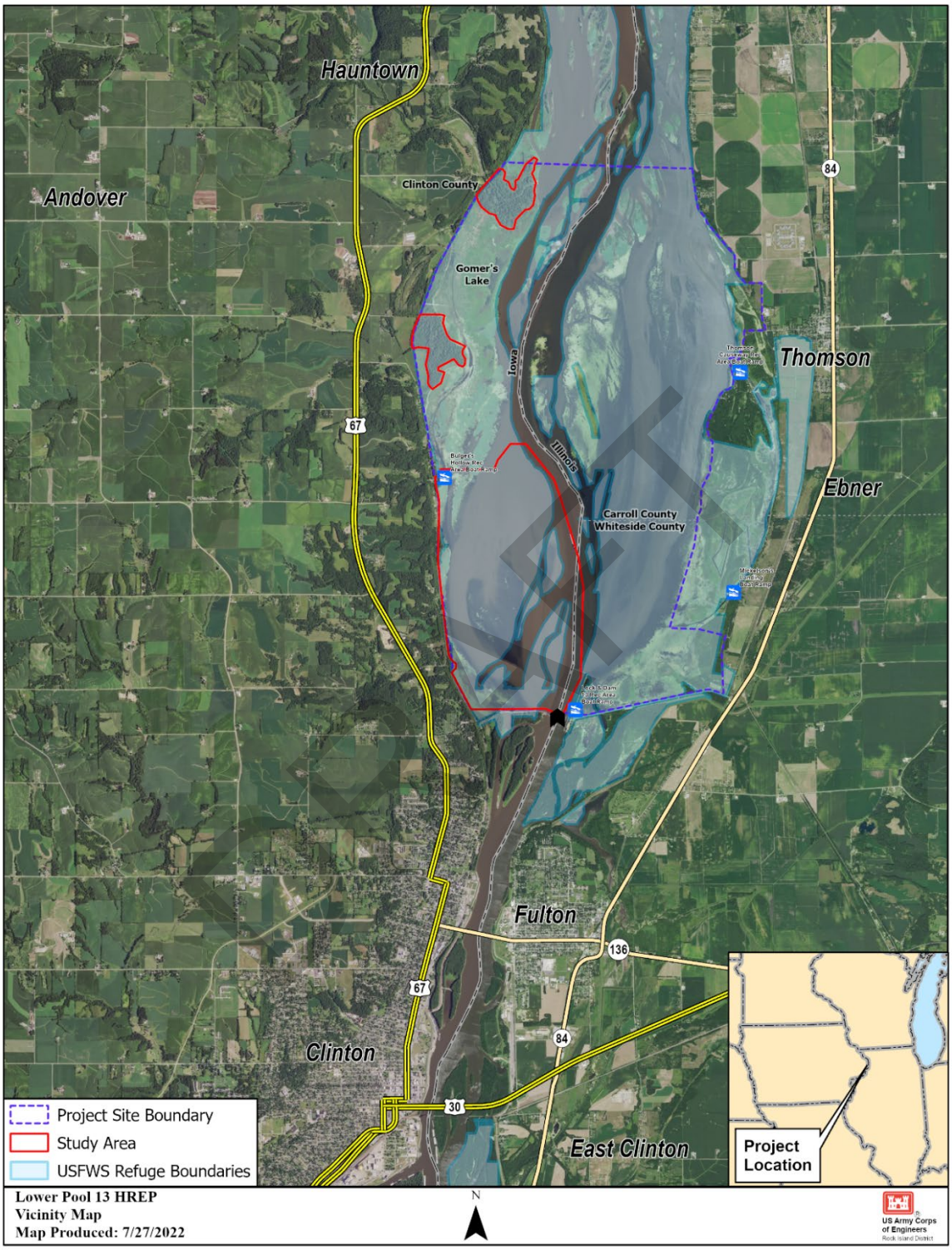

Figure-H-1. Lower Pool 13 HREP Study Area

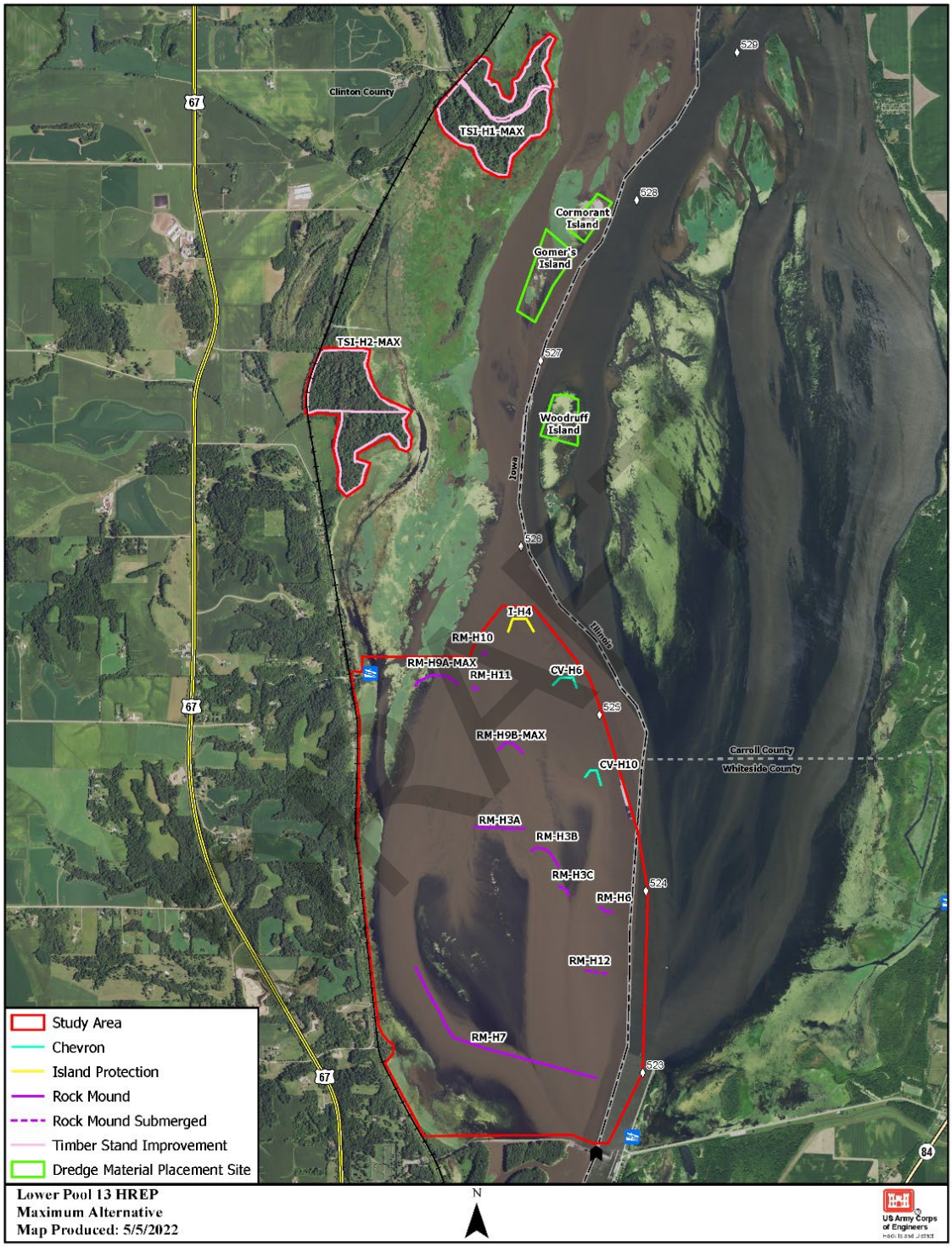

Figure H-2. Lower Pool 13 HREP Project Features

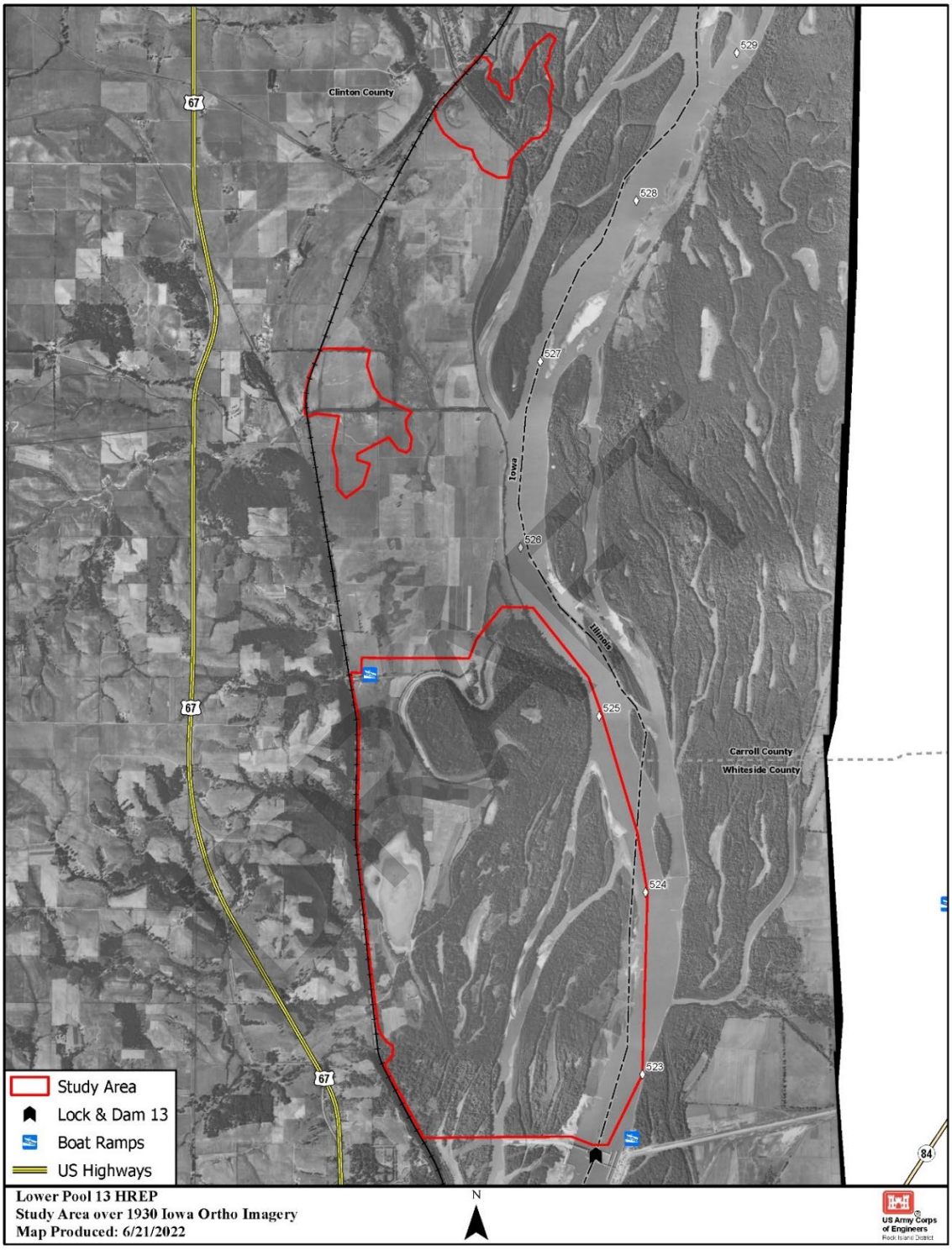

Figure H-3. 1930 Aerial Imagery with Study Area

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX B
ECONOMIC AND SOCIAL CONSIDERATIONS

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13 HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX B
ECONOMIC AND SOCIAL CONSIDERATIONS

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1 REGIONAL ECONOMIC DEVELOPMENT RECONS ANALYSIS

1.1 General

The U.S. Army Corps of Engineers (USACE) Institute for Water Resources, Louis Berger, and Michigan State University have developed a regional economic impact modeling tool, RECONS (Regional ECONomic System), that provides estimates of jobs and other economic measures such as labor income, value added, and sales that are supported by USACE programs, projects, and activities. This modeling tool automates calculations and generates estimates of jobs, labor income, value added, and sales through the use of IMPLAN®'s multipliers and ratios, customized impact areas for USACE project locations, and customized spending profiles for USACE projects, business lines, and work activities. RECONS allows the USACE to evaluate the regional economic impact and contribution associated with USACE expenditures, activities, and infrastructure.

1.2 Description of Metrics

"Output" is the sum total of transactions that take place as a result of the construction project, including both value added and intermediate goods purchased in the economy. "Labor Income" includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. "Value Added" or "Gross Regional Product" represents the value-added output of the study regions. This metric captures all final goods and services produced in the study areas because of the existence of the project. It is different from output in the sense that one dollar of a final good or service may have multiple transactions associated with it. "Jobs" is the estimated worker-years of labor required to build the project.

1.3 Assumptions

Input-output analysis rests on the following assumptions. The production functions of industries have constant returns to scale, so if output is to increase, inputs will increase in the same proportion. Industries face no supply constraints; they have access to all the materials they can use. Industries have a fixed commodity input structure; they will not substitute any commodities or services used in the production of output in response to price changes. Industries produce their commodities in fixed proportions, so an industry will not increase production of a commodity without increasing production in every other commodity it produces. Furthermore, it is assumed that industries use the same technology to produce all their commodities.

1.4 Results

1.4.1 SAV Objective

The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Clinton (IA) are estimated to be $62,264,000. Of this total expenditure, $39,533,562 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $62,264,000 support a total of 596.5 full-time equivalent jobs, $33,113,734 in labor income, $32,012,651 in the gross regional product, and $61,704,457 in economic output in the local impact area. More broadly, these expenditures support 1,412.4 full-time equivalent jobs, $90,237,066 in labor

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income, $107,694,127 in the gross regional product, and $189,236,586 in economic output in the nation. The results of the RECONs analysis are summarized in Table B-1.

Table B-1. Lower Pool 13 Habitat Rehabilitation and Enhancement Project Regional Economic Development (RED) Summary (SAV Objective Cost)

Area	Output	Jobs*	Labor Income	Value Added
Local				
Direct Impact	$39,533,562	448.5	$26,705,689	$20,291,719
Secondary Impact	$22,170,895	148.0	$6,408,045	$11,720,932
Total Impact	$61,704,457	596.5	$33,113,734	$32,012,651
State				
Direct Impact	$48,073,803	557.1	$36,678,098	$26,374,060
Secondary Impact	$45,390,075	267.9	$13,970,915	$24,632,067
Total Impact	$93,463,878	824.9	$50,649,013	$51,006,127
US				
Direct Impact	$61,834,767	816.5	$50,179,074	$38,551,470
Secondary Impact	$127,401,819	595.9	$40,057,992	$69,142,657
Total Impact	$189,236,586	1,412.4	$90,237,066	$107,694,127

* Jobs are presented in full-time equivalence (FTE)

1.4.2 Results Efficient

The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Clinton (IA) are estimated to be $38,797,000. Of this total expenditure, $24,633,554 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $38,797,000 support a total of 371.7 full-time equivalent jobs, $20,633,328 in labor income, $19,947,238 in the gross regional product, and $38,448,346 in economic output in the local impact area. More broadly, these expenditures support 880.1 full-time equivalent jobs, $56,227,153 in labor income, $67,104,732 in the gross regional product, and $117,914,233 in economic output in the nation. Table B-2 summarizes these results.

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Table B-2. Lower Pool 13 Habitat Rehabilitation and Enhancement Project Regional Economic Development (RED) Summary (Efficient Cost)

Area	Output	Jobs*	Labor Income	Value Added
Local				
Direct Impact	$24,633,554	279.5	$16,640,444	$12,643,868
Secondary Impact	$13,814,792	92.2	$3,992,884	$7,303,370
Total Impact	$38,448,346	371.7	$20,633,328	$19,947,238
State				
Direct Impact	$29,955,020	347.1	$22,854,301	$16,433,805
Secondary Impact	$28,282,776	166.9	$8,705,345	$15,348,360
Total Impact	$58,237,795	514.0	$31,559,645	$31,782,165
US				
Direct Impact	$38,529,543	508.8	$31,266,824	$24,021,608
Secondary Impact	$79,384,691	371.3	$24,960,329	$43,083,125
Total Impact	$117,914,233	880.1	$56,227,153	$67,104,732

* Jobs are presented in full-time equivalence (FTE)

1.4.3 Results Maximum

The expenditures associated with All Work Activities, with Ability to Customize Impact Area and Work Activity at Clinton (IA) are estimated to be $71,429,000. Of this total expenditure, $45,352,736 will be captured within the local impact area. The remainder of the expenditures will be captured within the state impact area and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the expenditures $71,429,000 support a total of 684.3 full-time equivalent jobs, $37,987,937 in labor income, $36,724,779 in the gross regional product, and $70,787,094 in economic output in the local impact area. More broadly, these expenditures support 1,620.3 full-time equivalent jobs, $103,519,585 in labor income, $123,546,251 in the gross regional product, and $217,091,419 in economic output in the nation. Table B-3 summarizes these results.

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Table B-3. Lower Pool 13 Habitat Rehabilitation and Enhancement Project Regional Economic Development (RED) Summary (Maximum Cost)

Area	Output	Jobs*	Labor Income	Value Added
Local				
Direct Impact	$45,352,736	514.6	$30,636,655	**$23,278,575**
Secondary Impact	$25,434,358	169.8	$7,351,282	**$13,446,204**
Total Impact	$70,787,094	684.3	$37,987,937	**$36,724,779**
State				
Direct Impact	$55,150,066	639.1	$42,076,961	**$30,256,212**
Secondary Impact	$52,071,304	307.3	$16,027,375	**$28,257,804**
Total Impact	$107,221,370	946.4	$58,104,336	**$58,514,016**
US				
Direct Impact	$70,936,585	936.7	$57,565,224	**$44,226,085**
Secondary Impact	$146,154,833	683.6	$45,954,361	**$79,320,167**
Total Impact	$217,091,419	1,620.3	$103,519,585	**$123,546,251**

* Jobs are presented in full-time equivalence (FTE)

2 ENVIRONMENTAL JUSTICE

Environmental justice (EJ) is defined as 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, with no group bearing a disproportionate burden of environmental harms and risks.

Several Executive Orders direct federal agencies to identify and address any disproportionately high adverse human health or environmental effects of federal actions to "minority" and/or "low-income" populations[1]:

- Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 16, 1994)
- Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities through the Federal Government (January 20, 2021)
- Executive Order 13990: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis (January 20, 2021)
- Executive Order 14008: Tackling the Climate Crisis at Home and Abroad (January 27, 2021)

[1] Executive Order 12898 utilizes the terms "minority" and "low income." Recent Executive Orders use a broader term, "disadvantaged," which includes communities that are historically and currently marginalized, underserved, and overburdened by pollution.

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Environmental justice concerns may arise from impacts on the chemical, biological and physical environment, such as human health or ecological impacts on communities of color,[2] economically disadvantaged,[3] and/or tribal and Indigenous American populations, or from related social or economic impacts. The Council of Environmental Quality (CEQ) guidance on conducting EJ analyses in NEPA documents (CEQ, 1997) and Promising Practices for EJ Methodologies in NEPA Reviews (CEQ, 2016) indicate that a "minority" population exists where the percentage of "minorities" in an affected area either exceeds 50 percent or is meaningfully greater than in the general population or other appropriate unit of geographic analysis. The CEQ guidance also recommends utilizing the Census Bureau's poverty measures in determining "low-income" populations. The Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. For EJ analysis, "low-income" is considered a percent of census tract's population in households where household income is at or below 200% of the Federal poverty level.

The Corps conducted an evaluation of EJ impacts using a two-step process. As a first step, the affected area was evaluated using the EPA Environmental Justice Screening and Mapping Tool (EJSCREEN) (USEPA, 2022) and CEQ's Climate and Economic Justice Screen Tool (beta version) (CEQ, 2022) to determine whether it contains a concentration of communities of color and/or economically disadvantaged populations. Following that evaluation, the Corps determined whether the proposed action and its alternatives would result in negative effects on human health, environmental, climate-related and other impacts on communities.

2.1 Step One

Using EJSCREEN, a 2.5-mile radius was created around the study area to capture both IA and IL affected areas. This area includes Clinton County, IA and Carroll and Whiteside Counties in IL. See Attachment A for the full EJSCREEN report.

- The tool identified a 7% value for communities of color in the affected area which is lower than the 50 percent threshold. This value is not meaningfully greater than the general population of the state average (14 percentile) and EPA regional average (20 percentile). The Corps further evaluated the Census tract mapping for communities of color and did not identify a "minority" population in the affected area. See Attachment B for the EJSCREEN Minority figure.

- The "low-income" populations in the IA and IL affected area counties (28%) are above the 20% threshold and are similar to the general state populations (28 percentile) and EPA regional average (30 percentile). To further refine the analysis, the census tracts were evaluated to determine the status of "low-income" populations immediately

[2] The phrase "communities of color" and/or "people of color" are used in place of the term "minority." All three terms/phrases include people who list their racial status as a race other than non-Hispanic, white-alone individuals.
[3] The phase "economically disadvantaged" is used in addition to "low-income." Note that EJ SCREEN tools specifically use "low-income" in their demographic indicators.

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adjacent to the study area. By utilizing census data, “low-income” populations that may not have been revealed when looking at the broader EJSCREEN information could be analyzed. In addition, comparison of economically disadvantaged populations among different parts of the study area could more accurately be conducted to ensure that potential disproportionate impacts within the Study area itself were considered. The Corps identified an economically disadvantaged population to the south of the study area near Lyons, IA. This community is shown in Figure B-1.

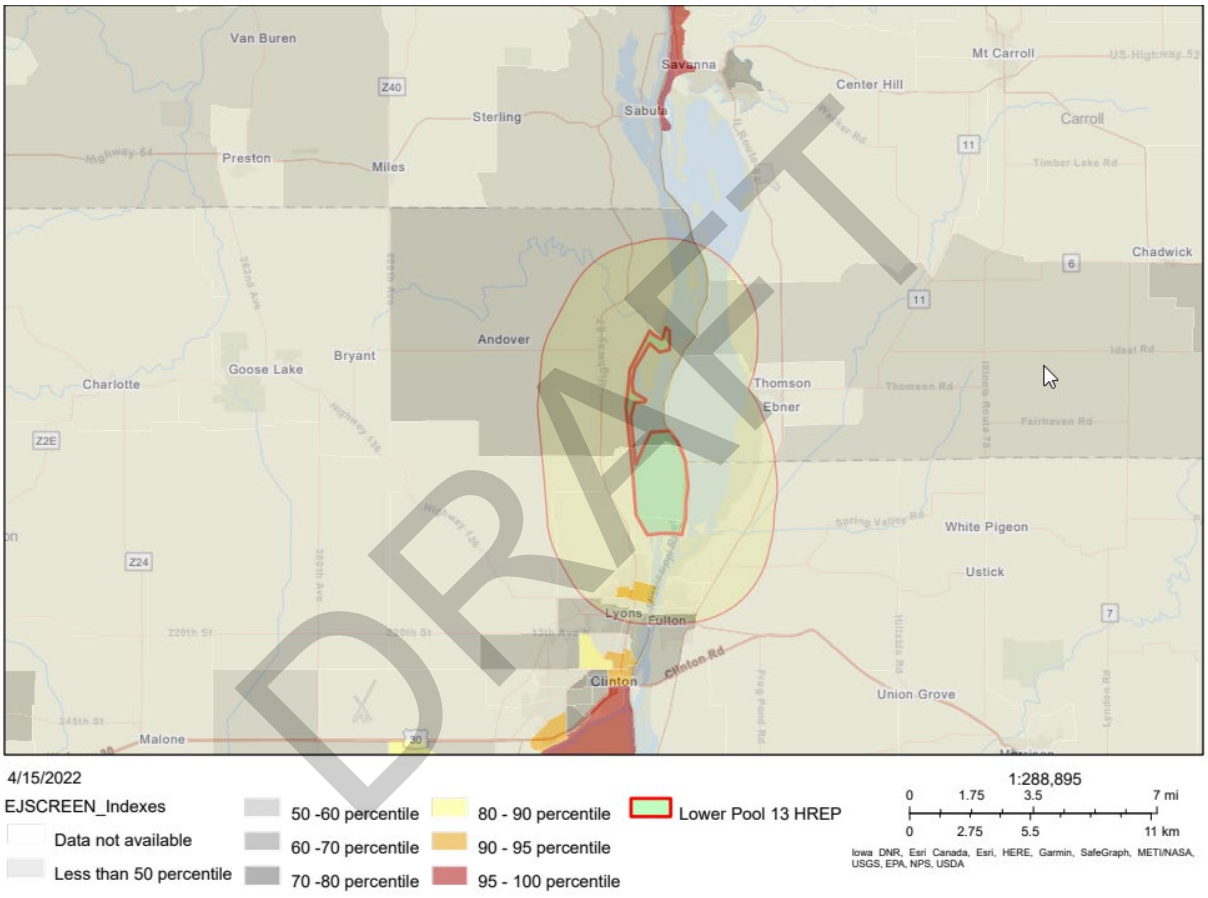

Figure B-1. 2-mile Radius Around Study Area and Distribution of Low-Income Communities (EJSCREEN)

The CEQ tool was also used per EO 14008. This tool identifies communities that are disadvantaged in one or more categories of criteria *if* the census tract is above the threshold for one of more environmental or climate indicators *and* the census tract is above the threshold for socioeconomic indicators. Census tracts for IA and IL used in the CEQ tool did not identify disadvantaged communities in either state. See Attachment B for the CEQ tool results.

Even though a disadvantaged community was not identified using the CEQ tool, the Corps evaluated the economically disadvantaged population identified in EJSCREEN to determine if disproportionately high adverse human health or environmental effects could occur.

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2.2 Step Two

River training structure construction (chevron, rock mounds), island construction and dredging activities have historically occurred throughout Pool 13 and in and adjacent to the Study area. Channel maintenance will continue throughout the study area and future river training structures are designed to be distributed throughout the length of the project. The in-water and timber stand improvements (TSI) activities are outside of the economically disadvantaged population as shown in Figure B-1. Any potential impacts from in-water or TSI activities are minimized by the fact that residential areas are not generally located immediately adjacent to the river channel or forest management areas. Therefore, construction and dredging activities associated with the alternative considered and any associated disturbances would not generally be near residences. In addition, given that USACE has determined that project features do not impact flood heights, the Project is not expected to impact areas in the floodplain. Because of these considerations the USACE has determined that the No Action alternative and the Tentatively Selected Plan is not anticipated to disproportionally affect environmental justice areas of concern. Potential social and economic benefits (including recreation and aesthetics) as described in Section 8 would benefit EJ areas on concern. The proposed action will be in full compliance with Executive Order 12898, 13985, 13990, and 14008 following completion of the NEPA process.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX B
ECONOMIC AND SOCIAL CONSIDERATIONS

ATTACHMENT A
USEPA EJSCREEN REPORT

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EJScreen Report (Version 2.0)

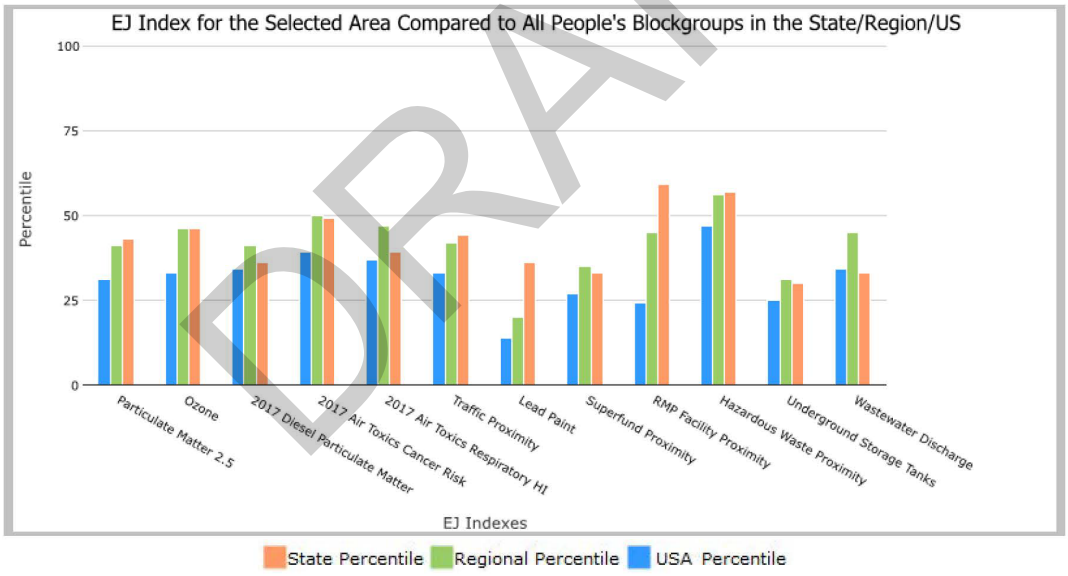
2.5 miles Ring around the Area, IOWA, EPA Region 7

Approximate Population: 8,944

Input Area (sq. miles): 61.29

Lower Pool 13 HREP

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
Environmental Justice Indexes			
EJ Index for Particulate Matter 2.5	43	41	31
EJ Index for Ozone	46	46	33
EJ Index for 2017 Diesel Particulate Matter*	36	41	34
EJ Index for 2017 Air Toxics Cancer Risk*	49	50	39
EJ Index for 2017 Air Toxics Respiratory HI*	39	47	37
EJ Index for Traffic Proximity	44	42	33
EJ Index for Lead Paint	36	20	14
EJ Index for Superfund Proximity	33	35	27
EJ Index for RMP Facility Proximity	59	45	24
EJ Index for Hazardous Waste Proximity	57	56	47
EJ Index for Underground Storage Tanks	30	31	25
EJ Index for Wastewater Discharge	33	45	34



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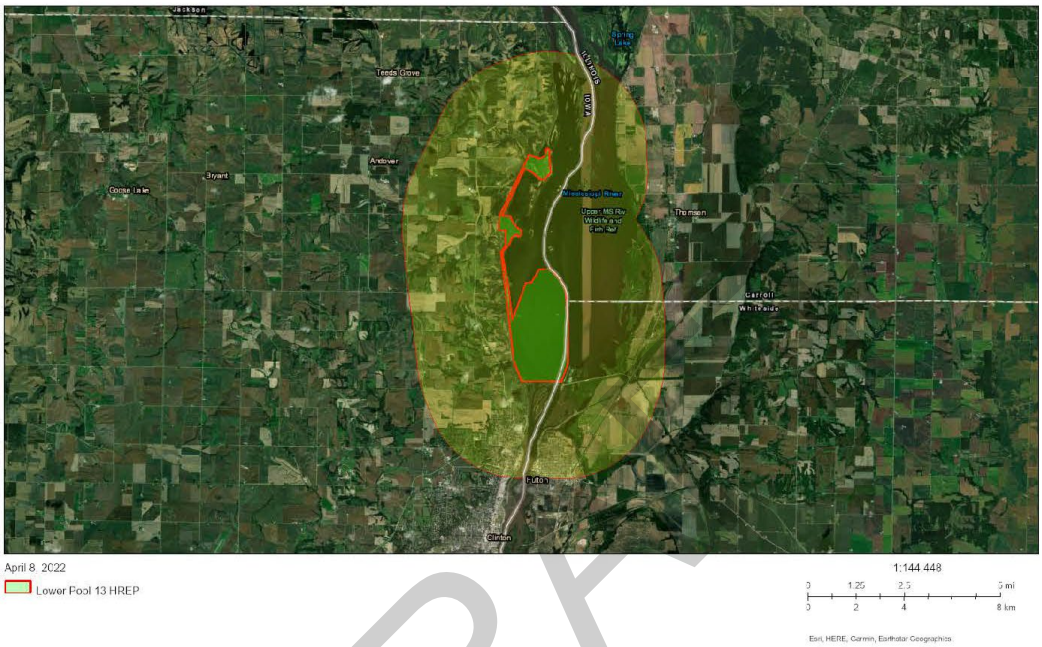
This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

2.5 miles Ring around the Area, IOWA, EPA Region 7

Approximate Population: 8,944

Input Area (sq. miles): 61.29

Lower Pool 13 HREP



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Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0

EJScreen Report (Version 2.0)

2.5 miles Ring around the Area, IOWA, EPA Region 7

Approximate Population: 8,944

Input Area (sq. miles): 61.29

Lower Pool 13 HREP

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Pollution and Sources							
Particulate Matter 2.5 ($\mu g/m^3$)	9.11	8.23	93	8.26	87	8.74	64
Ozone (ppb)	42.3	41.8	70	44.1	29	42.6	50
2017 Diesel Particulate Matter* ($\mu g/m^3$)	0.185	0.17	64	0.221	<50th	0.295	<50th
2017 Air Toxics Cancer Risk* (lifetime risk per million)	20	22	88	26	<50th	29	<50th
2017 Air Toxics Respiratory HI*	0.27	0.24	85	0.33	<50th	0.36	<50th
Traffic Proximity (daily traffic count/distance to road)	150	390	53	410	50	710	41
Lead Paint (% Pre-1960 Housing)	0.61	0.41	76	0.33	81	0.28	84
Superfund Proximity (site count/km distance)	0.071	0.11	65	0.1	58	0.13	54
RMP Facility Proximity (facility count/km distance)	0.4	1.2	31	0.95	45	0.75	55
Hazardous Waste Proximity (facility count/km distance)	0.078	0.45	30	1	23	2.2	12
Underground Storage Tanks (count/km^2)	2.1	1.7	76	2.5	69	3.9	60
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.00043	0.21	60	2.9	40	12	42
Socioeconomic Indicators							
Demographic Index	18%	21%	51	25%	42	36%	25
People of Color	7%	14%	44	20%	33	40%	15
Low Income	28%	28%	57	30%	51	31%	51
Unemployment Rate	4%	4%	68	4%	64	5%	50
Linguistically Isolated	0%	2%	64	2%	65	5%	45
Less Than High School Education	8%	8%	65	9%	57	12%	46
Under Age 5	7%	6%	58	6%	58	6%	60
Over Age 64	22%	17%	79	16%	80	16%	81

*Diesel particular matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's 2017 Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

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For additional information, see: www.epa.gov/environmentaljustice

EJScreen is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJScreen documentation for discussion of these issues before using reports. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJScreen outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

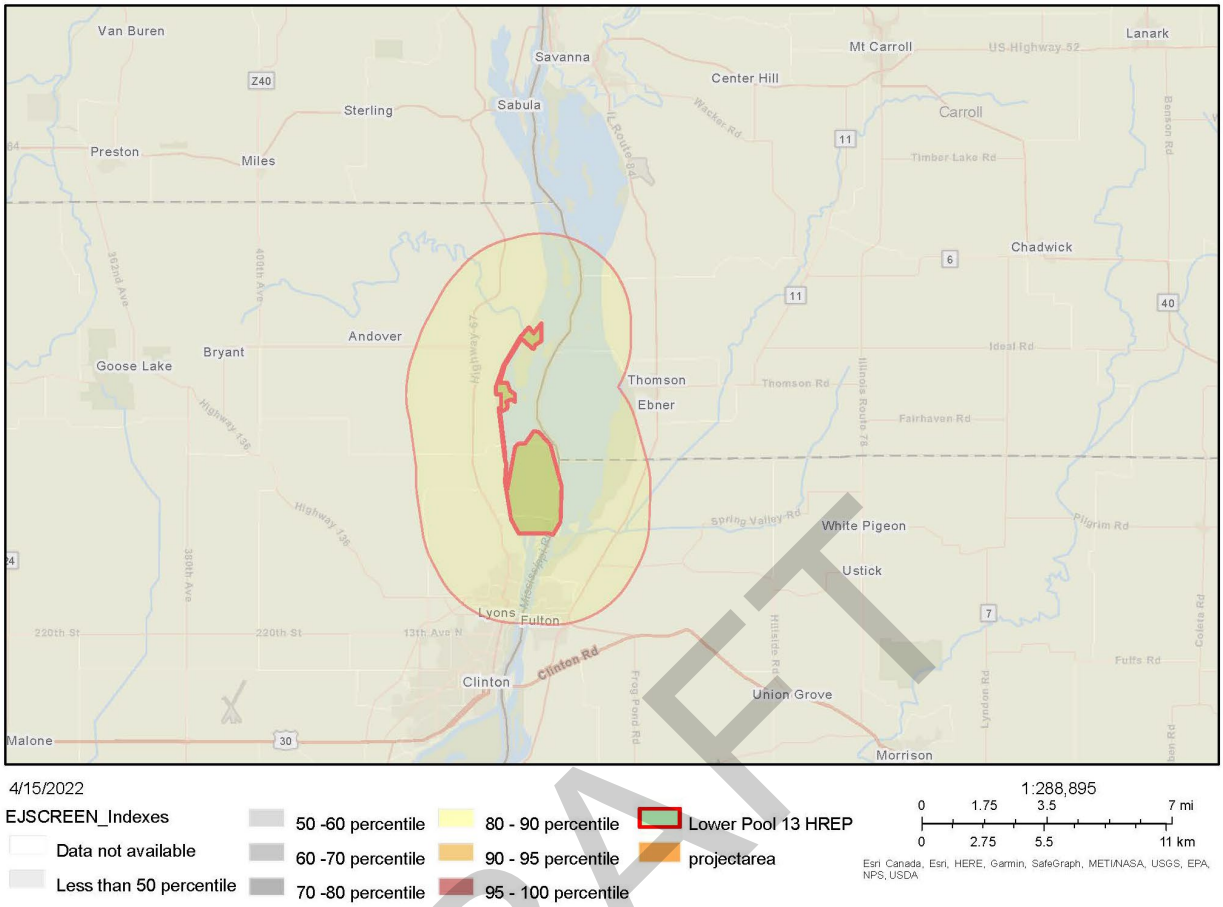

Figure B-A-1. EJScreen - Minority Populations near Study Area

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX B
ECONOMIC AND SOCIAL CONSIDERATIONS

ATTACHMENT B
CEQ BETA TOOL RESULTS

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Figure B-B-1. CEQ's Screening Tool results for Clinton County, Iowa

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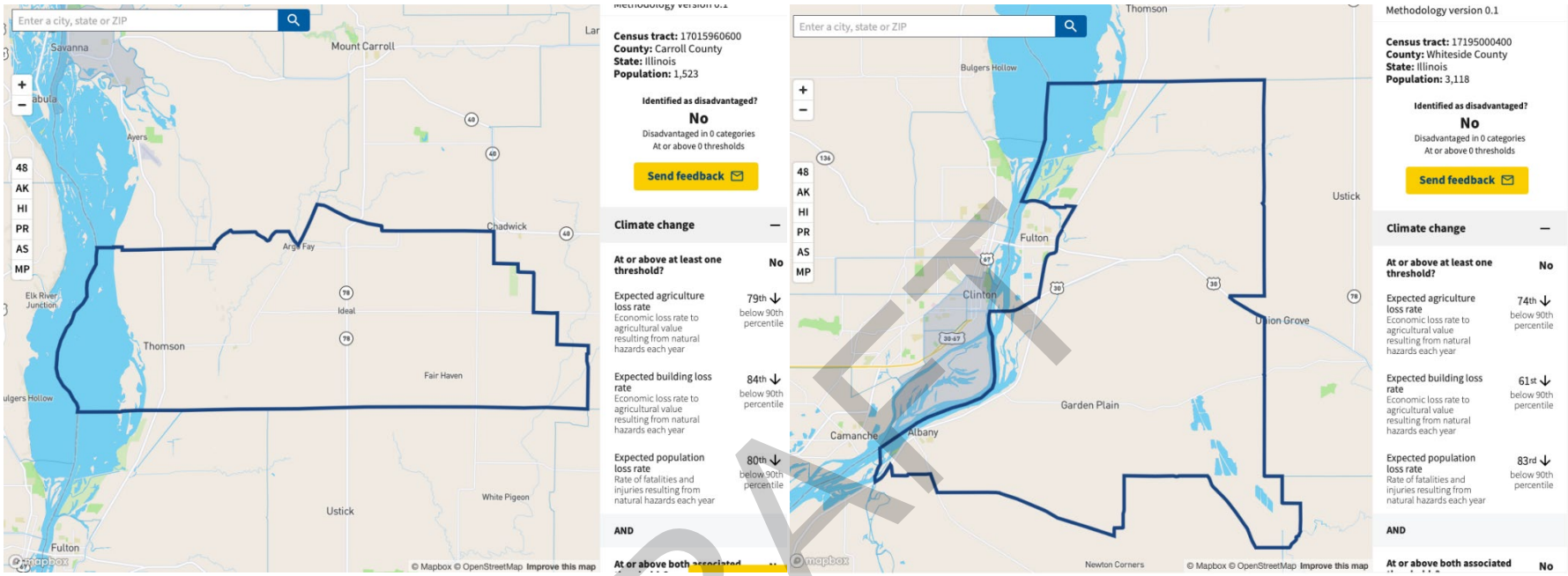

Figure B-B-2. CEQ's Screening Tool results for Carroll and Whiteside Counties, Illinois

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX C
REAL ESTATE PLAN

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

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REAL ESTATE PLAN

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1. PURPOSE AND GENERAL PROJECT INFORMATION

1.1. Purpose

The information in this Real Estate Plan (REP) is based on preliminary data and is subject to change even after approval of the REP.

This REP supports the Upper Mississippi River Restoration (UMRR), Lower Pool 13, Habitat Rehabilitation and Enhancement Project's (Project) Feasibility Report. The Lower Pool 13 Project is designed to address problems associated with island degradation and diminished aquatic vegetation cover and diversity as a result of the lock and dam system on the Upper Mississippi River (UMR). The Project features of island restoration, island stabilization, restoration of depth diversity, and the improvement of timber stand areas will support the restoration, enhancement, and maintenance of natural river processes, structures, and functions, and consequently, allow for the creation, enhancement, and maintenance of a quality habitat for all native and desirable plant, migratory waterfowl, bird, animal, and fish species as a sustainable ecosystem. The REP identifies the overall real estate requirements for the Project and provides the estimated real estate costs of the recommended plan as proposed.

1.2. Project Authority

The UMRR Program supports the ecosystem restoration for the Mississippi River Basin. The UMRR was originally authorized by Congress in Section 1103 of the Water Resources Development Act (WRDA) of 1986, Public Law 99-662, codified at 33 U.S.C. § 652. The original authorizing legislation has been amended several times since its enactment, and one element of the latest version now focuses on the evaluation, planning, and construction of measures for fish and wildlife habitat improvements through Habitat Rehabilitation and Enhancement Projects (HREPs).

The UMRR is a Federal-State partnership program to evaluate, plan, and construct fish and wildlife HREPs and to monitor the natural resources of the Mississippi River system. For this HREP, the United States Fish & Wildlife Service (USFWS) is the Federal Sponsor that operates and maintains the UMR National Wildlife and Fish Refuge (NWFR) in the study area.

2. DESCRIPTION OF THE LANDS, EASEMENTS, RIGHTS-OF-WAY, RELOCATIONS, AND DISPOSAL/BORROW AREAS (LERRD) FOR CONSTRUCTION, OPERATION, AND MAINTENANCE OF THE PROJECT

The Project is located between River Miles 522.5 and 529.0 of the Mississippi River in Clinton County, Iowa, across from Carroll and Whiteside Counties in Illinois. The Project lies within navigation Pool 13 of the Upper Mississippi River 9-foot channel project, which is part of the UMR Refuge and is managed by the USFWS. One additional parcel, Woodruff Island, is located within the boundaries of Carroll County, Illinois. The Project is primarily comprised of vast areas of open water with submerged islands, sloughs, backwater lakes, and flowing channels. The study area is located in the southwest corner of the lower portion of Pool 13 of the Mississippi River, right above Lock and Dam 13. Floodplain landforms are minimal near the Iowa shoreline, but rather bluffs are fairly close to the shoreline near the study area. The Project is located in the 2nd Congressional District in Iowa and the 17th Congressional District in Illinois. The Project Site Boundary containing the study area and the location of the rock mound, chevron, access dredging, island protection, and timber stand improvement features and dredged material placement areas within the UMR Refuge is shown in Figure C-1.

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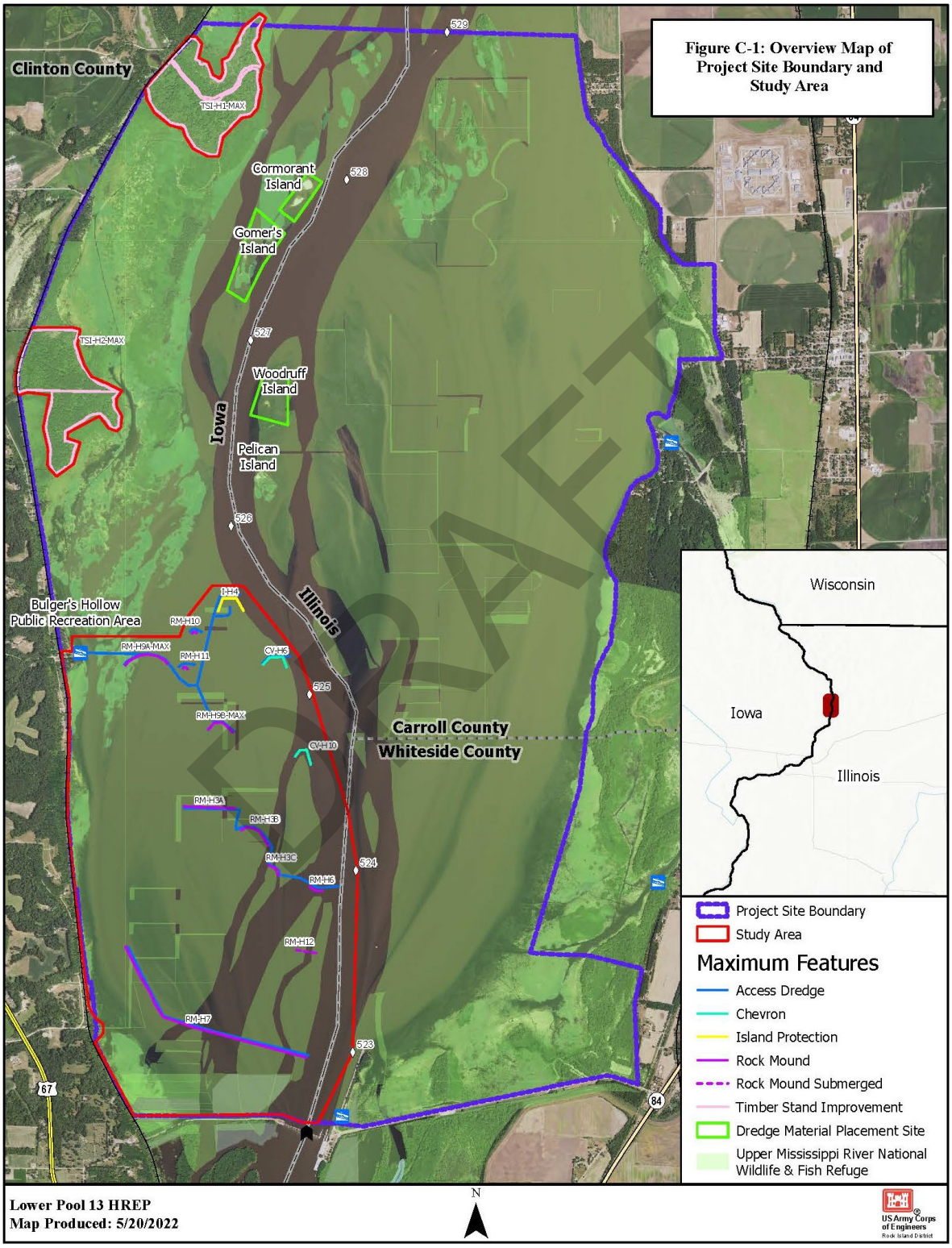

Figure C-1. Overview Map of Project Site Boundary **and** Study Area

2.1.1. Dredge Material Placement

The Project features include dredge cuts that will result in the placement of dredged material. The placement sites for the disposal of the dredged material are planned to be upon and adjacent to Gomer's Island (USACE Tract IAIS-37B; 31.59 acres) and Cormorant Island (USACE Tract IAIS-39; 14.56 acres), both of which are located within the boundaries of the State of Iowa, and Woodruff Island (USFWS Tract; 23 acres), located within the boundaries of the State of Illinois. The dredged material placement sites are shown in Figure C-2.

2.1.2. Staging and Access

All staging for the Project is located on Federal land and is planned to be in Bulger's Hollow Recreational Area, which is part of Federal Tracts FIA-67 and FIA-68 and managed by the USACE. Bulger's Hollow Recreational Area is accessed via 170th Street and crosses over the Dakota, Minnesota, & Eastern Railroad Corporation, a subsidiary of the Canadian Pacific Railway, at a public railroad crossing. Bulger's Hollow Recreational Area has a small gravel boat launch, which will allow for access to the study area by boat. Rock material is expected to be delivered via barge from a northern quarry. The staging area-river access is shown in Figure C-2.

2.1.2. Staging and Access

All staging for the Project is located on Federal land and is planned to be in Bulger's Hollow Recreational Area, which is part of Federal Tracts FIA-67 and FIA-68 and managed by the USACE. Bulger's Hollow Recreational Area is accessed via 170th Street and crosses over the Dakota, Minnesota, & Eastern Railroad Corporation, a subsidiary of the Canadian Pacific Railway, at a public railroad crossing. Bulger's Hollow Recreational Area has a small gravel boat launch, which will allow for access to the study area by boat. Rock material is expected to be delivered via barge from a northern quarry. The staging area-river access is shown in Figure C-2.

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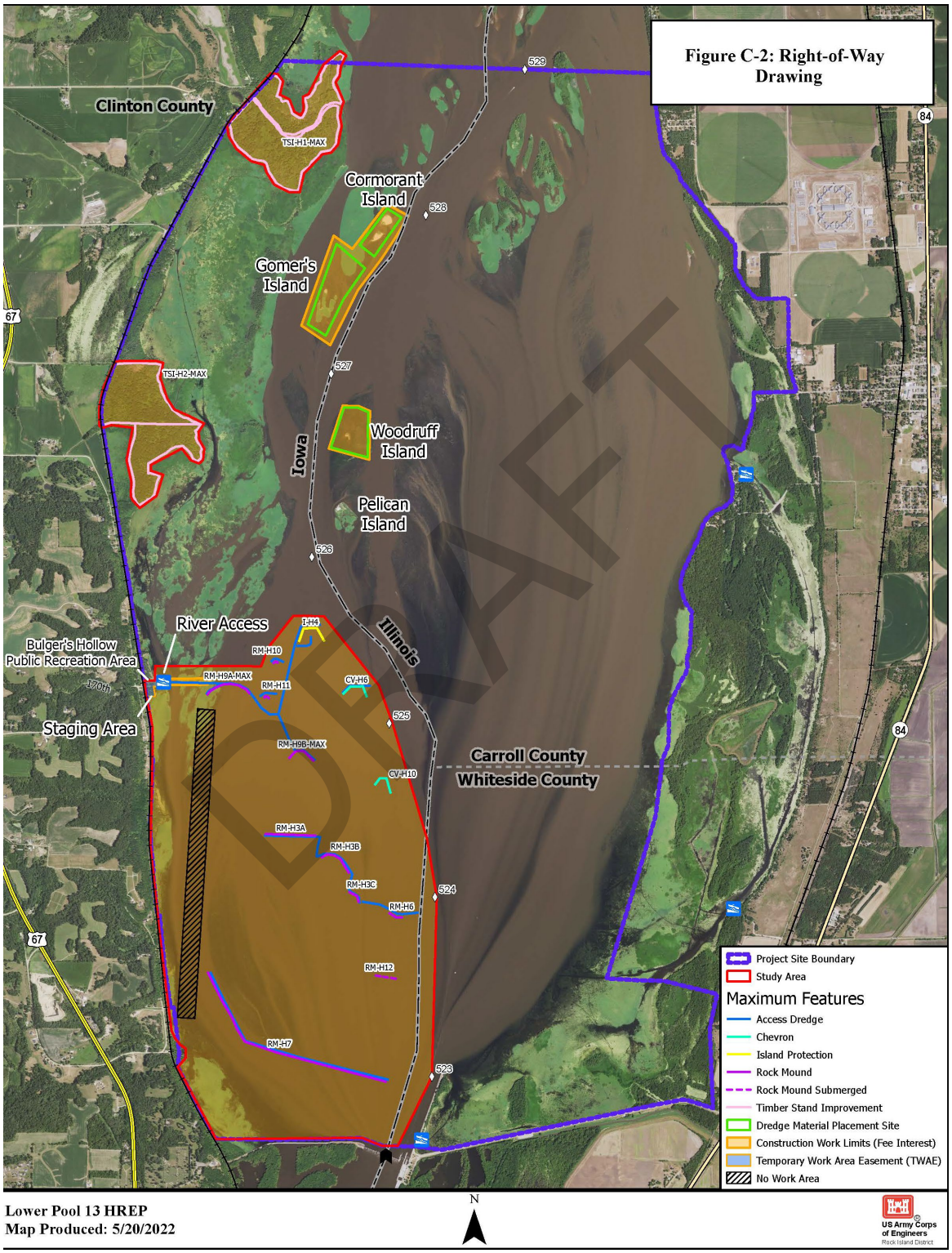

Figure C-2. Right-of-Way Drawing

2.1.3. Number of Tracts, Ownership, Easement Estates Required, and Acres

The Project is a full Federal project. The real estate required for the Project includes the study area, the dredged material placement areas, and the areas for staging and river access. The minimum standard estate for the staging and access is a Temporary Work Area Easement for the Project and the minimum standard estate for the construction of the Project features is Fee. The United States owns all the lands impacted in Fee.

Ninety-two USACE tracts are part of the study area boundaries, which includes the Timber Stand Improvement areas, located in Clinton County, Iowa, and encompass a total 1,614 acres. The USACE tracts within the study area are provided to the USFWS for fish and wildlife management through the 1961 Iowa General Plan and the subsequent Cooperation Agreement and 2001 Amendment between USACE and USFWS. Nineteen USFWS tracts are within the study area boundaries and encompass a total of 561.5 acres. The USFWS-managed USACE tracts and the USFWS tracts are part of the UMR NWFR.

The real estate required for the Project is outlined in Table C-1.

Table C-1. Real Estate Required for the Project

Number of Tracts	U.S. Agency Holding Title	Easement Estate Required	Tract Acres
96	USACE	Fee	1660.15
20	USFWS	Fee	584.5
2	USACE	Temporary Work Area Easement (staging & access)	4.22

The United States tracts t within the study area, dredged material placement areas, and staging and river access areas are shown in Figure C-3.

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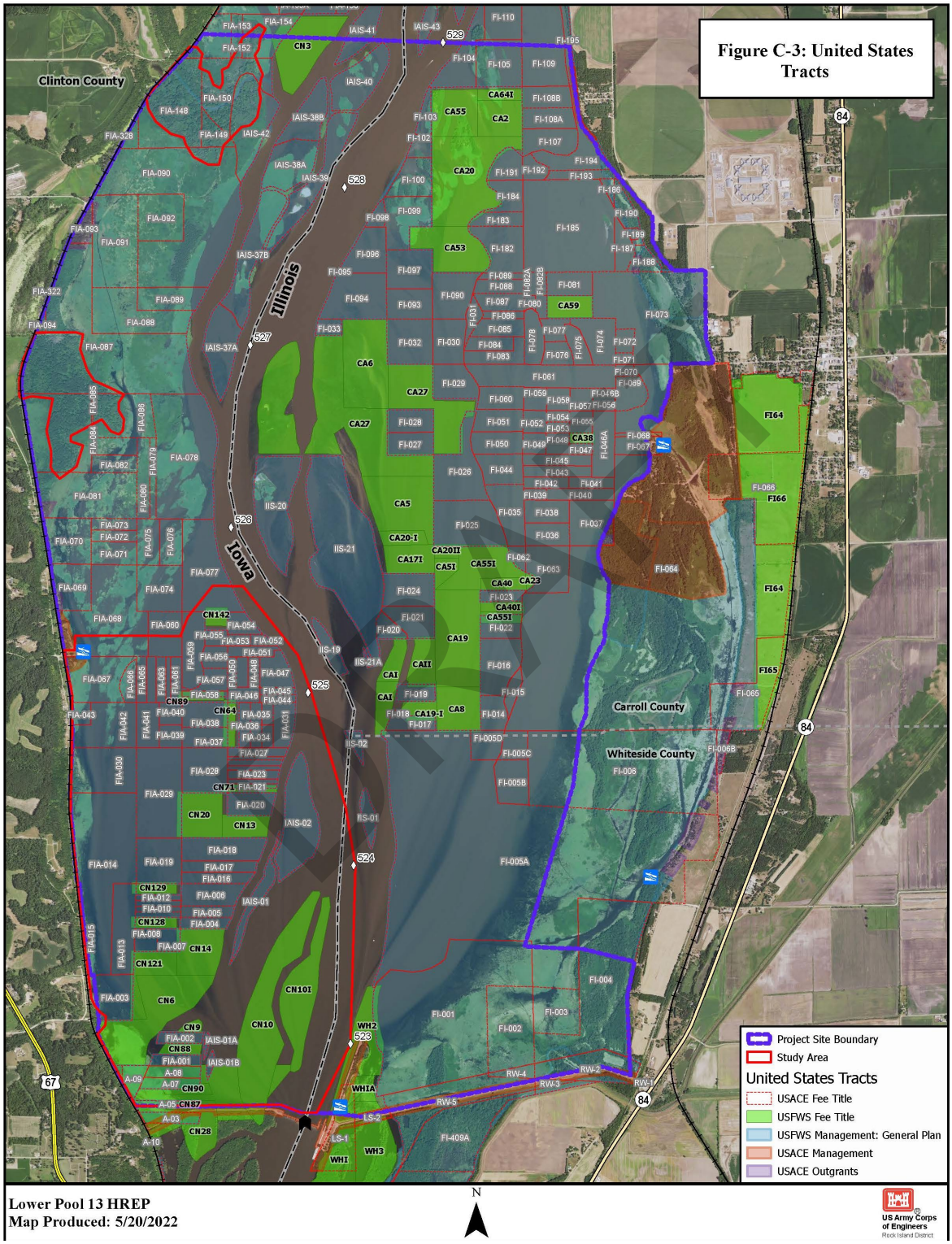

Figure C-3. United States Tracts

3. SPONSOR-OWNED LANDS

The sponsor is the USFWS; the entity that manages, operates, and maintains the UMR NWFR. There are USFWS lands within the study area of the Project, as listed above.

4. PROPOSED NON-STANDARD ESTATES

It is not anticipated any Non-Standard Estates will be required for the Project.

5. EXISTING FEDERAL OR OVERLAPPING PROJECTS

Bulger's Hollow Recreational Area. The proposed Iowa land-based staging site is located on portions of USACE Tracts FIA- 67 and FIA-68, known as Bulger's Hollow Recreational Area, which serves the public as a primitive campground and provides river access with a gravel boat ramp.

Dredged Material Management Plan for Dredged Material Placement, Upper Mississippi, River Miles 525.1-538.7, Pool 13, Sabula Reach, Sabula Lower, Dark Slough, Elk River and Pomme de Terre Dredge Cuts Project. A portion of this DMMP Project overlaps this Project.

Upper Mississippi River National Wildlife and Fish Refuge. The proposed area is part of the UMR NWFR, managed by the USFWS. The Project goals support the UMR NWFR goals.

Upper Mississippi River System – Environmental Management Program, Pool 13, Potters Marsh Habitat Restoration and Enhancement Project. This HREP is located in Carroll and Whiteside Counties, IL, between RM 522.5 and 526 and contains approximately 2,305 acres of aquatic, wetland, and terrestrial habitat.

6. FEDERALLY OWNED LANDS OR OTHER INTERESTS

The lands needed for the Project are owned in Fee by the United States.

7. NAVIGATION SERVITUDE

A Legal Opinion from the Office of Counsel will be sought regarding the applicability of navigation servitude.

8. PROJECT MAP

Figure C-1 depicts the Project footprint, with sites for activities necessary for the construction of the Project noted in Figure C-2.

9. INDUCED FLOODING

It is not anticipated that the Project will cause any induced flooding because no water level management features are part of this phase. In addition, the flood plain impacts have been assessed.

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10. BASELINE COST ESTIMATE FOR REAL ESTATE

There are no Real Estate Acquisition Costs associated with the Project because the Project will occur on Federally owned lands.

11. RELOCATION ASSISTANCE BENEFITS, PUBLIC LAW 91-646

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 OR TIMBER ACTIVITY OR HARVESTING

No mineral or timber activity or harvesting is anticipated to be impacted by the Project.

13. NON-FEDERAL SPONSOR'S LEGAL AND PROFESSIONAL ACQUISITION CAPABILITY TO ACQUIRE LANDS, EASEMENTS AND RIGHT-OF-WAYS

No acquisitions are necessary for the Project; therefore, this section does not apply.

14. ZONING ORDINANCE REQUIREMENTS

It is not anticipated that any zoning classifications or ordinances will need adjustment for the Project.

15. ACQUISITION SCHEDULE

There are no acquisitions necessary for the execution the Project.

16. PUBLIC UTILITY OR FACILITIES RELOCATION, ALTERATIONS OR REPLACEMENT

There are currently no planned facility or utility relocations.

17. HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

Appendix E, *Engineering,* Attachment H, Hazardous, Toxic and Radioactive Waste, indicates the "No Work Zone" within the study area. Please see Appendix E, *Engineering*, for more details.

18. LANDOWNER OPPOSITION OR PUBLIC CONCERNS

Public input will be obtained through the public review process, tentatively scheduled to begin in the Fall of 2022.

19. NOTIFICATION OF RISKS OF ACQUIRING LANDS BEFORE EXECUTION OF THE PROJECT PARTNERSHIP AGREEMENT

The Project is fully Federal, so this section is not applicable.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX D
COORDINATION AND PUBLIC INVOLVEMENT

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Memorandum dated July 26, 2018, from Mississippi Valley Division to the Rock Island District Commander approving the Lower Pool 13 HREP Fact Sheet D-1

Distribution list and comments received from the public open house dated November 14, 2019 ..... D-8

Memorandum dated December 20, 2019, from the MVD Director of Programs to the Rock Island District Commander approving the Review Plan for the Lower Pool 13 HREP D-33

Memorandum dated January 11, 2022, from Sharonne Baylor, USFWS, explaining the benefits of feature I-H4 as an earthen island rather than a rock mound feature D-34

Email communication dated July 12, 2022, from Christine Schwake (IA DNR) to the Rock Island District clarifying the current 401 Water Quality Certification for 2022-2026 Nationwide Permits no longer includes IA DNR coordination requirement for projects on the Mississippi River D-36

Upper Mississippi River National Wildlife and Fish Refuge, Lower Pool 13 HREP Goals and Objectives document dated June 7, 2019, and updated July 15, 2022, from USFWS ... D-42

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26 July 18

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

CEMVD-PDM

MEMORANDUM FOR Commander, Rock Island District

SUBJECT: Factsheet Approval - Upper Mississippi River Restoration Program, Lower Pool 13 Habitat Rehabilitation and Enhancement Project (HREP), Whiteside County, Illinois, and Clinton County, Iowa

1. Reference memorandum, CEMVR-PM-M, 26 June 2018, subject: Upper Mississippi River Restoration Program, Lower Pool 13 Habitat Rehabilitation and Enhancement Project (HREP), Whiteside County, Illinois, and Clinton County, Iowa (encl).

2. Subject Fact Sheet is approved for continued HREP planning.

3. The MVD point of contact for this action is Mr. Gabe Harris, CEMVD-PDM, (601) 634-5296.

Encl

GARY L. YOUNG
Chief, Planning Division

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

REPLY TO
ATTENTION OF
CEMVR-PM-M

JUN 26 2018

MEMORANDUM FOR Commander, US Army Corps of Engineers, Mississippi Valley Division (CEMVD-PD-SP/Harris), PO Box 80, 1400 Walnut Street, Vicksburg, Mississippi 39181-0080

SUBJECT: Upper Mississippi River Restoration Program, Lower Pool 13 Habitat Rehabilitation and Enhancement Project (HREP), Whiteside County, Illinois, and Clinton County, Iowa, Fact Sheet

1. The subject Fact Sheet (Encl 1) is submitted for your review and approval. An electronic copy has been sent to Mr. William Harris, CEMVD-PD-SP.

2. The Lower Pool 13 HREP project is located in Pool 13 of the Upper Mississippi River at river miles 523.0 to 529.0. The project addresses island and landmass erosion, sedimentation, and wave resuspension of sediments that impact the sustainability of habitat for aquatic vegetation, fisheries resources, and migratory water birds. The project goals include protecting, enhancing, and restoring habitat conditions for all native and desirable plant, wildlife, and aquatic species. On 29 March 2018, the Fish and Wildlife Interagency Committee (FWIC) recommended the Lower Pool 13 project. The River Resources Coordinating Team (RRCT) endorsed the project on 2 May 2018 and the Upper Mississippi River Restoration Program Coordinating Committee (UMRR-CC) endorsed the project on 16 May 2018.

3. Questions concerning this document should be addressed to Mr. Benjamin Ferrell, Project Manager, (309) 794-5154 or e-mail: Benjamin.M.Ferrell@usace.army.mil.

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STEVEN M. SATTINGER
COL, EN
Commanding

Encl
Lower Pool 13 Fact Sheet

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT (HREP)
POOL 13, UPPER MISSISSIPPI RIVER, IOWA AND ILLINOIS
UPPER MISSISSIPPI RIVER RESTORATION PROGRAM
ROCK ISLAND DISTRICT

FACT SHEET

I. LOCATION

The Lower Pool 13 Riverine, Backwater, and Floodplain Habitat Project is located in Pool 13 of the Upper Mississippi River (UMR), at river mile (RM) 523.0-529.0. The area consists of backwater lakes, sloughs, flowing channels, and impounded water residing over historic flooded islands and remnant islands. The Project area is located in Whiteside County, IL, and Clinton County, IA. The closest Mississippi River community to the Project area is Clinton, Iowa; the community is located approximately three miles downstream from the Project area.

II. EXISTING RESOURCES

The lower section of Pool 13 is located in a valley that is 1.5 to 4.5 miles wide and contains few land masses. The lower section is oriented north to south. In this reach, a sediment laden tributary, the Elk River, enters the Project area. The Elk River's waters are generally turbid due to agriculturally sourced tributary inputs. The Elk River distributes its sediments and nutrients into the Mississippi River via Pool 13.

The Project area has been colonized by several species of submerged aquatic vegetation. Most of the aquatic habitat is between three and four feet deep. Migratory water bird use is high compared to other adjacent pools. Recently, resident water bird activity has been exponentially growing. A rookery has been established in the northern region of the Project area, located on an island; it has produced the first documented Iowa nesting site of White Pelicans since 1909. This island also maintains over 200 Double Crested Cormorant nests, Great Egret nests, Cattle Egret nests, Ring-bill Gull nests, and the first Iowa record of a successful Herring Gull nest.

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III. PROBLEM IDENTIFICATION

Pre-impoundment, Pool 13 consisted of permanent and seasonal lakes, forested wetlands, bottomland forests, braided islands, wet meadows, and main channels and sloughs. Lock and Dam 13 began operation in the late 1930's; the implementation resulted in the inundation of several thousands of acres of floodplain in lower Pool 13. Connectivity of backwater and off channel areas within the Project area changed from seasonal discharge related events to year round connectivity. The resulting constant inundation has contributed to island/landmass erosion, sedimentation, and resuspension of sediments due to wave action. Forecasted future conditions anticipate continued sedimentation and backwater sedimentation of fine materials. Wave resuspension of sediments in the Project area will continue to affect the sustainability of aquatic vegetation due to influences of the Elk River, ambient turbidity levels, and wind fetch. Fisheries resources in the Project area are expected to continue to degrade due to a lack of structure, habitat diversity, and overwintering habitat. Migratory water bird habitat will continue to be variable, primarily dependent on the stability levels of year to year aquatic plant production.

A variety of physical, chemical and biological stressors individually and cumulatively affect the quantity and quality of habitat for biota in the Project area. These stressors include, but are not limited to,

degradation of islands, isolated wetlands, over wintering habitats, sand/mud bar habitats, migratory water bird habitats, and aquatic species (fishes and mussels) channel habitats; invasive species; altered sediment transport and deposition; wind-driven sediment resuspension; sedimentation in off-channel areas; sediment/nutrient loading from tributaries; lack of fluctuating water levels as a result of impoundment; long riprap sections of shoreline; river regulation affecting stage hydrograph; and high lateral hydraulic connectivity.

Connectivity is high in the Project area, with over fifty percent of the total river flow being conveyed outside of the main channel. Backwaters adjacent to the impounded area are degrading because of island inundation, sediment deposition, and high turbidity. With a pool width of over 4.5 miles, wind fetch within the Project area is high. Wave erosion is apparent on many islands within the Project area. Erosion of islands will continue in the future, further degrading physical conditions in backwaters. Island erosion progression will remain at a moderate rate; there are a few locations in the Project area where land building is occurring, however, there is an overall net loss. Backwater fisheries habitats will continue to decline due to increased flows and sedimentation of presently protected areas. Waterfowl habitat will continue to deteriorate over time as the Project area's island and land mass degradation progresses due to the subjection of higher current velocities and wave action; in addition, negatively affecting plant species composition and coverage. Impoundment of the pool and permanently higher water tables has affected the health of floodplain forest habitat on islands and adjacent floodplain areas. These higher water tables are adversely affecting floodplain forest composition and regeneration.

IV. PROJECT GOALS AND OBJECTIVES

Project goals are derived from the Environmental Pool Plans, Pools 11 through 22; the Habitat Needs Assessment; and Reach Planning efforts. These project goals are consistent with the systemic goals adopted by the Environmental Management Program Coordinating Committee and the Navigation Environmental Coordination Committee in January 2008.

Maintain, Enhance, Restore, and Emulate Natural River Processes, Structures and Functions to promote a Sustainable Ecosystem

- Enhance altered hydraulic connectivity
- Improve water clarity, nutrient loading levels, and sediment loading/resuspension levels
- Restore sediment transport regime for geomorphic pattern regulation, channel and floodplain features, and floodplain topography diversity

Maintain, Enhance, and Create Quality Habitat for all Native and Desirable Plant, Animal, and Fish Species

- Restore habitat connectivity, riparian habitat, aquatic off-channel areas, terrestrial floodplain areas, and channel areas
- Enhance the diversity and population of native aquatic vegetation communities (Submerged Aquatic Vegetation, Emergent Aquatic Vegetation, Rooted and Floating), native floodplain forest and prairie communities, native fishes communities, native mussel communities, native bird communities, and amphibian and reptile communities

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V. PROPOSED PROJECT FEATURES

The proposed project features addressing the habitat goals for this Project area include island restoration, island stabilization, and backwater dredging. Restoring depth diversity and seasonal water level variation could also be pursued. Other potential actions include controlling invasive species and other habitat management actions. Material for restoration and stabilization of islands could come from Gomers Lake backwaters and the area north of the Bulgers Hollow boat ramp. Main channel sand, along with other suitable material, could also be used for feature construction.

The proposed features will protect, enhance, and restore habitat conditions for all native and desirable plant, wildlife, and aquatic species. Targeted species include mussels, turtles, shore birds, migratory birds, mammals, forest resources, and aquatic vegetation. Island stabilization and restoration are the main features identified for maintaining habitat quality in the lower Pool 13 area. Additional features to restore isolated wetlands, sand and mudflat habitat, and elevation of floodplain habitat are also proposed for the area. Pool-wide water level management (minor/major drawdown) is proposed as one tool to promote a stabilized ecosystem. Collectively, these features would provide the environmental conditions necessary to reach and maintain the desired future habitat and water management conditions proposed in the Project area.

The duration of outcomes are expected to continue for at least 50 years based on the performance of similar types of restoration projects that have been completed since 1986. Some outcomes will be sustained without additional maintenance or operation for >50 years, while other outcomes will require periodic maintenance (i.e. sandy terrestrial areas for turtle nesting habitat). The project features would be designed with limited Operations and Maintenance (O&M) involvement required. The authority for this study and potential project construction is provided by Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662), as amended. Proposed project features are referenced in Figure 1.

VI. IMPLEMENTATION CONSIDERATIONS

The presence of the Higgins Eye Pearly Mussel (Lampsilis higginsi) at various locations in Pool 13, indicates they may be present in the Project area. If present, many of the proposed project features can be modified to avoid any impact. However, the implementation of some potential actions may be constrained or limited if they are present in the area.

Plan formulation should consider the possibility of using channel maintenance generated sand as a potential source of material for construction of some proposed features.

VII. FINANCIAL DATA

The project features would be located entirely on the Upper Mississippi River National Wildlife and Fish Refuge. Therefore, in accordance with Section 906(e) of the Water Resources Development Act of 1986, the total estimated project cost of $15,000,000 would be 100% Federal. The U.S. Fish and Wildlife Service manages the lands and would be responsible for operation, maintenance, and rehabilitation of project features, in accordance with Section 107(b) of the Water Resources Development Act of 1992.

VIII. STATUS OF PROJECT

This project was presented to The Fish & Wildlife Interagency Committee (FWIC) at the February 15, 2018 meeting. It was accepted by the River Resources Coordinating Team on May 2, 2018. It was

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endorsed by the UMRR Coordinating Committee on 16 May 2018. Pending Mississippi Valley Division approval of this Fact Sheet, Feasibility is scheduled to begin in FY 2018.

IX. POINTS OF CONTACT

Corps of Engineers, Rock Island District, (309)-794-5428
U.S. Fish and Wildlife Service Upper Mississippi River Wildlife and Fish Refuge
- Savanna District, District Manager, (815)-273-2732
Iowa Department of Natural Resources, UMRR Habitat coordinator, (563)-872-4976

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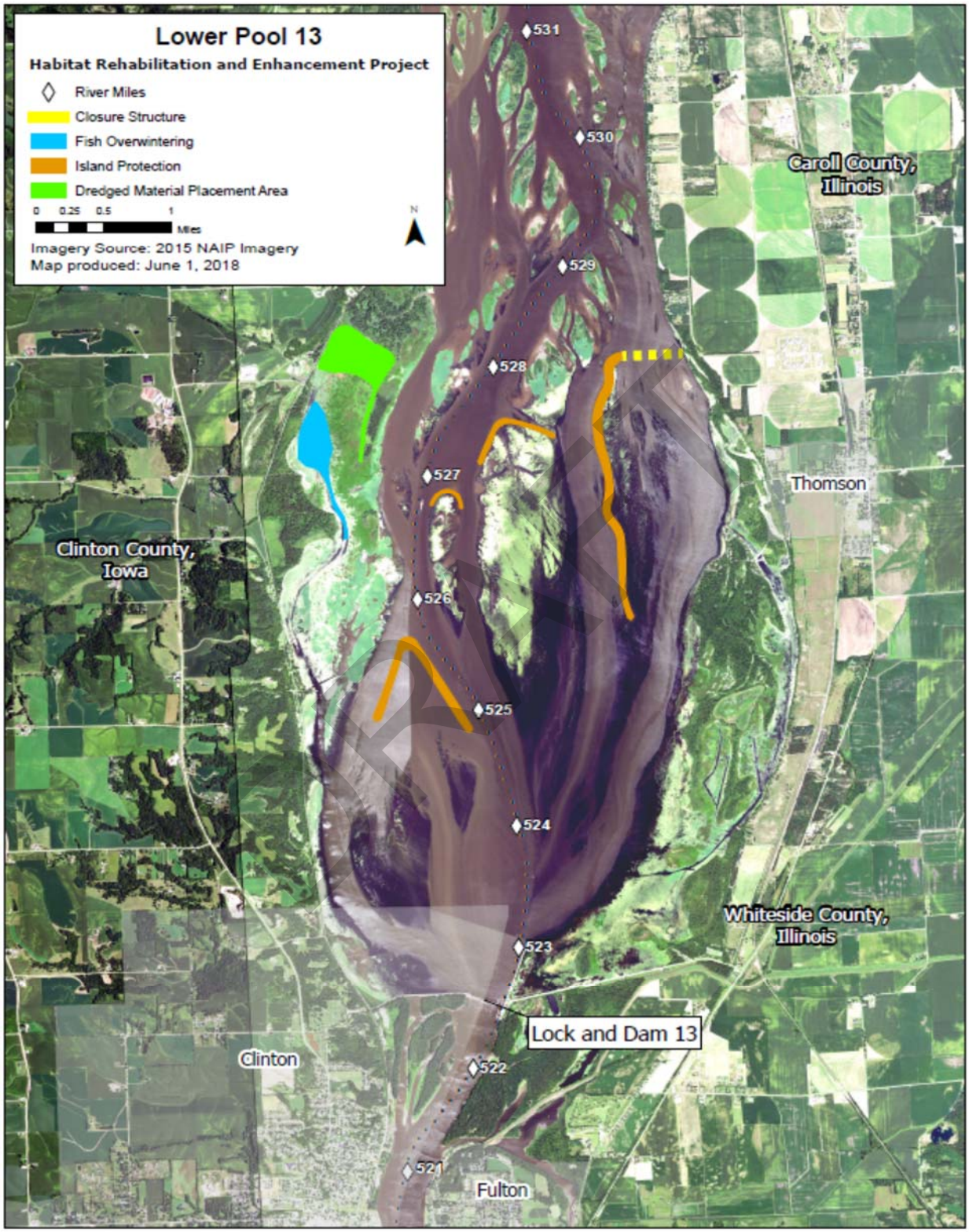

Figure 1. Lower Pool 13, Proposed Project Features

HONORABLE KIM REYNOLDS
GOVERNOR OF IOWA
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1222 SPRUCE ST
ST LOUIS, MO 63103-2833

TOM NOVAK ATTN: CEMVP-PM-A
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180 5TH ST E STE 700
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LEEANN RIGGS
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USACE - LOCK AND DAM 12
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KATHY GOURLEY R&C COORDINATOR
STATE HISTORICAL SOCIETY OF IOWA
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IL DEPT OF NATURAL RESOURCES,
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US Army Corps of Engineers®

Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading Innovating Partnering

1. What questions, comments or concerns do you have about this Project?

2. What would you like to see included in this Project?

Down the road more accessibility/trails for recreation paddlers

Protect the islands and edges but still allow for exploration.

3. Would you like to receive updates by being added to the Project mailing list?

Yes X **No** ____

(If yes, please provide your contact information below)

Name	Leslie Solberg
Address	[redacted]
Email	[redacted]

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
4	a. This open house provided an opportunity to better understand the Project.
4	b. This open house provided an opportunity to offer information about the Project area.
4	c. The displays and materials were informative.
5	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading·Innovating·Partnering

1. What questions, comments or concerns do you have about this Project?

Any plans for "Pelican Island." ?
Needs to be extended for ↑ habitat for waterbird nesting.

2. What would you like to see included in this Project?

DRAFT

3. Would you like to receive updates by being added to the Project mailing list?

Yes X **No** _____

(If yes, please provide your contact information below)

Name	Andrea Witt
Address	[redacted]
Email	[redacted]

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
5	a. This open house provided an opportunity to better understand the Project.
5	b. This open house provided an opportunity to offer information about the Project area.
5	c. The displays and materials were informative.
5	d. My questions and concerns were answered by a study team member.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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2. What would you like to see included in this Project?

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3. Would you like to receive updates by being added to the Project mailing list?
Yes X **No** _____

(If yes, please provide your contact information below)

Name	MARTIN G RAY
Address	[redacted]
Email	

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
_____	a. This open house provided an opportunity to better understand the Project.
_____	b. This open house provided an opportunity to offer information about the Project area.
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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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1. What questions, comments or concerns do you have about this Project?

2. What would you like to see included in this Project?

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3. Would you like to receive updates by being added to the Project mailing list?
Yes X **No** ____

(If yes, please provide your contact information below)

Name	BRIAN MOYSE
Address	[redacted]
Email	

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
4	a. This open house provided an opportunity to better understand the Project.
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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading-Innovating-Partnering

1. **What questions, comments or concerns do you have about this Project?**

This will take a LONG time + I hope people will support it + not kill it.

2. **What would you like to see included in this Project?**

The island stabilation / restoring depth / and vegetation to bring back fishes. I strongly vote for getting the pelicans ~~and~~ population down.

3. **Would you like to receive updates by being added to the Project mailing list?**

Yes X **No** ____

(If yes, please provide your contact information below)

Name	JEAN LARSON + Barb's answers!
Address	[redacted]
Email	

DRAFT

4. **Using the scale below, please rate your agreement with the following statements:**

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
4	a. This open house provided an opportunity to better understand the Project.
4	b. This open house provided an opportunity to offer information about the Project area.
3	c. The displays and materials were informative. If I understood them
4	d. My questions and concerns were answered by a study team member.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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2. **What would you like to see included in this Project?**

3. **Would you like to receive updates by being added to the Project mailing list?**
   Yes X **No** _____
   (If yes, please provide your contact information below)

Name	Darwin Kloft
Address	[redacted]
Email	

4. **Using the scale below, please rate your agreement with the following statements:**

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
_____	a. This open house provided an opportunity to better understand the Project.
_____	b. This open house provided an opportunity to offer information about the Project area.
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Upper Mississippi River Restoration

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1. **What questions, comments or concerns do you have about this Project?**

2. **What would you like to see included in this Project?**

3. **Would you like to receive updates by being added to the Project mailing list?**
   Yes X **No** ____

   (If yes, please provide your contact information below)

Name	Nick Meyer
Address	[redacted]
Email	

4. **Using the scale below, please rate your agreement with the following statements:**

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
____	a. This open house provided an opportunity to better understand the Project.
____	b. This open house provided an opportunity to offer information about the Project area.
____	c. The displays and materials were informative.
____	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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US Army Corps of Engineers®

Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading · Innovating · Partnering

1. What questions, comments or concerns do you have about this Project?

2. What would you like to see included in this Project?

3. Would you like to receive updates by being added to the Project mailing list?
Yes X **No** _____

(If yes, please provide your contact information below)

Name	LARRY Judd
Address	[redacted]
Email	

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
3	a. This open house provided an opportunity to better understand the Project.
4	b. This open house provided an opportunity to offer information about the Project area.
4	c. The displays and materials were informative.
3	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading-Innovating-Partnering

1. **What questions, comments or concerns do you have about this Project?**

2. **What would you like to see included in this Project?**

DRAFT

3. **Would you like to receive updates by being added to the Project mailing list?**
   Yes _____ No _____

   (If yes, please provide your contact information below)

Name	Randy Schmitt
Address	[redacted]
Email	

4. **Using the scale below, please rate your agreement with the following statements:**

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
_____	a. This open house provided an opportunity to better understand the Project.
_____	b. This open house provided an opportunity to offer information about the Project area.
_____	c. The displays and materials were informative.
_____	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

US Army Corps of Engineers®

Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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1. What questions, comments or concerns do you have about this Project?

2. What would you like to see included in this Project? More Fish habitat, Boat launch at the old Army Depot at Savana

DRAFT

3. Would you like to receive updates by being added to the Project mailing list?
Yes _____ No _____

(If yes, please provide your contact information below)

Name	Frank
Address	[redacted]
Email	

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
5	a. This open house provided an opportunity to better understand the Project.
5	b. This open house provided an opportunity to offer information about the Project area.
5	c. The displays and materials were informative.
5	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

US Army Corps of Engineers®

Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading · Innovating · Partnering

1. What questions, comments or concerns do you have about this Project?

SILTING ISSUES

2. What would you like to see included in this Project?

MORE BOAT ACCESS

3. Would you like to receive updates by being added to the Project mailing list?
Yes ✓ **No** ____

(If yes, please provide your contact information below)

Name	STEVE BAMMAN
Address	[redacted]
Email	

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
4	a. This open house provided an opportunity to better understand the Project.
4	b. This open house provided an opportunity to offer information about the Project area.
4	c. The displays and materials were informative.
N/A	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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US Army Corps of Engineers®

Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading · Innovating · Partnering

1. **What questions, comments or concerns do you have about this Project?**

2. **What would you like to see included in this Project?**
Backwater dredging, Flow diversion structures

3. **Would you like to receive updates by being added to the Project mailing list?**
Yes X **No** _____

(If yes, please provide your contact information below)

Name	David Frantz
Address	[redacted]
Email	

4. **Using the scale below, please rate your agreement with the following statements:**

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
_____	a. This open house provided an opportunity to better understand the Project.
_____	b. This open house provided an opportunity to offer information about the Project area.
_____	c. The displays and materials were informative.
_____	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading·Innovating·Partnering

1. **What questions, comments or concerns do you have about this Project?**

2. **What would you like to see included in this Project?**

3. **Would you like to receive updates by being added to the Project mailing list?**
   Yes ✓ **No** ____

   (If yes, please provide your contact information below)

Name	Brian Wall
Address	[redacted]
Email	

4. **Using the scale below, please rate your agreement with the following statements:**

   1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
____	a. This open house provided an opportunity to better understand the Project.
____	b. This open house provided an opportunity to offer information about the Project area.
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Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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1. What questions, comments or concerns do you have about this Project?

2. What would you like to see included in this Project?

3. Would you like to receive updates by being added to the Project mailing list?
Yes ✓ **No** _____

(If yes, please provide your contact information below)

Name	TOM DETERMANN
Address	[redacted]
Email	

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4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
5	a. This open house provided an opportunity to better understand the Project.
5	b. This open house provided an opportunity to offer information about the Project area.
5	c. The displays and materials were informative.
5	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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1. What questions, comments or concerns do you have about this Project?

2. What would you like to see included in this Project?

3. Would you like to receive updates by being added to the Project mailing list?
Yes ✓ **No** ____

(If yes, please provide your contact information below)

Name	Terry Kahler
Address	[redacted]
Email	

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
5	a. This open house provided an opportunity to better understand the Project.
5	b. This open house provided an opportunity to offer information about the Project area.
5	c. The displays and materials were informative.
5	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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US Army Corps of Engineers®

Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading · Innovating · Partnering

1. What questions, comments or concerns do you have about this Project?

CONCERN - FLOODING - LEVEES DESTROYING PROGRESS

2. What would you like to see included in this Project?

ISLANDS CREATED THAT WILL WITHSTAND FLOODING

3. Would you like to receive updates by being added to the Project mailing list?

Yes X **No** _____

(If yes, please provide your contact information below)

Name	CHAD MACKE
Address	[redacted]
Email	[redacted]

DRAFT

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
4	a. This open house provided an opportunity to better understand the Project.
4	b. This open house provided an opportunity to offer information about the Project area.
4	c. The displays and materials were informative.
3	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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1. **What questions, comments or concerns do you have about this Project?**

2. **What would you like to see included in this Project?**

Our concern is the backing up of water ~~on~~ our farm ground due to heavy dams in the slew. Have called & ask that they be removed but no action

3. **Would you like to receive updates by being added to the Project mailing list?**
   Yes ✓ **No** _____

   (If yes, please provide your contact information below)

Name	Stanley & Kay Dierks
Address	[redacted]
Email	

4. **Using the scale below, please rate your agreement with the following statements:**

   1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
_____	a. This open house provided an opportunity to better understand the Project.
_____	b. This open house provided an opportunity to offer information about the Project area.
_____	c. The displays and materials were informative.
_____	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
Leading · Innovating · Partnering

1. What questions, comments or concerns do you have about this Project?

2. What would you like to see included in this Project?

3. Would you like to receive updates by being added to the Project mailing list?
Yes _____ No _____

(If yes, please provide your contact information below)

Name	William Ashley
Address	[redacted]
Email	

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
_____	a. This open house provided an opportunity to better understand the Project.
_____	b. This open house provided an opportunity to offer information about the Project area.
_____	c. The displays and materials were informative.
_____	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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Lower Pool 13 HREP

Upper Mississippi River Restoration

Comment Card

Upper Mississippi River Restoration
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1. What questions, comments or concerns do you have about this Project?

Will it improve waterfowl hunting. I have marsh just off the elk river a mile or two from the Mississippi wondering how it will affect my ~~m~~ marsh.

2. What would you like to see included in this Project?

DRAFT

3. Would you like to receive updates by being added to the Project mailing list?

Yes X **No** _____

(If yes, please provide your contact information below)

Name	William Rick Fry
Address	[redacted]
Email	[redacted]

4. Using the scale below, please rate your agreement with the following statements:

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Rating	
_____	a. This open house provided an opportunity to better understand the Project.
_____	b. This open house provided an opportunity to offer information about the Project area.
_____	c. The displays and materials were informative.
_____	d. My questions and concerns were answered by a study team member.

Thank you for attending the open house, we appreciate your input.

Please hand in your completed comment card as you leave the open house.

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

20 Dec 19

CEMVD-PD

MEMORANDUM FOR Commander, Rock Island District

SUBJECT: Approval of the Upper Mississippi River Restoration, Lower Pool 13 Habitat Rehabilitation and Enhancement Project, Clinton County, Iowa, Carroll and Whiteside Counties, Illinois, Mississippi River Pool 13, River Mile 522.5-529.0, Review plan (RP)

1. References:

a. Memorandum, CEMVR-PM, 09 December 2019, subject: Upper Mississippi River Restoration, Lower Pool 13 Habitat Rehabilitation and Enhancement Project, Clinton County, Iowa, Carroll and Whiteside Counties, Illinois, Mississippi River Pool 13, River Mile 522.5-529.0, Review plan (RP).

b. EC 1165-2-217, Review Policy for Civil Works, 20 February 2018.

2. The enclosed Review Plan (RP) for the Lower Pool 13 Habitat Rehabilitation and Enhancement project has been prepared in accordance with EC 1165-2-217 and has been coordinated with MVD Staff who concurred with the RP.

3. The MVD hereby approves this RP, which is subject to change as circumstances require, consistent with project development under the Project Delivery Business Process. Non-substantive changes to this RP do not require further approval. Substantive revisions to this RP or its execution will require new written approval from this office. The district should post the approved RP to its internal website with sensitive information removed.

4. The MVD point of contact for this action is Ms. LeeAnn Riggs, CEMVD-PDM, [redacted]

BUILDING STRONG and Taking Care of People!

James A Bodron

Encl

JAMES A. BODRON, P.E., SES
Director of Programs

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Upper Mississippi River National Wildlife and Fish Refuge

Lower Pool 13 HREP
Benefits of I-H4 as Earthen Island rather than Rock Mound Feature

Prepared by: Sharonne Baylor, January 11, 2022

Background: During the November 29, 2021 Lower Pool 13 HREP inter-agency meeting, the Corps requested that the Refuge provide a description of the I-H4 feature benefits if the feature is built as an earthen island (i.e., a typical island with a sand base topped by fines) rather than as a rock mound. Describing the benefits will help the Corps "tell the story" of this feature in the Feasibility Report. The Refuge envisions I-H4 to be a low island (2-3' above low control pool).

I-H4 Earthen Island Benefits: In addition to addressing the project problems, opportunities, and objectives outlined in the Lower Pool 13 HREP "Problems and Objectives" table (updated by the Corps November 22, 2022), an earthen island would provide the following additional benefits, some of which are unquantifiable. These additional benefits would not be achieved with a rock mound. We expect the earthen island will transition through different habitats throughout its 50-year design life. Please note that these are not objectives for the feature, but are describing the benefits, including likely habitat benefits, associated with an earthen island feature.

- An earthen island, even with some rock protection, is more natural looking than a rock mound and is more consistent with the Refuge's Comprehensive Conservation Plan which includes the goal, "*We will strive to maintain and improve scenic qualities and wild character of the Upper Mississippi River Refuge*" and the guiding principles for habitat management programs (USFWS 2006). An earthen island, including shorelines protected with rock, would balance the Refuge's CCP goal and guidelines with the need to provide meaningful and effective protection of important habitat.

- An earthen island with sloping sides would provide feeding and loafing habitat for shorebirds and turtles at the edges of the island and in the shallow waters adjacent to the edges. Rock slopes are not easily accessible for some wildlife such as turtles which can become trapped in the rock voids.

- During some flow conditions, an earthen island may provide some turtle nesting habitat.

- Willows, during times when they are established on the island, will provide additional wind fetch protection which in turn will benefit submersed aquatic vegetation. (Note that we anticipate that willows and a grass mix will be planted at the end of construction to stabilize the island's soils.)

- Wildlife habitats on the earthen island will be dynamic and are expected, and will be allowed to, transition to various habitats over the I-H4 feature's 50-year design life. Some examples of expected habitats for an earthen island in this location include the

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following. (Note that because this will be a low island, we do not expect other types of trees that require less inundation days to grow or persist.)

  - Willows and grasses would provide neotropical migrant bird habitat.

  - If colonial nesting waterbirds such as American white pelicans, double-crested cormorants, ring-billed gulls, and possibly great blue herons and great egrets extensively use the earthen island, then the willow and grass habitat would likely be replaced by areas of with little to no vegetative cover which would provide nesting and loafing habitat for those types of waterbirds.

- An earthen island at this location could complement previous and future island enhancement, protection, and restoration (such as Pelican, Woodruff's, and Cormorant Islands) and associated habitats just upriver from this location.

- Construction access would only be needed at two or three locations along an earthen island because wheeled or tracked equipment could traverse on top of the island as it is being built. With a feature constructed entirely of rock, wheeled or tracked equipment would less likely be used to traverse the top of the rock. If equipment is not used to traverse the top of the rock, then access dredging would more likely be required along the entire length of the feature to facilitate rock placement.

References:

U.S. Fish and Wildlife Service. 2006. Upper Mississippi River National Wildlife and Fish Refuge Comprehensive Conservation Plan. U.S. Fish and Wildlife Service. Fort Snelling, Minnesota. 168 pp + Appendices A–G.

****

DRAFT

From: Schwake, Christine
To: Frohlich, Albert J CIV USARMY CEMVR (USA)
Cc: Laaker, Dillan J CIV USARMY CEMVP (USA)
Subject: [URL Verdict: Neutral][Non-DoD Source] Re: Pool 13 HREP Section 404/401 NWP 27 Justification
Date: Tuesday, July 12, 2022 11:55:23 AM

Hi Dillon,

The current Section 401 Water Quality Certification (401) for the 2022-2026 Nationwide Permits (issued on 10/12/2021) no longer has a condition requiring coordination with me for projects on the Mississippi River. (The 401 issued for the 2017-2022 Nationwide Permits did include that requirement.)

Thanks for checking with me!

Chris

On Tue, Jul 12, 2022 at 8:52 AM Frohlich, Albert J CIV USARMY CEMVR (USA) [redacted] wrote:

> I put her on the cc line. [redacted]
>
> ---
>
> **From:** Laaker, Dillan J CIV USARMY CEMVP (USA) [redacted]
> **Sent:** Tuesday, July 12, 2022 8:49 AM
> **To:** Frohlich, Albert J CIV USARMY CEMVR (USA) [redacted]; Frohlich, Wendy M CIV USARMY CEMVR (USA) [redacted]
> **Subject:** RE: Pool 13 HREP Section 404/401 NWP 27 Justification
>
> Thank you both for the clarification. Al, is this Chris with IA DNR? Do you have their contact info by chance?
>
> Thanks!
>
> Dillan Laaker
>
> Biologist
>
> U.S. Army Corps of Engineers
>
> Environmental Planning

DRAFT

RPEDN at Rock Island

[redacted]

[redacted]

From: Frohlich, Albert J CIV USARMY CEMVR (USA)
[redacted]
Sent: Tuesday, July 12, 2022 8:44 AM
To: Frohlich, Wendy M CIV USARMY CEMVR (USA)
[redacted]; Laaker, Dillan J CIV USARMY CEMVP (USA)
[redacted]
Subject: RE: Pool 13 HREP Section 404/401 NWP 27 Justification

The Mississippi River requires additional coordination with Iowa DNR. It is considered a special water. I would call Chris and discuss.

As far as our involvement with this NWP – since we do not permit ourselves, if Planning believes that the project meets the terms and conditions of the NWP 27, then state that in your EA documentation. Regulatory does not issue the standard NWP letter in this case.

Al

From: Frohlich, Wendy M CIV USARMY CEMVR (USA)
[redacted]
Sent: Tuesday, July 12, 2022 8:41 AM
To: Laaker, Dillan J CIV USARMY CEMVP (USA) [redacted]
<Albert.J.Frohlich@usace.army.mil>
Subject: RE: Pool 13 HREP Section 404/401 NWP 27 Justification

In IL, the NWP should cover you for both Section 10 and Section 404 - the 401 water quality certification with special conditions was issued with NWP 27.

I don't know what the IA DNR is asking for though.

DRAFT

Wendy Frohlich, Project Manager

U.S. Army Corps of Engineers

Regulatory Division – Eastern Branch

[redacted]

From: Laaker, Dillan J CIV USARMY CEMVP (USA) [redacted]
Sent: Tuesday, July 12, 2022 7:58 AM
To: Frohlich, Albert J CIV USARMY CEMVR (USA)
[redacted]
Cc: Frohlich, Wendy M CIV USARMY CEMVR (USA)
[redacted]
Subject: RE: Pool 13 HREP Section 404/401 NWP 27 Justification
Importance: High

Al,

Just checking in again on this NWP for our Lower Pool 13 HREP. We received a comment from IA DNR regarding coordination of this action under NWP 27 since this is occurring on the Mississippi River. I guess in addition to their state conditions, IA DNR reserves the right to provide additional conditions on certain waterways? Do you have any experience with this coordination and what it involves?

DRAFT

Dillan Laaker

Biologist

U.S. Army Corps of Engineers

Environmental Planning

RPEDN at Rock Island

O: (309) 794-5636

C: (618) 975-5017

From: Laaker, Dillan J CIV USARMY CEMVP (USA)
Sent: Tuesday, June 21, 2022 9:14 AM
To: Frohlich, Albert J CIV USARMY CEMVR (USA)
[redacted]
Subject: RE: Pool 13 HREP Section 404/401 NWP 27 Justification

Hey Al, sorry for the late reply. Yes, I think I could use some help, or at least another set of regulatory eyes to look this one over. We are going through DQC currently and I do not believe we have a regulatory POC assigned. If you need a LC for this please let me know.

Thanks!

Dillan Laaker

Biologist

U.S. Army Corps of Engineers

Environmental Planning

RPEDN at Rock Island

[redacted]

[redacted]

DRAFT

From: Frohlich, Albert J CIV USARMY CEMVR (USA)
[redacted]
Sent: Tuesday, May 31, 2022 5:28 PM
To: Laaker, Dillan J CIV USARMY CEMVP (USA) [redacted]
Subject: RE: Pool 13 HREP Section 404/401 NWP 27 Justification

Dillan – did you need help with this? I don't have much time to devote to it but if you need something, let m know.

Al

From: Laaker, Dillan J CIV USARMY CEMVP (USA) [redacted]
Sent: Tuesday, May 10, 2022 1:26 PM
To: Frohlich, Albert J CIV USARMY CEMVR (USA)
[redacted]
Cc: Frohlich, Wendy M CIV USARMY CEMVR (USA)
[redacted]
Subject: Pool 13 HREP Section 404/401 NWP 27 Justification

Al,

Thanks for walking me through the CWA compliance for HREPs a few months ago. If I remember right you are the IA POC in Regulatory, and 99% of our project will occur in IA. There is a "potential" dredged material placement site/island restoration on the IL side of the channel, so I included IL conditions in the attached NWP Justification Form. I am not sure if I am breaching protocol by sending this directly to you for review, but if I should be sending this request for review/concurrence to someone else please let me know.

If you have any questions shoot me an email or reach out on Teams.

Thanks!

Dillan Laaker

Biologist

U.S. Army Corps of Engineers

Environmental Planning

RPEDN at Rock Island

[redacted]

[redacted]

DRAFT

--

Christine Schwake • Environmental Specialist
Water Quality Bureau
Iowa Department of Natural Resources
[redacted]
502 E 9th St, Des Moines, IA 50319

DRAFT

UPPER MISSISSIPPI RIVER NATIONAL WILDLIFE AND FISH REFUGE

Lower Pool 13 HREP

U.S. FISH AND WILDLIFE SERVICE, NATIONAL WILDLIFE REFUGE SYSTEM, AND UPPER MISSISSIPPI RIVER NATIONAL WILDLIFE AND FISH REFUGE GOALS AND OBJECTIVES

Contact: Stephen Winter, Wildlife Biologist
Prepared June 7, 2019, Updated July 15, 2022

DRAFT

U.S. Fish and Wildlife Service and
National Wildlife Refuge System Goals and Objectives

Broad goals and objectives are provided by legislation that guides management of the National Wildlife Refuge System including the National Wildlife Refuge System Administration Act of 1966 and the National Wildlife Refuge System Improvement Act of 1997 16 U.S.C. 668dd to 668ee (Refuge Administration Act). These define the Refuge System and authorizes the Secretary of the Interior to permit any use of a refuge provided such use is compatible with the major purposes for which the refuge was established. The landmark National Wildlife Refuge System Improvement Act, passed by Congress in 1997, prepared the way for a renewed vision for the future of the refuge system whereby:

- Wildlife comes first.
- Refuges are cornerstones for biodiversity and ecosystem-level conservation.
- Lands and waters of the System are biologically healthy.
- Refuge lands reflect national and international leadership in habitat management and wildlife conservation.

Important provisions of this legislation and the subsequent policies to carry out its mandates include:

- The Establishment of a Broad National Policy for the Refuge System whereby each refuge shall be managed to fulfill the mission and its purposes.

- Directing the Secretary of the Interior to:

    - Provide for the conservation of fish, wildlife, and plants within the System.

    - Ensure biological integrity, diversity, and environmental health of the System for the benefit of present and future generations.

    - Carry out the mission of the System and purposes of each refuge; if conflict exists between these, refuge purposes take priority.

    - Ensure coordination with adjacent landowners and the states.

- Providing Compatibility of Uses Standards and Procedures whereby new or existing uses should not be permitted, renewed, or expanded unless compatible with the mission of the System or the purpose(s) of the refuge, and consistent with public safety.

- Planning whereby each unit of the Refuge System shall have a Comprehensive Conservation Plan completed by 2012.

- Compatibility Policy whereby no use for which the Service has authority may be allowed on a unit of Refuge System unless it is determined to be compatible. A compatible use is a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of the national wildlife refuge. Managers must complete a written compatibility determination for each use, or collection of like uses, that is signed by the manager and the Regional Chief of Refuges in the respective Service region.

- Biological Integrity, Diversity and Environmental Health Policy whereby the Service is directed in the Refuge Improvement Act to "ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained for the benefit of present and future generations of Americans…" The biological integrity policy helps define and clarify this directive by providing guidance on what conditions constitute biological integrity, diversity, and environmental health (BIDEH); guidelines for maintaining existing levels; guidelines for determining how and when it is appropriate to restore lost elements; and guidelines in dealing with external threats to BIDEH. The policy also provides guidance for the conservation and management of a broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems.

The specific legislation establishing the Upper Mississippi National Wildlife and Fish Refuge was the Upper Mississippi River Wild Life and Fish Refuge Act of 1924 and the stated purposes of the refuge in that legislation were:

- "...a refuge and breeding place for migratory birds included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, and…

- …to such extent as the Secretary of Agriculture may by regulations prescribe, as a refuge and breeding place for other wild birds, game animals, fur-bearing animals, and for the conservation of wild flowers and aquatic plants, and…

- …to such extent as the Secretary of Commerce may by regulations prescribe as a refuge and breeding place for fish and other aquatic animal life."

DRAFT

Upper Mississippi River National Wildlife and Fish Refuge
Purpose, Goals, and Objectives

The Upper Mississippi River National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS 2006) identified several relevant Goals and Objectives, including:

- Environmental Health Goal: We will strive to improve the environmental health of the Refuge by working with others.

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

    - Management practices will restore or mimic natural ecosystem processes or functions to promote a diversity of habitat and minimize operations and maintenance costs. Mimicking natural processes in an altered environment often includes active management and/or structures such as drawdowns, moist soil management, prescribed fire, grazing, water control structures, dikes, etc.

    - Maintenance and operation costs of projects will be weighed carefully because annual budgets are not guaranteed.

    - Terrestrial habitat on constructed islands and other areas needs to best fit the natural processes occurring on the river, which in many cases will allow for natural succession to occur.

    - If project features in Refuge Closed Areas serve to attract the public during the waterfowl season, spatial and temporal restrictions of uses may be required to reduce human disturbance of wildlife.

    - The esthetics of projects in context of visual impacts to the landscape should be considered in project design.

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Each refuge is required to complete a Habitat Management Plan that includes an identification of Resources of Concern associated with that refuge. Service policy (620 FW 1) defines Resources of Concern as:

> "All plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), System mission, or international, national, regional, state, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect "migrating waterfowl and shorebirds." Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts."

Furthermore, the comprehensive list of Resources of Concern associated with a refuge is refined to a subset known as Priority Resources of Concern. A draft set of Priority Resources of Concern have been identified by the Upper Mississippi River National Wildlife and Fish Refuge

and they serve in part to represent refuge priorities when the refuge engages in the planning and execution of partnership activities such as UMRR HREP projects.

Upper Mississippi River National Wildlife and Fish Refuge
Lower Pool 13 HREP-specific Priority Resources of Concern and Objectives

Using the refuge's habitat management plan (U.S. Fish and Wildlife Service 2019) and the Lower Pool 13 Fact Sheet (Upper Mississippi River Restoration 2018) as a foundation, the refuge has identified primary and secondary objectives it believes are appropriate for the Lower Pool 13 HREP, and the refuge priority resources of concern (ROC) that would be relevant to those objectives.

Refuge objectives and associated Priority ROC relevant to the Lower Pool 13 study area are identified in Tables 1 and 2.

Table 1: Refuge Primary Objectives and Priority ROC within the Lower Pool 13 HREP Study Area

Primary Objective	Priority Resources of Concern
Reduce wind-fetch to restore, enhance, and sustain submersed aquatic vegetation communities dominated by wild celery.	• Canvasback, scaup, tundra swan
Restore, enhance, and protect islands to maintain flow conditions and sediment dynamics that will restore, enhance, and sustain submersed aquatic vegetation dominated by wild celery.	• Canvasback, scaup, tundra swan
Restore, enhance, and protect lotic habitats to maintain flow conditions and sediment dynamics that will restore, enhance, and protect fluvial-dependent native fish and mussels.	• Fluvial-dependent native mussels, migratory fluvial-dependent native fish

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Table 2: Refuge Secondary Objectives and Priority ROC within the Lower Pool 13 HREP Study Area

Secondary Objective	Priority Resources of Concern
Restore, enhance, and protect deep lentic habitats maintain flow conditions and sediment dynamics that will restore, enhance, and protect limnophilic native fish and mussels.	• Limnophilic native fish, limnophilic native mussels
Restore, enhance, and protect islands to maintain flow conditions and sediment dynamics that will restore, enhance, and sustain emergent, floating-leaved, and submersed aquatic vegetation.	• Tundra swan, dabbling duck guild, secretive marsh birds
Restore, enhance, and protect bottomland forest in areas adjacent to or in close proximity to currently existing bottomland forest.	• Red-shouldered hawk, cerulean warbler, prothonotary warbler, transient neotropical migrant passerines, tree-roosting bats, midwestern wooded swamps and floodplains

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References

U.S. Fish and Wildlife Service. 2006. Upper Mississippi River National Wildlife and Fish Refuge Comprehensive Conservation Plan. U.S. Fish and Wildlife Service. Fort Snelling, Minnesota. 168 pp + Appendices A–G.

U.S. Fish and Wildlife Service. 2019. Upper Mississippi River National Wildlife and Fish Refuge Habitat Management Plan. U.S. Fish and Wildlife Service. Bloomington, MN. 127 pp + Appendices A–F. Available at https://ecos.fws.gov/ServCat/Reference/Profile/115578

Upper Mississippi River Restoration. 2018. Lower Pool 13 Habitat Rehabilitation and Enhancement Project, U.S. Army Corps of Engineers, Rock Island District. 5 pp.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

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Last Updated
May 16, 2022

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX E
ENGINEERING

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1. PURPOSE

In accordance with Engineering Regulation (ER) 111-2-1150, this Appendix documents the engineering and design effort during project formulation by the U.S. Army Corps of Engineers (Corps), Rock Island District (District). Engineering data and analyses in the feasibility phase shall be sufficient to develop the complete Project schedule and baseline cost estimate with reasonable contingency factors for each cost item or group of cost items. Engineering analysis shall integrate sound environmental engineering principles

2. PROJECT DESCRIPTION

The Lower Pool 13 project is located in Pool 13 of the Upper Mississippi River (UMR) between river miles (RMs) 522.5 and 529.0 (Figure E-1 and Table E-1). The study area is located in Carroll and Whiteside Counties, IL, and Clinton County, IA, approximately 3 miles upstream of Clinton, IA. The project features would be located entirely in the Upper Mississippi River National Wildlife and Fish Refuge (NWFR) and managed by the USFWS, Savanna District. The lower section of Pool 13 is located in a valley that is 1.5 to 4.5 miles wide and contains few land masses. The lower section is oriented north to south. The area consists of backwater lakes, sloughs, flowing channels, and impounded water residing over historic flooded islands and remnant islands.

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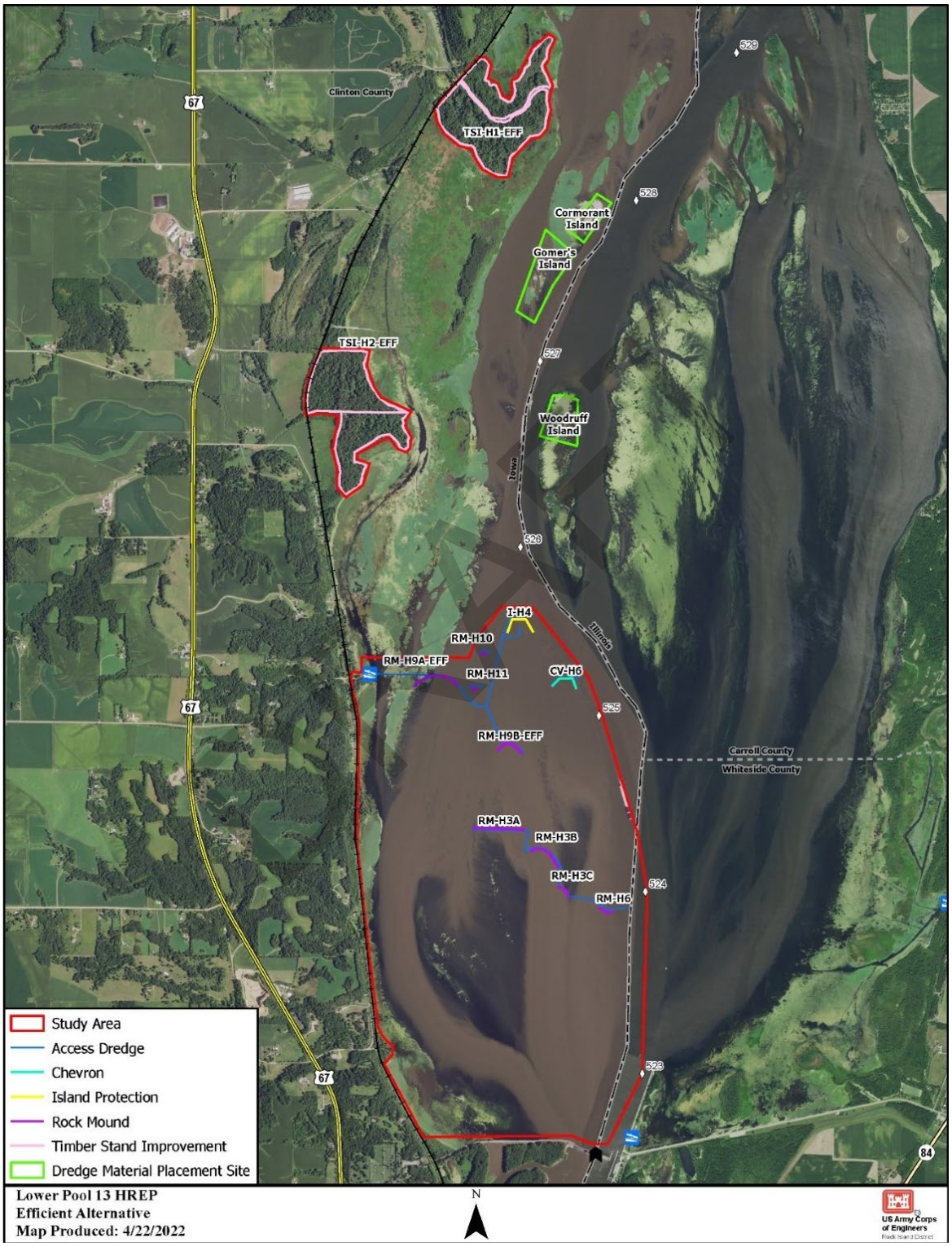

Figure E-1. Site Location and Features

Table E-1. Project Information

ProjectWise Link	B5UMRR131801 - Lower Pool 13 Southwest Corner
Solicitation/Contract	N/A at this time
P2 Project Name and Number	UMRR – Lower Pool 13, IA 469162
Technical Lead	Kara N. Mitvalsky, P.E.
Project Name	Lower Pool 13 Habitat Rehabilitation and Enhancement Project
Project Feature Type	river training structures, island creation, and timber stand improvement.
Project Location	Clinton County, Iowa & Carroll And Whiteside Counties, Illinois Between River Miles 522.5 and 529.0
Project Map Location	See Figure E-1
Project Description	The work includes, but is not limited to, access dredging, hauling and placing rock, hauling and placing dredged sand, transporting access dredged material to the disposal sites, tree clearing, tree plantings, and invasive species management

3. ENGINEERING

3.1. Hydrology and Hydraulics

Numerous elements of the hydraulic design are included in the feature description. Further descriptions are provided in the Attachment A, *Hydrology and Hydraulics* (including Climate Change Analysis) and Attachment E, *Water Quality.*

Water level information is available at Rivergages.com and in Appendix H, *Hydrology and Hydraulics.*

Water quality sampling may be required during dredging and excavation activities. Turbidity curtains will likely be required during aquatic excavations. See example turbidity curtain in Photograph E-1.

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Photograph E-1. Turbidity Curtain (Huron Island HREP Stage I)

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3.2. Surveying, Mapping, and Other Geospatial Data Requirements

Project datum information is summarized as follows:

- Horizontal: NAD 83 State Plane Illinois West 1202
- Vertical: NAVD88
- Geoid 12B (CONUS)
- Units: US Survey Feet
- Conversion: MSL12-0.64 feet = NAVD88

More details are included in Attachment E, *Survey, Mapping, and Geospatial Data.*

3.3. Geotechnical

Geotechnical information will be developed during the design phase of the project. Work is typical of similar designs at other HREPs, and design criteria developed were completed using lessons learned from previous projects.

Information regarding sediment analysis is provided in Attachment B, *Civil and Environmental Engineering.*

3.4. Environmental Engineering

This project is being constructed under the Upper Mississippi River Restoration program authority. Environmental Engineering considerations are included in Attachment B, *Civil and Environmental Engineering*. Hazardous Toxic and Radioactive Waste is discussed in Attachment H, *HTRW*.

Environmental considerations are included in the main report, including discussion on permit requirements, cultural resources, and NEPA considerations.

The project will be covered under Nationwide Permit 27 Environmental restoration. A Refuge Special Use Permit will be applied for during the project design phase. National Pollutant Discharge Elimination System Storm Water permits, if required, will be the responsibility of the construction Contractor.

3.5. Civil Design

Feature Layouts and feature selection is described in Attachment B, *Civil and Environmental Engineering*. Utility relocations are not required for this Project.

3.6. Structural Requirements

There are no structural components to this project.

3.7. Electrical and Mechanical Requirements

There are no electrical or mechanical requirements for this project.

3.8. Hazardous, Toxic and Radioactive Waste

A Phase I Environmental Site Assessment (ESA) was completed in the spring of 2022 for the Study Area and adjacent area. The Phase I ESA documented the Study Area history, reviewed state and Federal environmental databases, and identified potential Recognized Environmental Conditions (RECs). Information is provided in Attachment H, *Hazardous Toxic and Radioactive Waste (HTRW) Documentation Report.*

There is one historic recognized environmental concern (REC) present near the Study Area. In 1945, the University of Iowa and the US Army conducted testing near the extreme southwest corner of the study area. This testing area included a north-south running strip of water in the pool on the southwestern corner of the study area and was closed in August 1945. Prior to the development of the Lock and Dam System, the study area was a typical section of the Mississippi River, with forested floodplain, meanders, oxbows and island complexes. The REC includes a potential for testing pollutants in sediments in the extreme southwest corner of the project area based on US Army Ordnance Department activities conducted during World War II. This area of the Historic REC has been designated as a No Work Zone in regard to HREP measures, and therefore no construction activities will occur there. No other REC's, real or potential HTRW issues are present in the study area.

Flood flows create high velocities with the potential to increase scour at built features, within existing wild celery beds, and within a sensitive no-work area. Scour risk has not yet been evaluated. Higher flow conditions should be applied to the Lower Pool 13 HREP 2D HEC-RAS model to evaluate if proposed features increase velocities such that scour is likely. Further grid cell refinement of the model may be required to confidently answer these questions. Geotechnical investigations will occur during the PED analysis to determine substrate in the

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potential scour locations of concern. Areas of particular concern include: (1) the sensitive no-work area, (2) locations of existing wild celery beds, (3) the immediate vicinity of proposed features, (4) the immediate vicinity of dredge material placement sites, and (5) areas where mussels are found.
To mitigate the scour risk, post-TSP feasibility level of design analysis and PED analysis will adjust proposed features to ensure that they do not substantially increase scour risk and compound climate impacts. No features can be constructed or cause scour within the no work area.

As required for all earth working Projects in the 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, the District would stop work and follow the steps outlined in ER 1165-2-132.

Ensure all construction equipment is cleaned and free of soil residues, plant, pests, noxious weeds and seeds. No soils can be removed from site unless tested. Material dredged and placed on the placement sites shown do not require HTRW testing, but any material removed from the project site will require testing of the parameters listed in the following Table E-2.

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Table E-2. Soil and Materials Analytical Parameters

Volatiles Testing Requirements	
Item	**Method**
Volatiles	SW-8260B

Semi-Volatiles Testing Requirements	
Item	**Method**
Base/Neutrals Extractable Organics	SW-8270C
Acid Extractable Organics	SW-8270C

PCB Testing Requirements	
Item	**Method**
PCBs	SW-8082

Pesticides Testing Requirements	
Item	**Method**
Pesticides	8081A

Herbicides Testing Requirements	
Item	**Method**
Herbicides	8151

Metals Testing Requirements	
Item	**Method**
Antimony	6010 B
Arsenic	6010 B
Barium	6010 B
Beryllium	6010 B
Cadmium	6010 B
Chromium, total	6010 B
Chromium, hexavalent	6010 B
Cobalt	6010 B
Copper	6010 B
Lead, total	6010 B
Manganese	6010 B
Mercury	7471A
Nickel	6010 B
Selenium	6010 B
Silver	6010 B
Thallium	6010 B
Vanadium	6010 B
Zinc	6010 B
Boron	6010 B
Molybdenum	6010 B
Strontium	6010 B

TCLP Testing Requirements	
Item	**Method**
Arsenic	6010B
Barium	6010B
Benzene	8021
Cadmium	6010B
Chlordane	8081A
Chlorobenzene	8260B
Chloroform	8260B
Chromium	6010B
o-Cresol	8270C
m-Cresol	8270C
p-Cresol	8270C
2,4,D	8151A
1,4-Dichlorobenzene	8260B
1,2-Dichloroethane	8260B
1,1-Dichloroethylene	8260B
2,4 Dinitrotoluene	8270C
Endrin	8081A
Heptachlor	8081A
Hexachlorobenzene	8270C
Nitrobenzene	8270C
Pentachlorophenol	8270C
Pyridine	8270C
Trichloroethylene	8270C
2,4,5-Trichlorophenol	8270C
Methoxychlor	8081A
Methyl ethyl ketone	8260B
Mercury	7471A
Lindane	8081A
Lead	6010B
Hexachlorethane	8270C
Hexachlorobutadine	8270C
Tetrachloroethylene	8260B
Toxaphene	8081A
Silver	6010B
Selenium	6010B
2,4,6-Trichlorophenol	8270C
2,4,5-TP	8151A
Vinyl Chloride	8260B

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3.9. Construction Procedures and Water Control Plan

Detailed construction procedures will be developed in the design stage. Water control plans required during construction will need to address high water action plans and construction methods in variable river stages.

3.10. Initial Reservoir Filling and Surveillance Plan

Not applicable to this Project.

3.11. Flood Emergency Plans for Areas Downstream of Corps Dams

Not applicable to this Project.

3.12. Environmental Objectives and Requirements

Project Objectives (which are environmental objectives) are outlined in the Main Report.

3.13. Reservoir Clearing

Not applicable to this Project.

3.14. Operation and Maintenance

This project was developed to reduce the overall operation and maintenance for the project sponsor. Reference Attachment F, *Operation and Maintenance*, for more details.

3.15. Access Roads

The study area of interest is best accessed by boat. Five public boat ramps exist as reasonable access points to the project: Lock & Dam 13, Mickelson's Landing, Bulger's Hollow Recreation Area, Thomson Causeway Recreation Area, and Big Slough Recreation Area.

The boat ramp at Lock at Dam 13 is located four miles north of Fulton, IL, on the left descending bank of the river. Best access is off of State Highway 84 ("Great River Road"). This is a public boat ramp located on USACE owned property.

Mickelson's Landing boat ramp is a public access boat ramp between Fulton and Thomson, IL. It is located on the left descending bank at approximate RM 524.0. Access to this ramp is on Railroad Lane off Lock Road.

The public boat ramp at Bulger's Hollow Recreation Area provides access to this project It is located on the right descending bank about five miles north of Clinton, IA at approximate RM 525.1. The roadway for best access is Bulger's Hollow Road off State Highway 67. Recreation area and boat ramp are owned and maintained by USACE.

Thomson Causeway Recreation Area near Thomson, IL, offers a public boat ramp and a point of access for the Lower Pool 13 HREP. The boat ramp is on the left descending at approximate RM 526.6. Boat ramp and surrounding recreation are property of USACE. Potter Road offers best access to the boat ramp.

Big Slough Recreation Area offers a public access boat ramp and is located on the left descending bank at approximate RM 531.4. Big Slough Recreation Area property and boat

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ramp are owned and operated by USACE. The boat ramp is located on Riverview Road about five miles north of Thomson, IL.

The succeeding navigation charts (Figures E-2 and E-3) for the study area show the boat ramps for river access as described above.

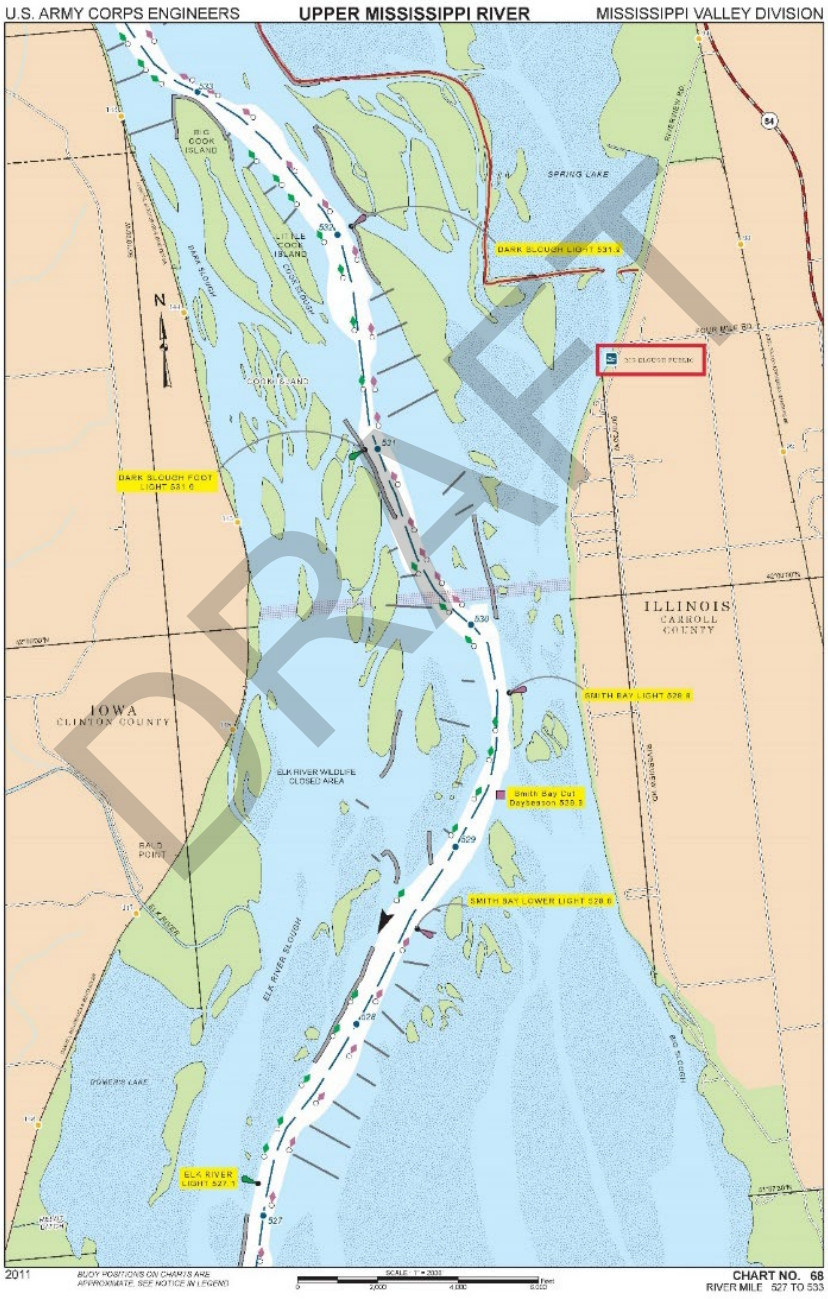

Figure E-2. Navigation Chart 68
Source: https://www.mvr.usace.army.mil/Missions/Navigation/Navigation-Charts/Upper-Mississippi-River/

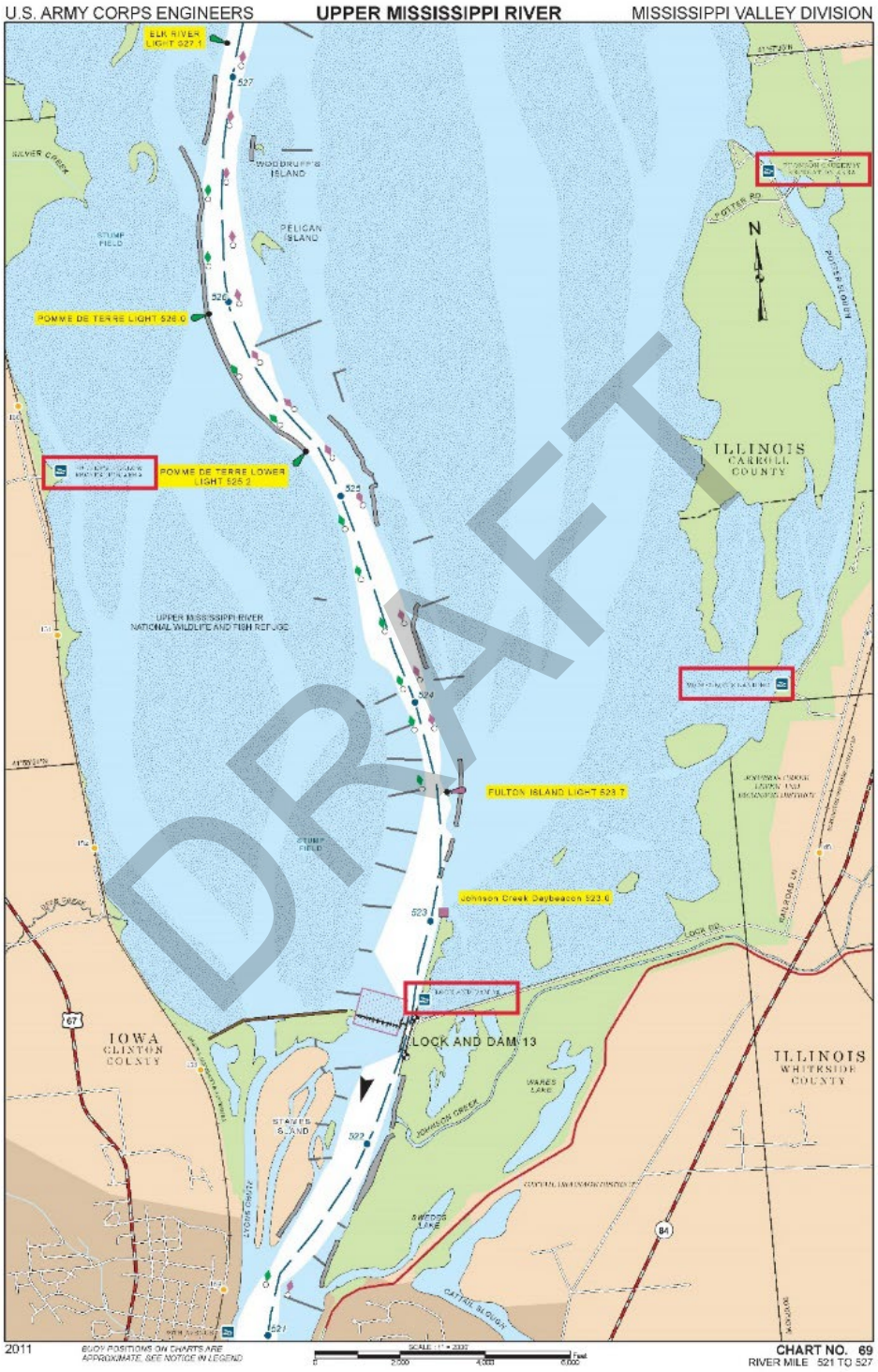

Figure E-3. Navigation Chart 69
Source: https://www.mvr.usace.army.mil/Missions/Navigation/Navigation-Charts/Upper-Mississippi-River/

3.16. Corrosion Mitigation

Not applicable to this Project.

3.17. Project Security

Safety and security are important parameters which would be detailed during the design phase. Of specific concern will be the coordination of regional hunting seasons during construction. While this area is not open for hunting, it is a refuge during that period and it is important to allow waterfowl a place to rest during that season.

Staging areas would be in generally remote locations, and equipment would need to be secured when there is no oversight in these locations.

3.18. Cost Estimates

Cost estimates are provided in Appendix F, *Cost Estimate*.

3.19. Schedule for Design and Construction

Design work would be completed in general 12 to 18 months prior to construction award.

Table E-3. Stage I Construction

Stage I	
Start Date: 10/1/25	**End Date: 11/10/28**
Measure Name	**Item**
TSI-H1-EFF	Timber Stand Improvement
TSI-H2-EFF	Timber Stand Improvement

Table E-4. Stage II Construction

Stage II	
Start Date: 1/1/27	**End Date: 3/29/29**
Measure Name	**Item**
I-H4	Riprap (RR6)
I-H4	Sand Fill
I-H4	Clay Cap
AD-CV-H4	Dredging/Excavation
CV-H6	Riprap (RR6)
AD-CV-H6	Dredging/Excavation

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Table E-5. Stage III Construction

Stage III	
Start Date: 1/1/29	**End Date: 11/12/30**
Measure Name	**Item**
RM-H10	Riprap (RR6)
AD-RM-H10	Dredging/Excavation
RM-H11	Riprap (RR6)
AD-RM-H11	Dredging/Excavation
RM-H9A-EFF	Riprap (RR6)
AD-RM-H9A	Dredging/Excavation
RM-H9B	Riprap (RR6)
AD-RM-H9B	Dredging/Excavation
AD-1	Dredging/Excavation

Table E-6. Stage IV Construction

Stage IV	
Start Date: 1/1/31	**End Date: 1/27/33**
Measure Name	**Item**
RM-H6	Riprap (RR6)
AD-RM-H6	Dredging/Excavation
AD-RM-H6_TRANS	Dredging/Excavation
RM-H3C	Riprap (RR6)
AD-RM-H3C	Dredging/Excavation
RM-H3B	Riprap (RR6)
AD-RM-H3B	Dredging/Excavation
RM-H3A	Riprap (RR6)
AD-RM-H3A	Dredging/Excavation

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3.20. Special Studies

No special studies were performed

3.21. Plates, Figures and Drawings

Refer to Appendix G, *Plates.*

3.22. Data Management

Data will be managed using the District's Bentley ProjectWise Explorer data management system. For more details refer to Appendix E, *Engineering*, Attachment G, *Data Management.*

3.23. Use of Metric System Measurements

This Project does not use the metric system of measurements. The Project does use the English system of measurements.

4. DESIGN CONSIDERATIONS

4.1. Design Criteria

Reference Attachment B, *Civil and Environmental Engineering*, for design criteria, including submerged aquatic vegetation, wind driven wave reduction, island protection, nesting islands, and overwintering habitat.

4.2. Feature Site Location

Feature Site Locations and siting is described in Attachment B, *Civil and Environmental Engineering*. Information that led to feature siting included the following:

- Sponsor Recommendations
- Site Visits
- Water Depths
- Water Quality Monitoring Data (LTRM and USACE)
- Sediment Sources
- Vegetation Monitoring
- Habitat Suitability Index
- Velocity
- Wind Wave Modeling
- Sediment Evaluations
- Canvas Back Use Area
- Mussel Surveys
- Aerial Photography and Mapping
- Navigation Impacts
- Access Dredging
- Recreational Boating Impacts
- Floodplain Impacts
- Hazardous, Toxic and Radioactive Waste (HTRW)
- Real Estate Boundaries.

4.3. River Training Structures

Features were located to provide optimum conditions for SAV, including a reduction in velocities during the growing season, and providing wave breaks to reduce the resuspension of sediment. Several of these features are in a chevron shape, but other rock mound feature alignments were determined based on bathymetry, wind wave modeling, or velocity modeling. For both chevrons and rock mounds, stone sizes were set as IL DOT RR6 for the feasibility study, however, further design may refine stone sizes.

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Based on the design criteria selected for velocity, turbidity and depth, along with information regarding velocity and wind fetch/wave modeling, the team developed a series of potential features to alter the existing conditions to meet the criteria required to restore the submerged aquatic vegetation habitat. These structures were considered to be constructed in various shapes and with different materials. In general, they can be divided into three separate types: Islands, Rock Mounds, and Chevrons.

All stone work will be constructed by barge (Photograph E-2). Typical equipment will include a hopper barge and excavators to place the stone. Areas are very shallow for stone placement, so access dredging will be required to get into the site. Excavated material will be transported to dedicated placement sites.



Photograph E-2. Stone Placement in Water By Barge, Beaver Island HREP (June 2019)

4.3.1. Chevrons

A chevron is a navigation structure that is placed in the shallow side of the river channel pointing upstream (example chevron in Photograph E-3). These features are often constructed using large riprap to withstand high flow and wind wave action on the Mississippi River. Once the material is placed, it would be shaped to a uniform elevation, with side slopes set near 2H:1V. The top width will be 10 feet. The chevron top elevations for this Project are dictated by the Canvasback exclusion areas and are at flat pool (582.36 NAVD88) so as not to provide a site barrier for this desirable species.



Photograph E-3. Chevron Constructed at Beaver Island HREP (September 2019)



Photograph E-4. Series of Chevron Dikes on the Mississippi River
(Source: UMRR-EMP Environmental Design Handbook, 2012)

Locations for chevron features in Pool 13 are included in Figure E-4 along with the rock mound features in the upper segment of the southwest quadrant of Pool 13.

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4.3.1.1. CV-H1 Chevron

This feature was located on the eastern side of the pool with the purpose to deflect flow and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

4.3.1.2. CV-H2 Chevron

This feature was located on the eastern side of the pool with the purpose to deflect flow and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

4.3.1.3. CV-H3 Chevron

This feature was located on the eastern side of the pool with the purpose to deflect flow and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

4.3.1.4. CV-H4 Chevron

This feature was located on the western side of the pool with the purpose to deflect flow and promote vegetation growth, creating a shadow effect similar to Pelican Island. This feature was screened due to the study area being refined to the higher priority portion of the pool.

4.3.1.5. CV-H5 Chevron

This feature was altered and re-named I-H4. See Section 4.3.3.1, *I H-4 Island Construction.*

4.3.1.6. CV-H6 Chevron

This feature is located adjacent to the navigation channel on the western side of the pool with the purpose to deflect flow and promote vegetation growth, creating a shadow effect similar to Pelican Island. This location was selected based on bathymetry as well as an optimum location to meet project goals. While there are sufficient depths to access the site for stone placement along the channel side, access dredging will also be required. (AD-H6).

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.1.7. CV-H10 Chevron

Following velocity modeling, CV-H10 was selected by the sponsors. The feature is located along the navigation channel but will still require some access dredging (AD-CV-H10), similar to CV-H6. Excavated material will be transported to an island placement site. The intent of this feature is to prevent wind fetch.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

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Several chevron features will be further evaluated during feasibility level design as summarized in Table E-7.

Table E-7. Chevron Measures for Further Evaluation

Feature	Material	Quantity	Unit
CV-H6	Riprap	8,500	TN
AD-CV-H6	Excavation	7,400	CY
CV-H10	Riprap	12,500	TN
AD-CV-H10	Excavation	15,400	CY

4.3.2. Rock Mounds

A rock mound is a navigation structure that is placed in the shallow side of the river channel very similar to chevrons. The primary difference is the alignment may differ somewhat from the standard chevron shape. These features are often constructed using large riprap to withstand high flow and wind wave action on the Mississippi River. Once the material is placed, it would be shaped to a uniform elevation, with side slopes set near 2H:1V. The top width will be 10 feet. The rock mound top elevations for this Project are dictated by the Canvasback exclusion areas and are at flat pool (582.36 NAVD88), so as not to provide a site barrier for this desirable species. Rock mound locations are shown in Figures E-4 through E-6.

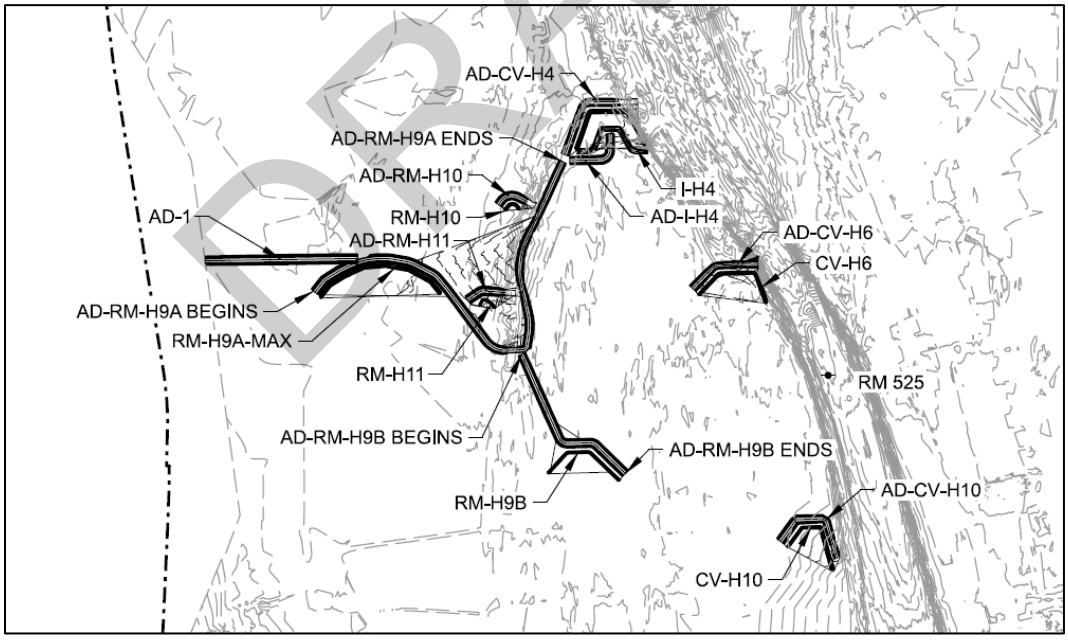

Figure E-4. Southwest Quadrant Upper Structures

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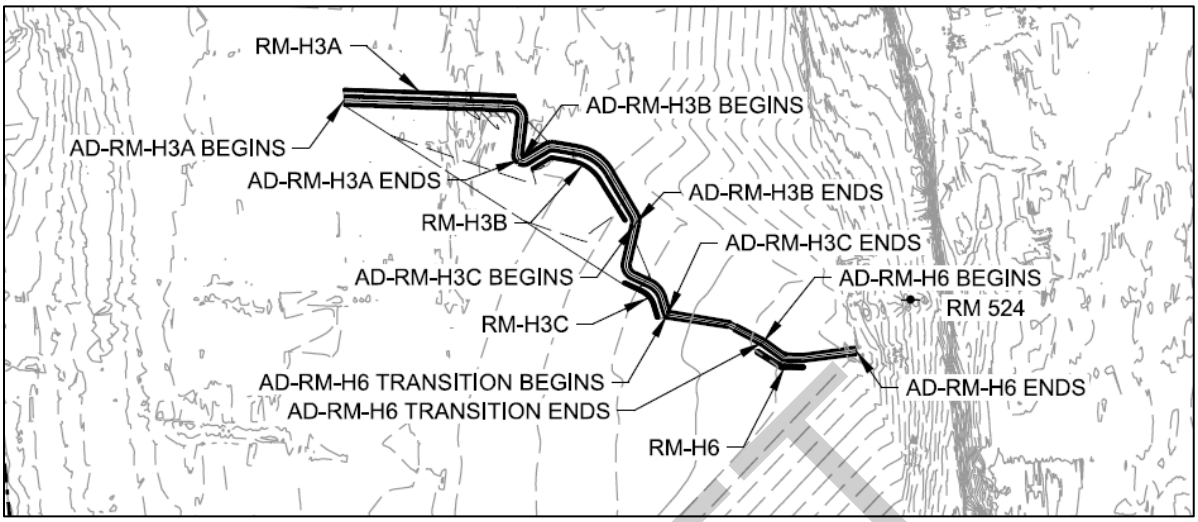

Figure E-5. Southwest Quadrant Middle Structures

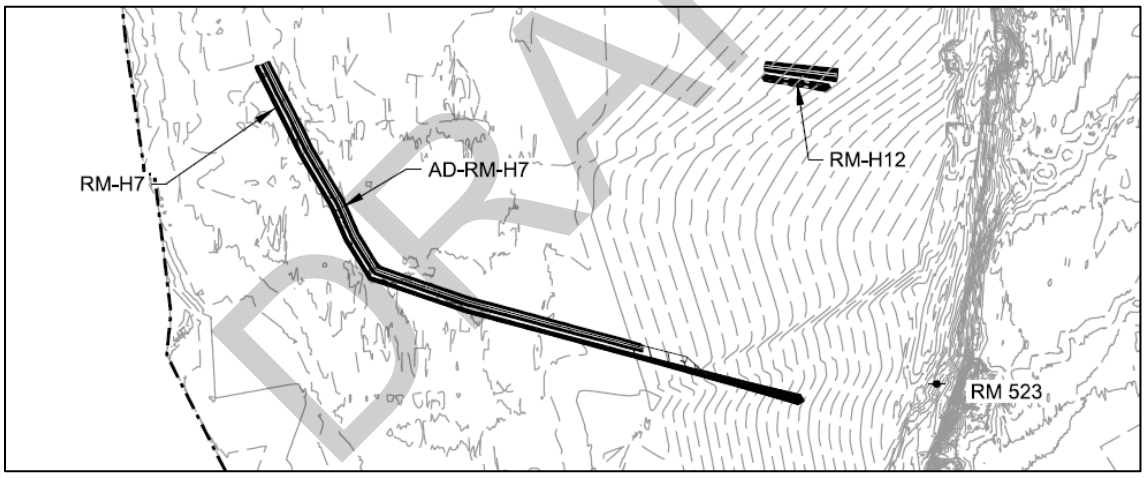

Figure E-6. Southwest Quadrant Lower Structures

4.3.2.1. RM-H1 Rock Mound

This feature was located on the eastern side of the pool with the purpose to reduce wind fetch and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

4.3.2.2. RM-H2 Rock Mound

This feature was located on the eastern side of the pool with the purpose to reduce wind fetch and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

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4.3.2.3. RM-H3A Rock Mound

RM-H3A is located at the upper portion of the middle segment of the southwest quadrant. This feature was placed to align with historical land mass feature structures. RM-H3A is constructed to flat pool elevation to break up wind generated waves reducing the resuspension of sediment upstream of the structure and promote vegetation downstream, in addition to optimizing velocities. Access dredging will be required to access the site. Access dredging would include AD-RM-H3A, AD-RM-H3B, AD-RM-H3C, and AD-RM-H6. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.4. RM-H3B Rock Mound

RM-H3B is located towards the middle of the middle segment of the southwest quadrant. This feature was placed near the historic channel. RM-H3B is constructed to flat pool elevation to break up wind generated waves reducing the resuspension of sediment upstream of the structure, in addition to optimizing velocities. Access dredging will be required to access the site. Access dredging would include AD-RM-H3B, AD-RM-H3C, and AD-RM-H6. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.5. RM-H3C Rock Mound

RM-H3C is located towards the middle of the middle segment of the southwest quadrant. This feature was placed at the head of historic island where resuspension starts. RM-H3C is constructed to reduce the amount of wave action from the lower pool, protect backwater area, and slow velocities to promote vegetation. Access dredging will be required to access the site. Access dredging would include AD-RM-H3A, AD-RM-H3B, and AD-RM-H3C. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.6. RM-H4 Rock Mound

This feature was located on the eastern side of the channel with the purpose to reduce wind fetch and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

4.3.2.7. RM-H5 Rock Mound

This feature was located on the eastern side of the channel with the purpose to reduce wind fetch and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

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4.3.2.8. RM-H6 Rock Mound

RM-H6 is located above a large vegetation bed in the southwest corner. This feature was placed at the historical edge of a forested island. RM-H6 is constructed to flat pool elevation to reduce the wave action from the lower pool. Without the proposed feature, the flow path would allow hydraulic connectivity and sedimentation to have a forecasted impact on the SAV bed. Access dredging (AD-RM-H6) will be required to access the site. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.9. RM-H7 Rock Mound

RM-H7 is located along the lower edge of the southwest quadrant below a large vegetation bed, selected to protect against wind/wave action. This feature was placed close to the channel and along the historical land features. RM-H7 is constructed to flat pool elevation. It is expected that this feature will reduce the amount of wave action from the lower pool. Access dredging (AD-RM-H7) will be required for access to the site. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.10. RM-H8 Rock Mound

This feature was located on the eastern side of the channel with the purpose to reduce wind fetch and promote vegetation growth. This feature was screened due to the study area being refined to the higher priority portion of the pool.

4.3.2.11. RM-H9A-MAX Rock Mound

RM-H9A-MAX is located along the upper edge of the southwest quadrant, closer to the Bulger's Hollow Access. This feature was placed along the historic edge of a forested island (pre-inundation) and in a shallower portion of the pool. RM-H9A-MAX is designed to 2.5 ft above flat pool. This height was selected based on past HREP project success at this elevation (Harper's Slough Island) and FWS recommendations. In addition to optimizing velocity, it is expected that this feature will provide wind breaks leading into the critical habitat of Gomer's Lake. Access dredging between the boat ramp and this site will be required for general access to the site. Access dredging would include AD-H4, AD-H9A, and AD-1. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.12. RM-H9A-EFF Rock Mound

RM-H9A-EFF has the same alignment as RM-H9A-MAX. RM-H9A-EFF is designed to flat pool elevation and has a 30 ft gap in the center to allow for flow diversity and boat traffic. In addition to optimizing velocity, it is expected that this feature will provide wind breaks leading into the

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critical habitat of Gomer's Lake. Access dredging between the boat ramp and this site will be required for general access to the site. Access dredging would include AD-I-H4, AD-RM-H9A, and AD-1. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.13. RM-H9B Rock Mound

RM-H9B is located along the lower center in the upper segment of the southwest quadrant. This feature was selected at the historic edge of a forested island (pre-inundation) to reduce velocities and protect against wind fetch. This feature will require access dredging AD-H4, AD-RM-H9A and AD-RM-H9B. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.14. RM-H10 Rock Mounds

RM-H10 was selected as a smaller structure by the USFWS. The purpose for this structure is to create flow diversities within the upper segment of the southwest quadrant. This structure would require access dredging to deliver stone to the site, including AD-H4, AD-RM-H9A, and AD-RM-H10. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.15. RM-H11 Rock Mounds

RM-H11 was selected as a smaller structure by the USFWS. The purpose for this structure is to create flow diversities within the upper segment of the southwest quadrant. This structure would require access dredging to deliver stone to the site, including AD-H4, AD-RM-H9A, and AD-RM-H11. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

4.3.2.16. RM-H12 Rock Mound

RM-H12 is located within the lower segment of the southwest quadrant. This feature was placed close to the channel to break up wind fetch and create flow diversity. This feature consists of three mounds with 30 foot gaps between them. RM-H12 is constructed to flat pool elevation. It is expected that this feature will increase diversity flows and create conditions to promote SAV growth. Access dredging (AD-RM-H12) will be required for access to the site. Excavated material would be transported to the island placement sites.

See Appendix G, *Plates,* for the plan view and typical view of the feature. The rock mound features evaluated are summarized in Table E-8.

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Table E-8. Rock Mound Features Evaluated

Feature	Material	Quantity	Unit
RM-H9A_MAX	Riprap	20,000	TN
RM-H9A_EFF	Riprap	8,700	TN
AD-RM-H9A	Excavation	69,100	CY
AD-1	Excavation	34,700	CY
RM-H9B	Riprap	5,000	TN
AD-RM-H9B	Excavation	31,900	CY
RM-H3A	Riprap	6,700	TN
AD-RM-H3A	Excavation	38,800	CY
RM-H3B	Riprap	6,200	TN
AD-RM-H3B	Excavation	21,800	CY
RM-H3C	Riprap	4,200	TN
AD-RM-H3C	Excavation	11,500	CY
RM-H6	Riprap	9,700	TN
AD-RM-H6	Excavation	2,900	CY
AD-RM-H6_TRANSITION	Excavation	6,000	CY
RM-H7	Riprap	85,500	TN
AD-RM-H7	Excavation	66,800	CY
RM-H10	Riprap	1,200	TN
AD-RM-H10	Excavation	5,100	CY
RM-H11	Riprap	1,000	TN
AD-RM-H11	Excavation	6,800	CY
RM-H12	Riprap	24,800	TN
AD-RM-H12	Excavation	0	CY

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4.3.3. Island Construction

Island features would address the lack of diverse habitat in the southwest portion of Pool 13. In addition to providing reduction of velocity to reach the target velocities, and creating a barrier to wind driven waves, these features also have many other habitat benefits (example island constructions shown in Figure E-7 and E-8).

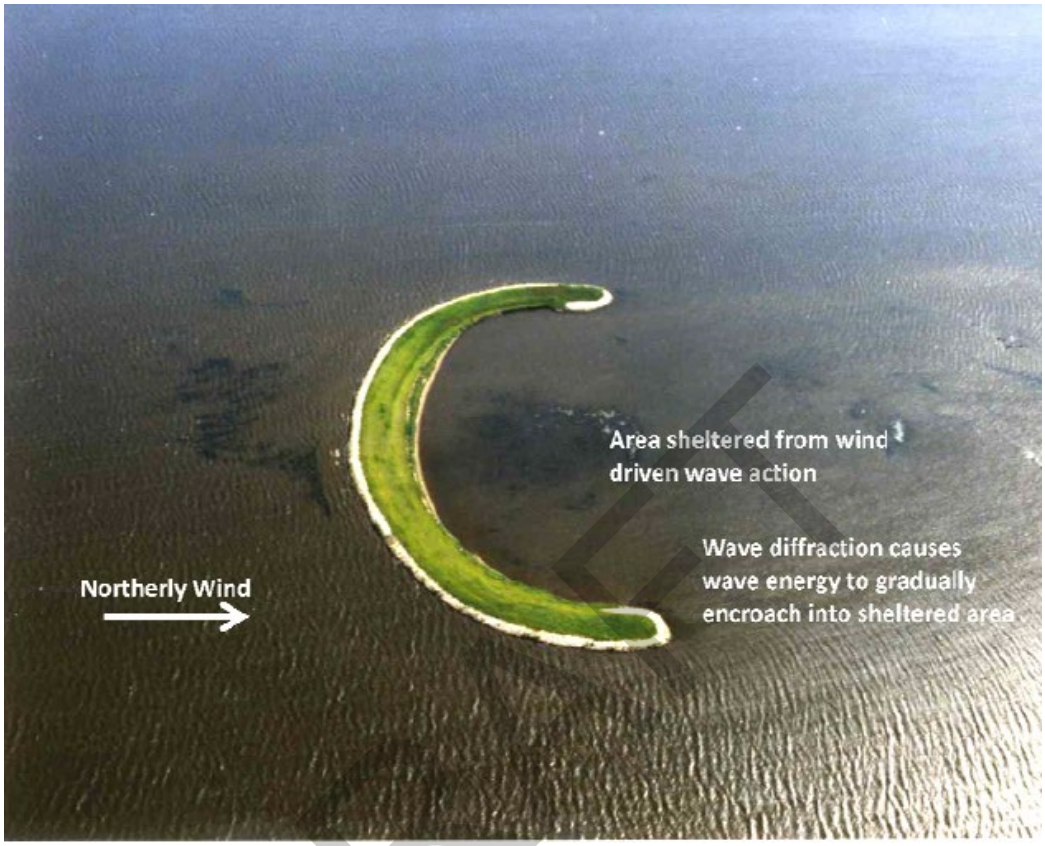

Figure E-7. Example of Reduced Wave Action and Sediment Resuspension (Source: UMRR-EMP Environmental Design Handbook, 2012)

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Figure E-8. Pool 8 Wind Barrier Islands

4.3.3.1. I-H4 Island Construction

This feature consists of a 150 foot top width sand island with a 1 foot clay or silt cap and a 10 ft wide rock protection layer on the upstream side. The proposed feature will be constructed to a target elevation of 584.86 feet, 2.5 feet above flat pool. This height was selected based on past HREP project success at this elevation (Harper's Slough Island) and FWS recommendations. The upstream slope (against the rock face) is 2 horizontal to 1 vertical, and the downstream slope is 6 horizontal to 1 vertical. This feature was proposed by the USFWS to create diverse habitat in this portion of the pool. Table E-9 summarizes the materials for this feature.

One potential construction sequence is as follows: The structure would be constructed starting along the main channel. A riprap berm would be placed on the upstream end of the proposed island. Access Dredging (AD-CV-H4) for this site would be required. Excavated material for rock placement would be placed on a barge and transported to IP-H4, IP-H5, or IP-H6. Once the rock berm was constructed, sand would be placed on the downstream side. Sand would come from a historic dredge cut in the navigation channel at approximate RM 529. Material would likely be excavated and transported to the site by barge. Transporting material through hydraulic pipes over a mile has significant loss of efficiency. Figure E-9 includes historic navigation dredge cuts near the study area.

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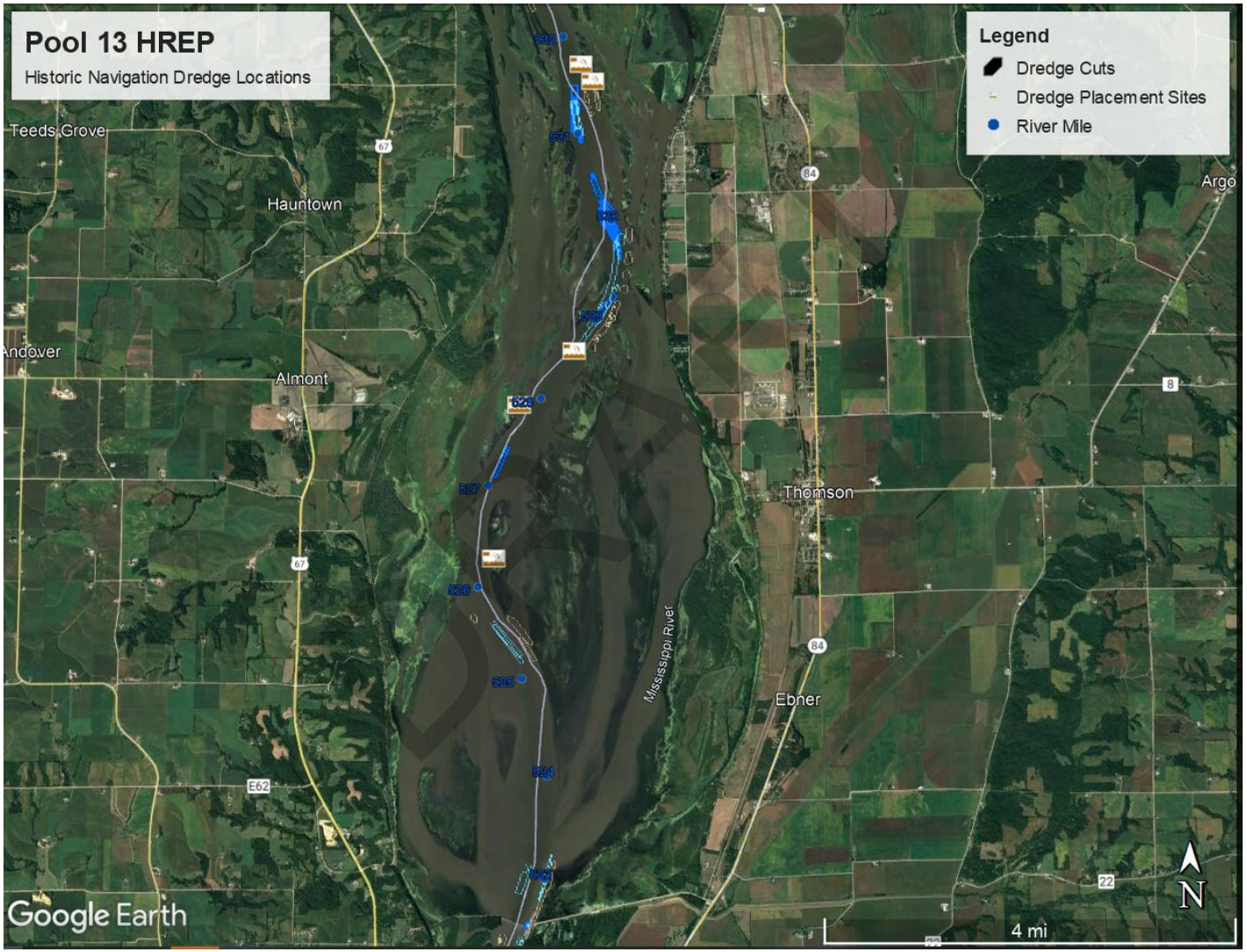

Figure E-9. Historic Navigation Dredging in Pool 13

Additional dredging (AD-I-H4) will occur on the downstream end of the island, and the excavated material would be placed as a 1 foot cap along the top of the island.

The USFWS provided the following additional benefits of the feature:

- In addition to addressing the project problems, opportunities, and objectives an earthen island would provide the following additional secondary benefits that would not be achieved with a rock mound, some of which are unquantifiable. An earthen island is anticipated to transition through different habitats throughout its 50-year design life.

- This type of feature would be more natural looking than a rock mound and is more consistent with the Refuge's Comprehensive Conservation Plan which includes the goal, "We will strive to maintain and improve scenic qualities and wild character of the Upper Mississippi River Refuge" and the guiding principles for habitat management programs (USFWS 2006). An earthen island, including shorelines protected with rock, would balance the Refuge's CCP goal and guidelines with the need to provide meaningful and effective protection of important habitat.

- An earthen island with sloping sides would provide feeding and loafing habitat for shorebirds and turtles at the edges of the island and in the shallow waters adjacent to the edges. Rock slopes are not easily accessible for some wildlife such as turtles which can become trapped in the rock voids. During some flow conditions, an earthen island may also provide some turtle nesting habitat.

- Willows, during times when they are established on the island, will provide additional wind fetch protection which in turn will benefit submersed aquatic vegetation. Feature design would include some willow and grass mix to be planted following construction to provide additional stability to the island.

- Wildlife habitats on the earthen island will be dynamic and are expected, and will be allowed to, transition to various habitats over the I-H4 feature's 50-year design life. Some examples of expected habitats for an earthen island in this location include the following:
    - Willows and grasses would provide neotropical migrant bird habitat.
    - If colonial nesting waterbirds such as American white pelicans, double-crested cormorants, ring-billed gulls, and possibly great blue herons and great egrets extensively use the earthen island, then the willow and grass habitat would likely be replaced by areas of little to no vegetative cover which would provide nesting and loafing habitat for those types of waterbirds.
    - An earthen island at this location could complement previous and future island enhancement, protection, and restoration (such as Pelican, Woodruff's, and Cormorant Islands) and associated habitats just upriver from this location.

See Appendix G, *Plates,* for the plan view and typical view of the feature.

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Table E-9. Island Construction Measure

Feature: I-H4		
Material	**Quantity**	**Units**
CV-H4 Riprap	21,700	TN
I-H4 Clay/Silt Cap	6,200	CY
I-H4 Sand	55,400	CY
AD-I-H4 Dredging/Excavation	9,400	CY
AD-CV-H4 Dredging/Excavation	10,200	CY

4.3.4. Island Erosion Protection

The intent of island protection is to shield existing islands from eroding, thereby continuing to slow velocities downstream and benefit SAV growth. These features also preserve existing island habitat, adding to the diversity of habitat and flows on the Mississippi. Examples of island protection are shown in Photographs E-5 and E-6.

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Photograph E-5. Example of Island Protection (Huron Island HREP, September 2020)



Photograph E-6. Example of Island Protection (Huron Island HREP, September 2020)

A site visit in the fall of 2020 was conducted to observe island erosion in the study area. While some locations exhibited erosion conditions, it was determined that further analysis of erosion rates and significance to habitat degradation in the study area was necessary to determine need and justification for pursuing island protection features.

An island erosion analysis was conducted utilizing photos over 19 years, corrected for the water level at the time the photo was taken, and determined that no significant erosion was occurring on the islands. Further discussion on location and screening of island protection features are included in Sections 4.3.4.1 through 4.3.4.7. If site conditions change, these islands can be reevaluated in the future.

4.3.4.1. IP-H0 Island Protection

IP-H0 is the upstream most island on the right descending bank of the navigation channel (Photograph E-7). Island Protection was considered to maintain the existing island habitat. This measure was screened based on island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts.

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Photograph E-7. IP-H0 October 2020

4.3.4.2. IP-H1 Island Protection

IP-H1 is the upstream most island on the left descending bank of the navigation channel (Photograph E-8). This island is located at a bend in the channel with deep water on the upstream end. Currently, barges run up to the island, causing sponsor concern that the island may begin eroding. IP-H1 Island protection was sited to maintain SAV beds downstream of the island. This measure was screened based on island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts.



Photograph E-8. IP-H1 (October 2020)

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4.3.4.3. IP-H2 Island Protection

IP-H2 is the second series of islands on the left descending bank (Photograph E-9). Island Protection was considered to maintain the island habitat. This measure was screened based on the island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts.



Photograph E-9. IP-H2 (October 2020)

4.3.4.4. IP-H3A Island Protection

IP-H3A Island Protection was considered to maintain the existing island habitat. This feature also protects existing wild celery beds downstream and provided the opportunity for TSI measures. This measure was screened based on the island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts.

4.3.4.5. IP-H3B Island Protection

IP-H3B Island Protection was considered to maintain the island habitat. This feature also protects existing wild celery beds downstream and provided the opportunity for TSI measures. This measure was screened based on the island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts.

Based on the island erosion analysis there was no significant rate of erosion found in order to justify feature

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4.3.4.6. IP-H3C Island Protection

IP-H3C Island Protection was considered to maintain the existing island habitat (Photograph E-10). This feature also protects existing wild celery beds downstream and provided the opportunity for TSI measures. This measure was screened based on the island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts.



Photograph E-10. IP-H3 (October 2020)

4.3.4.7. IP-H4 Island Protection

IP-H4 is located on the right descending bank and has been a historic placement location for dredge material, also known as Cormorant Island (Photograph E-11). This feature was considered to maintain the existing habitat, protect wild celery beds downstream, and to provide for TSI measures. This feature was screened based on the island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts. However, it was retained as an island placement site for the access dredge material from feature construction. See Section 4.5.1, *Cormorant Island Placement Site*, for additional details.



Photograph E-11. IP-H4 (October 2020)

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4.3.4.8. IP-H5 Island Protection

IP-H5 is located on the right descending bank and has been a historic placement location for dredge material, also known as Gomer Island (Photograph E-12). This feature was considered to maintain the existing habitat, protect wild celery beds downstream, and to provide for TSI measures. This feature was screened based on the island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts. However, it was retained as an island placement site for the access dredge material from feature construction. See Section *4.5.2, Gomer's Island Placement Site* for additional details.



Photograph E-12. IP-H5 (October 2020)

4.3.4.9. IP-H6 Island Protection

IP-H6 is located on the right descending bank and has been a historic placement location for dredge material, also known as Woodruff Island. This feature was considered to maintain the existing habitat, protect wild celery beds downstream, and to provide for TSI measures. This feature was screened based on the island erosion analysis, site visit observations, data research, and rescoping/prioritization efforts. However, it was retained as an island placement site for the access dredge material from feature construction. See, *4.5.3. Woodruff Island Placement Site,* for additional details. See example bankline protection in Photograph E-13.

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Photograph E-13. Bankline Protection (Beaver Island HREP, July 2019)

4.3.4.10. IP-H7 Island Protection

IP-H7 Island Protection was considered to maintain the existing conditions and island habitat. This measure was screened based on the site visit observations, data research, and rescoping/prioritization efforts.

4.3.4.11. IP-H8 Island Protection

IP-H8 Island Protection was considered to protect the head of the existing island and maintain the existing vegetation beds. This measure was screened based on the site visit observations, data research, and rescoping/prioritization efforts.

4.3.4.12. IP-H9 Island Protection

IP-H9 Island Protection was considered to protect the head of the existing island and maintain the existing vegetation beds. This measure was screened based on the site visit observations, data research, and rescoping/prioritization efforts.

4.4. Access Dredging

Access dredging is necessary for construction of the project features. The minimum bottom elevation for access dredging is 574.36 ft (NAVD88). Dredge cuts are designed with a bottom width of 50 ft, side slopes of 4H:1V, at least 25 ft from the toe of the constructed features. Material is assumed to consist of a mixture of clay and silt and will be barged to the disposal sites upstream. Example access dredging is shown in Photographs E-14 through E-17.

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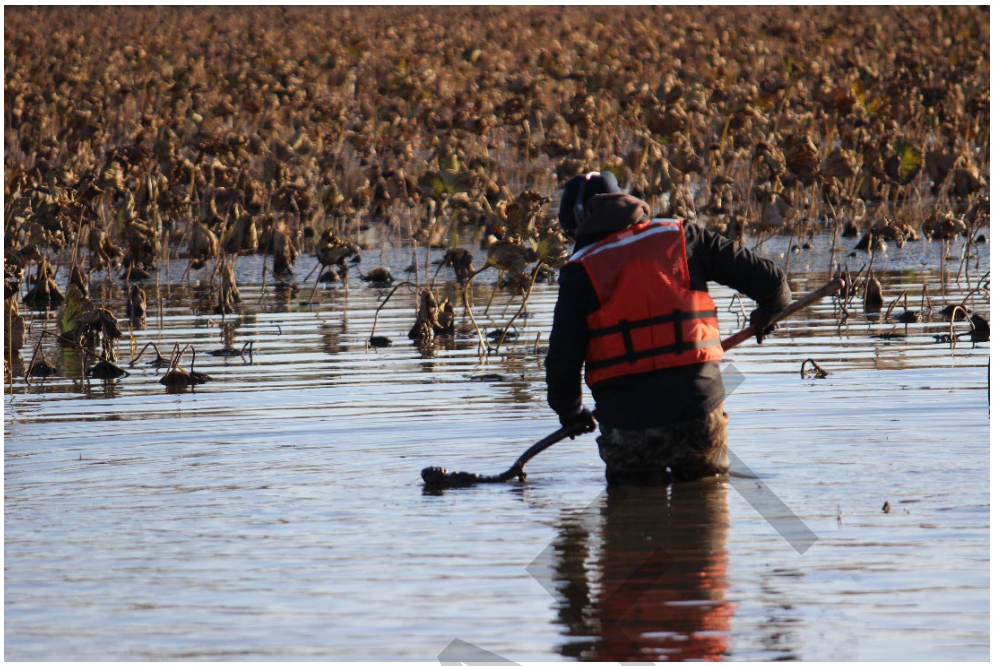

Photograph E-14. Shallow Water Requiring Access Dredging (October 2020)



Photograph E-15. Excavator Removes Material and Places in Hopper Barge (Beaver Island 2019)

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Photograph E-16. Access Dredging Will Excavate Material and Place Into a Hopper Barge (Beaver Island HREP, October 2021)

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Photograph E-17. Material Is Lifted From Hopper Barge and Placed at Final Placement Site (Beaver Island HREP, October 2020)

4.5. Dredge Material Placement Sites

Three placement sites were identified as desirable locations for access dredge material placement. This material provides a secondary benefit as island habitat for colonial nesting birds and in restoring historic island footprints (Photographs E-18 through E-20).



Photograph E-18. Nesting Bird Habitat on islands that have received dredged material in Lower Pool 13 (October 2020)



Photograph E-19. Buttonbush on Dredged Material Islands, Lower Pool 13 (October 2021)

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Photograph E-20. Nests on Cormorant Island (October 2021)

The dredge material will be placed on the disposal sites to a top elevation of 586.00 NAVD88 (corresponding to the 0.2 AEP event). This is similar to the design elevation of Pelican Island which has been successful in providing nesting habitat. Side slopes were set at 1V:4H for stability and to prevent sloughing. Dredged material placement sites will be designed further during PED, ensuring that once the material is placed it will not migrate off site. Slopes may be flattened and/or protection of slopes may be required based on further analysis. Dredge disposal site capacity is 858,600 CY. Total anticipated access dredging quantity for the TSP is 255,600 CY. The site footprints as identified in early iterations to match historic island footprints and sites will be refined during design.

Double-crested cormorants (Phalocrocorax auritus) & American white pelicans (Pelicanus erythrorhynchos) are the two species of colonial nesting birds that are most likely to utilize these islands for nesting. Pelicans are a ground-nesting species and cormorants will nest on the ground when suitable trees are not available. Over time, if trees are able to establish, egret and heron species may also utilize these islands.

4.5.1. Cormorant Island Placement Site

Cormorant Island Placement Site, previously evaluated as an Island Protection feature (IP-H4), is the most upstream placement site evaluated. This site has been used as a dredge placement site for navigation dredging in the past. This placement site is the lowest priority out of the three sites.

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4.5.2. Gomer's Island Placement Site

Gomer's Island Placement Site, previously evaluated as an Island Protection feature (IP-H5), is situated just downstream of the Cormorant Island Placement Site. Gomer's Island Placement Site is the second priority out of the three sites.

4.5.3. Woodruff Island Placement Site

Woodruff Island Placement Site, previously evaluated as an Island Protection feature (IP-H6), is situated just downstream and on the opposite side of the channel of the Gomer's Island Placement Site. Woodruff Island Placement Site is the highest priority out of the three sites.

The three potential dredged material placement sites and proposed quantities are summarized in Table E-10.

Table E-10. Dredged Material Placement Sites

Dredge Disposal Site	Quantity	Units
Cormorant Island Placement Site	149,800	CY
Gomer's Island Placement Site	504,000	CY
Woodruff Island Placement Site	204,800	CY

4.6. Timber Stand Improvement (TSI)

TSI measures would address the identified floodplain forest problems and restoration objectives related to lack of diversity and loss of spatial extent by enhancing the age, composition, and structure of the existing forest. The forest inventory results and more details on the TSI prescriptions are included in Appendix A, *Environmental*, Attachment F, *Forest Inventory Data & Prescription.* The PDT used the Floodplain Forest model, to evaluate the following measures.

4.6.1. TSI-H1-MAX Timber Stand Improvement

TSI-H1-MAX identified approximately 294 acres to receive timber stand improvement. Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment. The target for tree thinning is to release good form understory trees and increase light by cutting stressed and poor in growth form understory and midstory trees. Thinning will be uneven; some areas require no thinning due to open canopy conditions. Tree plantings will focus on increasing species and age diversity in areas where gaps in the canopy exist. Shrub plantings target positive impacts to pollinator species and migratory bird use during fall migration. Tree and/or shrub planting efforts are primarily intended to be conducted using containerized stock. Invasive species treatment will include fall and spring season herbicide application to reed canary grass in canopy gaps.

4.6.2. TSI-H1-EFF Timber Stand Improvement

The Efficient Alternative treatment identifies the minimum effort to improve forest growth over

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the next 50 years. TSI-H1-EFF is over the same area as TSI-H1-MAX but has a reduction in suppressed tree cutting, reduction in planting stock size for the trees, reduction in treatments including and the quantity of understory shrubs, reduction in reed canary grass treatment area, and does not include herbaceous plant planting for improved benefits of pollinator species. The location of TS-H1 is shown in Figure E-10.



Figure E-10. TSI-H1 Location

4.6.3. TSI-H2-MAX Timber Stand Improvement

TSI-H2-MAX identified approximately 241 acres to receive timber stand improvement. Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment, similar to TSI-H1-MAX.

4.6.4. TSI-H2-EFF Timber Stand Improvement

Differences in the maximum and efficient alternatives for TSI-H2-EFF are the same as those for TSI-H1-MAX and TSI-H1-EFF.

The location of TSI-H2 is shown in Figure E-11.

Example TSI activities are shown in Photographs E-21 through E-27.

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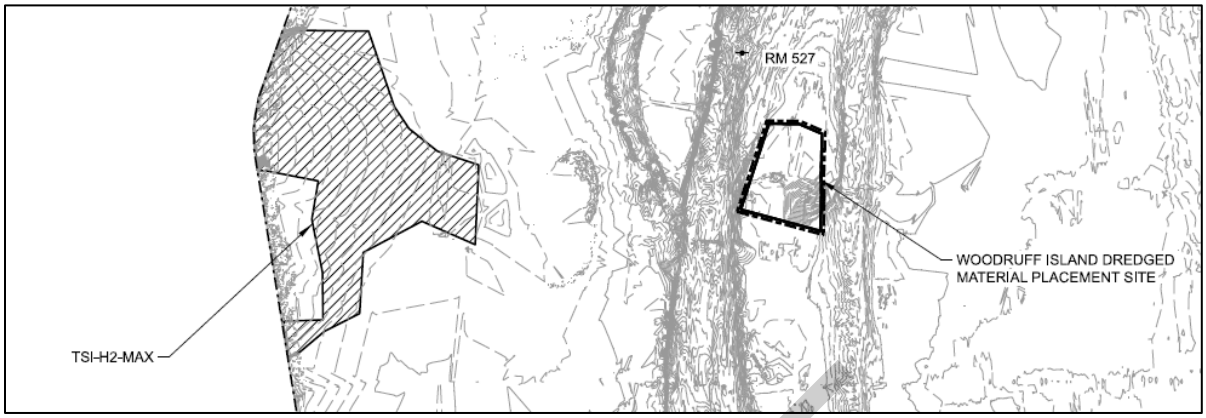

Figure E-11. TSI-H2 Location



Photograph E-21. Thinning treatment at Beaver Island HREP, March 2021



Photograph E-22. Double Girdle at Beaver Island HREP, April 2022



Photograph E-23. Stump Sprout at Beaver Island HREP November 2021



Photograph E-24. Stump Sprouts at Beaver Island HREP November 2021



Photograph E-25. Canopy Opened at Beaver Island HREP November 2021

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Photograph E-26. Trees Cleared To Open Canopy Around Existing Pin Oak Tree at Beaver Island HREP November 2021



Photograph E-27. Tree Planting in Area Where Canopy Was Opened at Beaver Island HREP
November 2021

4.7. Aquatic Habitat Restoration

Aquatic habitat restoration features that were considered included excavation for overwintering habitat, closure structures, and berm construction. Significant factors contributing to the value of winter bluegill habitat on the UMRS include water depth, dissolved oxygen (DO), water temperature, and current velocity. The features mentioned would create desirable habitat by ensuring adequate depth for fish and other aquatic species to survive during the winter, reducing velocities, and sedimentation to ensure the longevity of the overwintering dredge cuts.

However, based on project priorities and narrowing the Study Area, all of these features were screened. Further details pertaining to each feature are found in Sections 4.7.1. through 4.7.3

4.7.1. 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 would also provide material to increase topographic diversity within the floodplain forest. Several potential areas in the Study Area were evaluated for excavation.

4.7.1.1. DR-H1 Dredge Cut

DR-H, also known as Upper Gomer's Lake Dredge Cut, was intended to provide overwintering habitat. This feature was screened because its success was determined to be lower than other more optimum locations.

4.7.1.2. DR-H2 Dredge Cut

DR-H2, also known as Penguins Dredge Cut, was intended to provide overwintering habitat. This feature was screened because its success was determined to be lower than other more optimum locations. This location was already performing favorably for overwintering habitat.

4.7.1.3. DR-H3 Dredge Cut

DR-H3, also known as Upper Willow Access, was intended to provide overwintering habitat. This feature was screened due to rescoping and prioritization of the southwest portion of the pool.

4.7.1.4. DR-H4 Dredge Cut

DR-H4, also known as Middle Gomers Lake Dredge Cut, was intended to provide overwintering habitat and aquatic diversity. Dredge material would have been used to construct flow diversion berms. Access to this area requires the Lower Gomers Lake Dredge Cut or the Lower Willow Access Dredge Cut. This feature was screened due to rescoping and prioritization of the southwest portion of the pool.

4.7.1.5. DR-H5 Dredge Cut

DR-H5, also known as Lower Willow Access, was intended to provide overwintering habitat. This feature was screened due to rescoping and prioritization of the southwest portion of the pool.

4.7.1.6. DR-H6 Dredge Cut

DR-H6, also called Lower Gomers Lake, was intended to provide overwintering habitat and aquatic diversity. Dredge material would have been used to construct flow diversion berms. This feature was screened due to rescoping and prioritization of the southwest portion of the pool.

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4.7.1.7. DR-H7 Dredge Cut

DR-H7, also known as Lock Dredge Cut West, was intended to provide overwintering habitat. This feature was screened because its success was determined to be lower than other more optimum locations and prioritization of the southwest portion of the pool.

4.7.1.8. DR-H8 Dredge Cut

DR-H8, also known as Lock Dredge Cut East, was intended to provide overwintering habitat. This feature was screened because its success was determined to be lower than other more optimum locations and prioritization of the southwest portion of the pool.

4.7.2. Closure Structures

Closure structures were proposed to reduce velocities and therefore reduce sediment input.

4.7.2.1. CL-H1 Closure Structure

CL-H1 was considered to reduce velocities and replicate downstream islands to promote SAV growth. This feature was screened due to an anticipated lack of benefits in this location since existing SAV beds were already doing well. Other screening considerations included floodplain concerns and a dependency on CL-H3.

4.7.2.2. CL-H2 Closure Structure

CL-H2 was considered to reduce velocities and replicate downstream islands to promote SAV growth. This feature was screened due to an anticipated lack of benefits in this location since existing SAV beds were already doing well.

4.7.2.3. CL-H3 Closure Structure

CL-H3 was considered to reduce velocities and replicate downstream islands to promote SAV growth. This feature was screened due to an anticipated lack of benefits in this location since existing SAV beds were already doing well. Other screening considerations included floodplain concerns and a dependency on CL-H1.

4.7.3. Diversion Berms

Diversion Berms have been proposed as a potential measure to improve aquatic habitat by deflecting sediment and reducing flows in the Study Area. Berms are generally constructed with soils and rock, though new design concepts involving woody material are being developed. Berms also present a beneficial use opportunity via utilization of excavated material.

4.7.3.1. Flow Diversion Berm Upper

This measure includes the construction of a diversion berm to protect the shoreline adjacent to Upper Gomers Lake Dredge Cut and direct flows back to the channel.

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4.7.3.2. Flow Diversion Berm Middle

This structure is a chevron that would protect a large bed of aquatic vegetation from high flows and sediment dispersion.

4.7.3.3. SAV Flow Diversion Berm

This feature consists of constructing a chevron shaped berm at the northern end of a large area of SAV. This feature would redirect flows around the SAV, reducing water velocities and turbidity, thus creating better growth and sustainment conditions for the SAV.

4.7.3.4. BR-H1 Berm

The intent of this proposed feature was to act as a sediment barrier. This feature would aim at controlling sediment influx into the complex and catching sediment buildup on the structure. Sediment that does make it into the backwater would then be filtered by the wetland. This feature was screened due to prioritization of the southwest portion of the pool.

4.7.3.5. BR-H2 Berm

The intent of this proposed feature was to protect the head of an existing island and maintain the vegetation bed downstream of the island. This feature was reconsidered and broken in to IP-H8 and IP-H9.

4.7.3.6. BR-H3 Berm

The intent of this proposed feature was to act as a sediment barrier and create flow diversity. This feature was screened due to constructability and cost concerns as well as a determination to prioritize other features and portions of the pool.

4.7.3.7. BR-H4 Berm

The intent of this proposed feature was to act as a sediment barrier and create flow diversity. This feature was reconsidered and moved forward as a willow filter (WF-H2). It was then screened due to re-scoping and prioritization of other features and portions of the pool.

4.7.3.8. BR-H5 Berm

The intent of this proposed feature was to act as a sediment barrier to protect a dredge cut feature and to protect existing vegetation. This feature was screened due to prioritization of the southwest portion of the pool.

4.8. Alternatives

Refer to Main Report Section 4, *Formulation of Project Alternatives,* for the list of alternatives were evaluated and Section 5, *Evaluation and Comparison of Alternatives,* for the CE-ICA comparison of the alternatives. Table E-11 includes the features carried forward as part of one

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or multiple alternatives are included in Table E-11.

Table E-11. Project Features Evaluated for CE-ICA

Item No.	Description	Qty	Unit
I-H4	Riprap	21,700	CY
I-H4	Sand	55,400	CY
I-H4	Clay/Silt Cap	6,200	CY
CV-H6	Riprap	8,500	TN
CV-H10	Riprap	7,900	TN
RM-H9A_MAX	Riprap	12,800	TN
RM-H9A_EFFICIENT	Riprap	6,000	TN
RM-H9B	Riprap	5,000	TN
RM-H3A	Riprap	6,700	TN
RM-H3B	Riprap	6,200	TN
RM-H3C	Riprap	4,200	TN
RM-H12	Riprap	14,300	TN
RM-H7	Riprap	85,500	TN
RM-H10	Riprap	1,200	TN
RM-H11	Riprap	1,000	TN
AD-CV-H4	Excavation/Dredging	19,600	CY
AD-CV-H6	Excavation/Dredging	7,400	CY
AD-RM-H9A	Excavation/Dredging	69,100	CY
AD-RM-H9B	Excavation/Dredging	31,900	CY
AD-RM-H3A	Excavation/Dredging	38,800	CY
AD-RM-H3B	Excavation/Dredging	21,800	CY
AD-RM-H3C	Excavation/Dredging	11,500	CY
AD-RM-H6	Excavation/Dredging	2,900	CY
AD-RM-	Excavation/Dredging	6,000	CY
AD-RM-H7	Excavation/Dredging	66,800	CY
AD-RM-H10	Excavation/Dredging	5,100	CY
AD-RM-H11	Excavation/Dredging	6,800	CY
AD-1	Excavation/Dredging	34,700	CY
AD-CV-H10	Excavation/Dredging	13,400	CY
AD-RM-H12	Excavation/Dredging	0	CY
IP-H4 Cormorant Island	Dredged Material	149,800	CY
IP-H5 Gomers Island Placement	Dredged Material	504,000	CY
IP-H6 Woodruff Island	Dredged Material	204,800	CY

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5. TENTATIVELY SELECTED PLAN

The tentatively selected plan is described in Section 7, *Tentatively Selected Plan*.

6. VALUE ENGINEERING STUDY

The VE study shall be completed in compliance with ER 11-1-321. The VE study will be conducted during the design stage.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT A
HYDROLOGY AND HYDRAULICS

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APPENDIX E
ENGINEERING APPENDIX

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1. INTRODUCTION

The following sections detail the hydraulic and hydrologic analysis completed for the Lower Pool 13 HREP Feasibility Study. Please refer to main report for the study description.

Initial hydraulic rise modeling has been completed to determine floodplain impacts of the proposed work. That analysis is not detailed within this appendix attachment, but is available in a separate memo.

1.1 Vertical Datum

All elevations used in this appendix are expressed using the NAVD88 vertical datum unless otherwise stated. For hydraulic modeling, conversions between MSL12 and NAVD88 vertical datums is provided in Appendix E, *Engineering*, Attachment E, *Survey, Mapping, and Geospatial Data*

2. CLIMATE

Monthly climate data for the Clinton #1 U.S. Cooperative Network Station (gage #131635) from the Midwestern Regional Climate Center is summarized in Tables A-1 and A-2 (Midwestern Regional Climate Center, 2022). The data for precipitation, snowfall and temperature below is from the most recent 30-year period, 1990-2019.

Table A-1. Average and Extremes of Monthly Precipitation and Snowfall (COOP gage #131635)

	Precipitation						Snow		
	Average	Maximum		Minimum			Average	Maximum	
Month	(in)	(in)	Year	(in)	Year		(in)	(in)	Year
Jan	1.46	2.84	1999	0.37	2018		9.5	21.2	2019
Feb	1.71	3.33	2001	0.26	1991		7.7	27.0	2008
Mar	2.34	5.27	1991	0.58	2014		3.8	13.3	1999
Apr	3.44	7.55	2013	0.63	2018		0.7	5.9	1997
May	4.35	12.35	1996	0.74	1992		0.0	0.0	
Jun	5.14	14.63	1990	0.97	1992		0.0	0.0	
Jul	3.86	8.75	1992	0.15	1991		0.0	0.0	
Aug	4.38	8.76	1993	1.10	2013		0.0	0.0	
Sep	3.44	9.69	2019	0.33	2017		0.0	0.0	
Oct	2.64	5.92	2018	0.29	2005		0.3	5.2	2019
Nov	2.23	6.74	2015	0.26	2007		2.2	15.1	2018
Dec	1.90	4.71	2015	0.48	1995		8.3	25.6	2000
Annual	**36.78**						**31.53**		

Fluctuation of temperatures in east-central Iowa can be extreme, evidenced by a minimum monthly temperature of -29° F in February and a maximum monthly temperature of 103° F in July. Precipitation is moderate with an average annual value of 36.78 inches. The average annual snowfall is 31.53 in.

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Table A-2. Average and Extremes of Monthly Temperature (COOP gage #131635)

Month	Average (°F)	Maximum (°F)	Minimum (°F)
Jan	22.28	62	-29
Feb	26.67	73	-29
Mar	38.95	83	-15
Apr	51.38	89	14
May	62.29	94	24
Jun	71.31	96	39
Jul	74.54	103	49
Aug	72.49	99	45
Sep	65.67	98	29
Oct	53.38	91	18
Nov	39.53	79	2
Dec	27.60	70	-19
Annual	**50.49**		

3. HYDROLOGY AND HYDRAULICS OVERVIEW

3.1 Historic and Current Mississippi River Hydrology

Table A-3 shows a summary of the nearby gages and their characteristics. The District records continuous stages and computed flows at L&D 12 (Bellevue, IA) and L&D 13 (Fulton, IL). Historic stage data is available at Sabula, IA. The L&D13 gage (RM 522.4) with a drainage area of 85,500 square miles, is closest to the study area (USACE, 2022).

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Table A-3. Summary of Available Stream Gages

Gage Name	River Mile	Drainage Area (sq. miles)	Gage Zero Elevation (ft MSL12)	Gage Zero Elevation (ft NAVD88)	Period of Record	Flat pool stage (ft)	Flat pool elevation (ft MSL12)	Flat pool elevation (ft NAVD88)	Available data
Mississippi River at L&D 12, Bellevue, IA	556.7	82,400	580.2	579.5	1936- present	11.8	592.0	591.3	Stage and computed flow
Mississippi River at Sabula, IA	535		572.3	571.6	1881-2010				Stage -historic
Mississippi River at L&D 13, Fulton, IL	522.4	85,500	568.7	568.1	1937-present	14.3	583.0	582.4	Stage and computed flow

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L&D 13 is a low-head navigation dam and is not operated for flood control. This means that the primary purpose of the dam is to maintain sufficient depth for commercial navigation. When inflows exceed capacity of the dam (131,000 cfs), the gates are lifted out of the water and the river is allowed to run its course. Per “Water Control Manual, Lock and Dam No. 13” (USACE, 1996), Pool 13 is regulated at Lock and Dam 13 (dam control point) with a 6-inch operation band. During the winter, a 1-foot operation band is authorized, but not typically conducted. Authorized elevations are listed below:

- Flat pool: 583.0 ft MSL12 (582.4 ft NAVD88)
- Normal operation band: 582.6-583.1 ft MSL12 (582.0–582.5 ft NAVD88)
- Winter operation band: 582.0–583.0 ft MSL12 (581.4–582.4 ft NAVD88)

Figure A-1 shows average annual elevation hydrographs for Lock and Dam 13 (Fulton, IL) pool gage and Lock and Dam 12 (Bellevue, IA) tail gage. Hydrographs were developed with data from 1990–2019. The LD 13 pool gage is immediately downstream of the study area and is strongly influenced by regulation of the dam. The L&D 12 tail gage illustrates spring/summer flooding (typically peaking in late April), a slight pulse of higher flows in the fall, followed by more stable flows through the winter.

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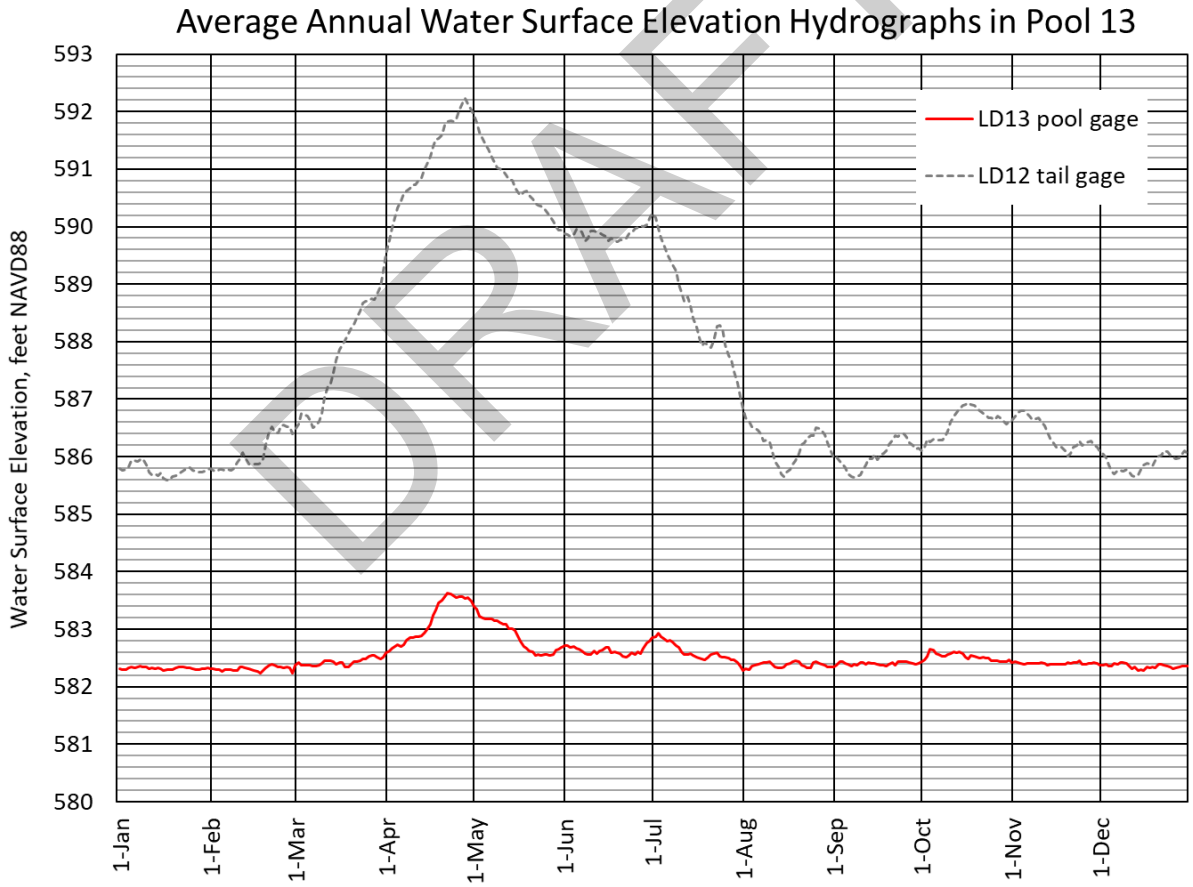

Figure A-1. Average Annual Elevation Hydrographs for Lock and Dam 13 (Fulton, IL) Pool Gage and Lock and Dam 12 (Bellevue, IA) Tail Gage (1990-2019)

3.2 Mississippi River Flow Duration

Table A-4 and Figure A-2 show flow duration curves for the most recent 30-year period (1990–2019) for (1) all data and (2) only May 1–September 30 data at the Lock and Dam 13, Fulton, IL gage. The period from 1990–2019 was selected to characterize existing conditions and as the basis for design. This most recent 30-year period was selected because it is considered short enough to represent a stationary dataset (i.e., statistical properties of the data are not anticipated to change over time) and long enough to provide a representative sample size to adequately represent the population. The curve developed with May 1–September 30 data describes flows pertinent to the wild celery growing season. The median (50% exceedance duration) flow for all months is 50,900 cfs and the median flow for May 1–September only is 55,500.

Table A-4. Flow Duration Curves at L&D 13 Developed from (1) All Data 1990–2019 and (2) May 1–September 30 1990–2019

% days exceeded	Discharge, cfs		% days exceeded	Discharge, cfs	
	All data	May 1–Sept 30		All data	May 1–Sept 30
99.90%	11,200	10,900	35%	67,300	84,900
99.50%	14,900	14,400	30%	75,100	92,700
99%	17,700	17,800	25%	84,400	99,500
98%	20,000	20,100	20%	93,500	106,600
97%	21,100	21,400	15%	103,300	115,800
96%	22,100	22,600	10%	117,200	130,100
95%	23,100	23,600	9%	120,600	133,000
94%	23,800	24,700	8%	125,300	137,400
93%	24,600	25,600	7%	131,000	141,000
92%	25,200	26,500	6%	136,900	147,600
91%	25,900	27,200	5%	143,800	154,600
90%	26,600	28,000	4.5%	147,900	158,800
85%	29,400	32,700	4%	152,100	161,000
80%	32,300	37,600	3.5%	157,700	163,200
75%	34,600	42,000	3%	161,100	167,800
70%	37,300	46,300	2.5%	165,500	173,400
65%	40,200	51,100	2%	173,100	181,200
60%	43,300	55,500	1.5%	183,300	195,100
55%	46,500	59,800	1%	202,300	210,500
50%	50,900	64,900	0.5%	224,200	234,200
45%	55,600	70,300	0.1%	244,600	244,400
40%	61,000	77,000			

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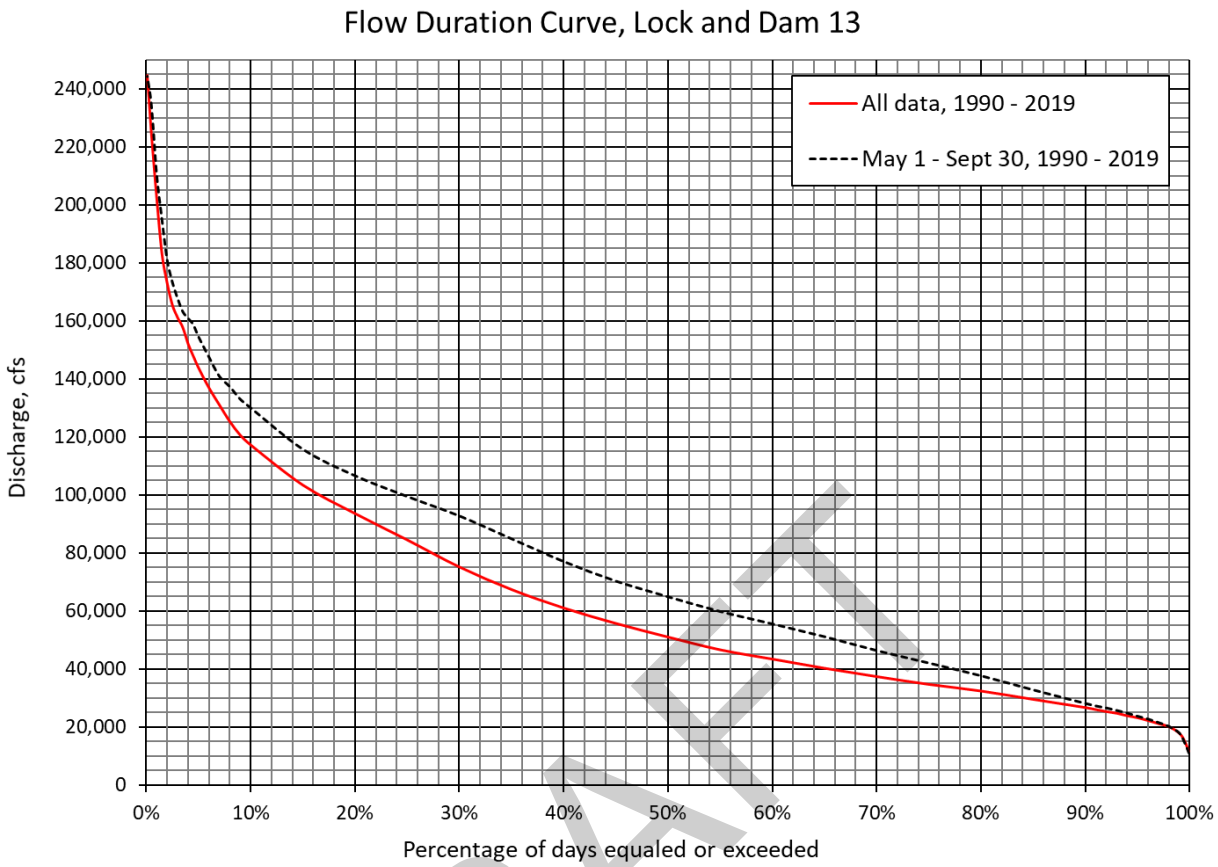

Figure A-2. Flow Duration Curves at L&D 13.

Duration curve developed from all data 1990–2019 is shown in red. Duration curve developed from May 1–September 30 1990–2019 is shown in black (dashed).

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3.3 Mississippi River Elevation Duration

Table A-5 and Figure A-3 show elevation duration curves for the most recent 30-year period (1990–2019) for (1) all data and (2) only May 1–September 30 data at the Lock and Dam 13, Fulton, IL pool gage. Years and months for these analyses were determined for the same reasons as the flow exceedance duration analyses. Because water surface elevations at are regulated immediately upstream of Lock and Dam 13 most of the year, the median (50% exceedance duration) water surface elevation is 582.39 ft NAVD88 for both the all months analysis and the May 1–September 30 analysis. Differences between the two curves occur primarily above the 10% exceedance duration elevation.

Table A-5. Elevation Duration Curves at L&D 13 (pool) Developed from (1) All data 1990–2019 and (2) May 1–September 30 1990–2019. Elevations in NAVD88 vertical datum.

% Days Exceeded	Elev, ft NAVD88		% Days Exceeded	Elev, ft NAVD88	
	All Months	May 1-Sept 30		All Months	May 1-Sept 30
99.90%	581.36	581.25	35%	582.45	582.46
99.50%	581.75	581.54	30%	582.48	582.49
99%	581.86	581.85	25%	582.52	582.53
98%	581.95	581.96	20%	582.56	582.58
97%	581.99	582.00	15%	582.61	582.64
96%	582.01	582.03	10%	582.69	582.76
95%	582.03	582.04	9%	582.71	582.80
94%	582.05	582.07	8%	582.75	582.90
93%	582.07	582.08	7%	582.80	583.17
92%	582.09	582.10	6%	582.95	583.55
91%	582.11	582.11	5%	583.30	584.06
90%	582.12	582.13	4.5%	583.58	584.24
85%	582.18	582.18	4%	583.93	584.35
80%	582.22	582.22	3.5%	584.20	584.66
75%	582.26	582.25	3%	584.44	585.02
70%	582.29	582.28	2.5%	584.87	585.38
65%	582.31	582.31	2%	585.42	585.98
60%	582.34	582.34	1.5%	586.17	587.02
55%	582.36	582.36	1%	587.62	588.07
50%	582.39	582.39	0.5%	589.20	589.89
45%	582.41	582.41	0.1%	590.61	590.60
40%	582.43	582.44			

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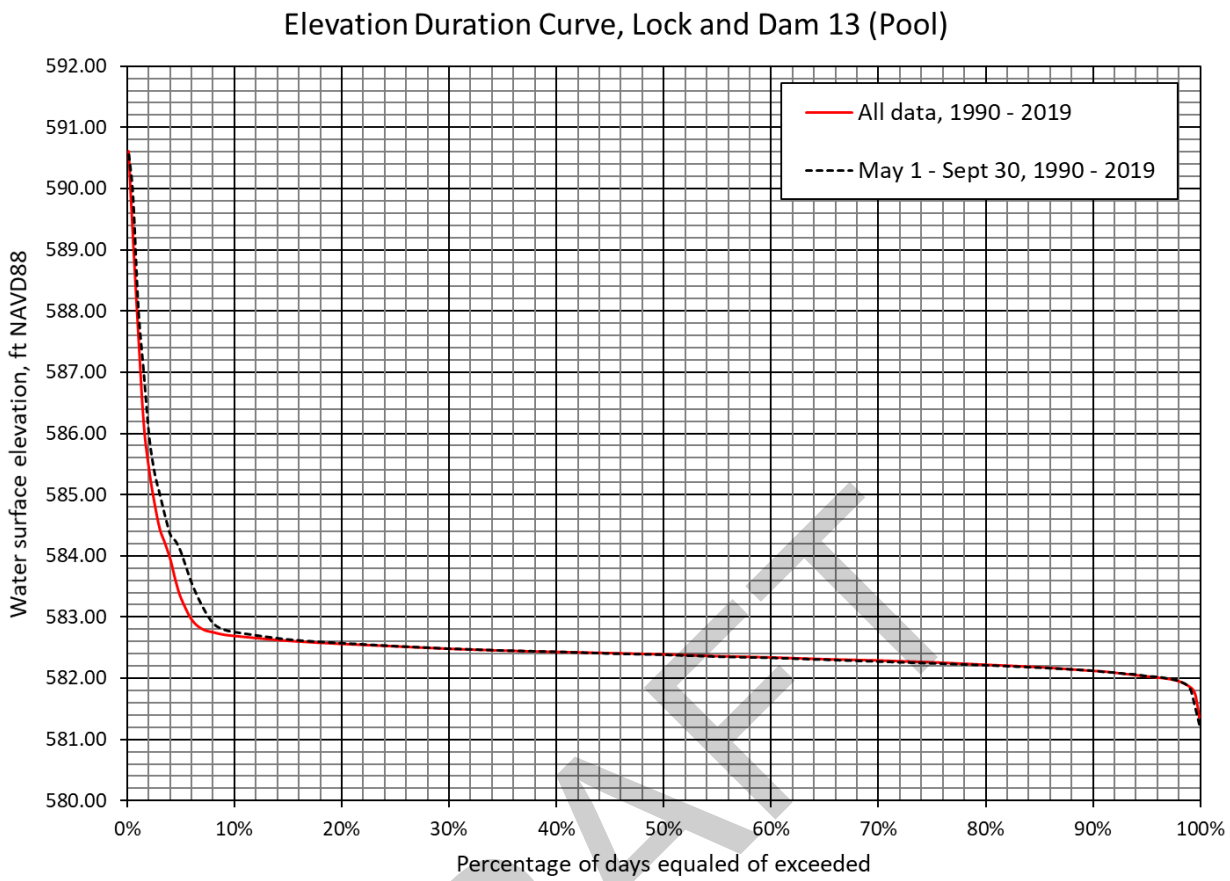

Figure A-3. Elevation Duration Curves at L&D 13.

Duration curve developed from all data 1990–2019 is shown in red. Duration curve developed from May 1–September 30 1990–2019 is shown in black (dashed).

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3.4 Mississippi River Flood Conditions

Table A-6 lists the 15 highest water events at the Mississippi River at L&D 13, Fulton, IL gage; the highest flood on record occurred in late April 1965 and resulted in a water surface elevation of 592.85 feet NAVD88 (24.75 feet of stage).

The 2004 Upper Mississippi River System Flow Frequency Study (UMRSFFS) includes several cross sections through the study area (USACE, 2004). Table A-7 shows results from the 2004 UMRSFFS that pertain to the study area and nearby gages.

Table A-6. Record High Stages at Mississippi River at L&D 13, Fulton, IL Gage

Stage (ft)	Water Surface Elevation (ft NAVD88)	Date
24.75	592.9	4/28/1965
23.31	591.4	4/24/2001
22.17	590.3	7/8/1993
21.77	589.9	4/30/2019
21.37	589.5	4/26/1969
21.23	589.3	4/27/1952
21.06	589.2	4/21/2011
21.00	589.1	4/26/1951
20.72	588.8	4/19/1997
20.35	588.5	5/7/1975
19.95	588.1	3/25/1973
19.86	588.0	4/15/1967
19.66	587.8	10/6/1986
19.27	587.4	7/3/2014
19.08	587.2	6/16/2008

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Table A-7. 2004 Upper Mississippi River System Flow Frequency Study–Water Surface Elevations (WSE) and Discharges Corresponding to Each Annual Exceedance Probability (AEP) (USACE, 2004)

River Mile	0.5 AEP		0.2 AEP		0.1 AEP		0.04 AEP		0.02 AEP		0.01 AEP		0.005 AEP		0.002 AEP	
	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)
522.6	582.4	131,000	585.1	174,000	587.3	202,000	589.8	235,000	591.5	259,000	593.1	283,000	594.3	306,000	595.6	337,000
522.7	582.4	131,000	585.2	174,000	587.4	201,000	589.8	235,000	591.5	259,000	593.1	283,000	594.3	306,000	595.6	337,000
522.8	582.5	131,000	585.3	174,000	587.4	201,000	589.9	235,000	591.6	259,000	593.2	283,000	594.4	306,000	595.6	337,000
523.1	582.6	131,000	585.4	174,000	587.5	201,000	590.0	235,000	591.7	259,000	593.3	283,000	594.4	306,000	595.7	337,000
523.6	582.7	131,000	585.4	174,000	587.6	201,000	590.0	235,000	591.7	259,000	593.3	283,000	594.5	306,000	595.7	337,000
524	582.8	131,000	585.5	174,000	587.6	201,000	590.1	235,000	591.8	259,000	593.3	283,000	594.5	306,000	595.7	336,000
524.5	583.0	131,000	585.6	174,000	587.7	201,000	590.1	235,000	591.8	259,000	593.4	283,000	594.5	306,000	595.8	336,000
525	583.2	131,000	585.7	174,000	587.7	201,000	590.2	235,000	591.8	259,000	593.4	283,000	594.5	306,000	595.8	336,000
526	583.4	131,000	585.8	174,000	587.8	201,000	590.3	235,000	591.9	259,000	593.4	283,000	594.6	306,000	595.8	336,000
526.6	583.6	131,000	586.0	174,000	587.9	201,000	590.3	235,000	591.9	259,000	593.5	283,000	594.6	306,000	595.9	336,000
527	583.8	131,000	586.1	174,000	588.0	201,000	590.4	235,000	592.0	259,000	593.5	283,000	594.6	306,000	595.9	336,000
528	584.0	131,000	586.2	174,000	588.1	201,000	590.4	235,000	592.0	259,000	593.5	283,000	594.7	306,000	595.9	336,000
528.5	584.3	131,000	586.4	174,000	588.2	201,000	590.5	235,000	592.1	259,000	593.6	282,000	594.7	306,000	596.0	336,000
529	584.4	131,000	586.6	174,000	588.3	201,000	590.6	235,000	592.2	259,000	593.7	282,000	594.8	306,000	596.0	336,000
529.7	584.6	131,000	586.7	174,000	588.4	201,000	590.7	235,000	592.2	259,000	593.7	282,000	594.8	306,000	596.1	336,000
530	584.8	130,000	586.9	174,000	588.6	201,000	590.8	235,000	592.3	259,000	593.8	282,000	594.9	306,000	596.1	336,000
530.9	585.1	130,000	587.1	174,000	588.8	201,000	591.0	235,000	592.5	259,000	593.9	282,000	595.0	306,000	596.3	336,000
531.7	585.4	130,000	587.4	174,000	589.0	201,000	591.1	235,000	592.6	259,000	594.0	282,000	595.1	306,000	596.4	336,000
532.3	585.6	130,000	587.6	174,000	589.2	201,000	591.3	235,000	592.7	259,000	594.1	282,000	595.3	306,000	596.5	336,000
532.55	585.7	130,000	587.7	174,000	589.3	201,000	591.4	235,000	592.9	259,000	594.2	282,000	595.3	306,000	596.6	336,000
532.8	585.8	130,000	587.8	174,000	589.4	201,000	591.5	235,000	593.0	259,000	594.3	282,000	595.4	306,000	596.6	336,000
533.5	586.0	130,000	588.1	174,000	589.7	201,000	591.8	235,000	593.2	259,000	594.5	282,000	595.6	306,000	596.8	336,000
534.1	586.2	130,000	588.4	174,000	590.0	201,000	592.0	234,000	593.4	259,000	594.7	282,000	595.7	305,000	596.9	336,000
535.1	586.4	130,000	588.6	174,000	590.3	201,000	592.3	234,000	593.7	259,000	594.9	282,000	595.9	305,000	597.1	336,000
535.5	586.6	130,000	588.8	174,000	590.4	201,000	592.5	234,000	593.8	259,000	595.0	282,000	596.1	305,000	597.3	336,000
535.7	586.6	130,000	588.9	174,000	590.6	201,000	592.6	234,000	594.0	259,000	595.1	282,000	596.2	305,000	597.4	336,000
535.9	586.7	130,000	589.0	173,000	590.7	200,000	592.7	234,000	594.1	258,000	595.2	281,000	596.3	305,000	597.5	335,000
536.4	586.9	130,000	589.3	173,000	590.9	200,000	593.0	234,000	594.4	258,000	595.5	281,000	596.6	305,000	597.7	335,000
537.1	587.2	130,000	589.6	173,000	591.3	200,000	593.4	234,000	594.7	258,000	595.8	281,000	596.8	305,000	598.0	335,000

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River Mile	0.5 AEP		0.2 AEP		0.1 AEP		0.04 AEP		0.02 AEP		0.01 AEP		0.005 AEP		0.002 AEP	
	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)
537.7	587.5	130,000	589.9	173,000	591.6	200,000	593.6	234,000	595.0	258,000	596.1	281,000	597.1	304,000	598.3	335,000
538.1	587.6	130,000	590.1	173,000	591.8	200,000	593.9	234,000	595.2	258,000	596.3	281,000	597.3	304,000	598.5	335,000
538.5	587.8	130,000	590.3	173,000	592.1	200,000	594.2	234,000	595.5	258,000	596.6	281,000	597.6	304,000	598.8	335,000
538.8	588.0	130,000	590.5	173,000	592.3	200,000	594.4	234,000	595.7	258,000	596.8	281,000	597.8	304,000	599.0	335,000
539.1	588.2	130,000	590.7	173,000	592.5	200,000	594.5	234,000	595.8	258,000	596.9	281,000	597.9	304,000	599.1	335,000
539.9	588.4	130,000	590.9	173,000	592.7	200,000	594.7	234,000	596.0	258,000	597.1	281,000	598.1	304,000	599.3	335,000
540.6	588.6	130,000	591.1	173,000	592.9	200,000	594.9	234,000	596.2	258,000	597.3	281,000	598.3	304,000	599.4	335,000
541.2	588.7	130,000	591.3	173,000	593.0	200,000	595.1	234,000	596.4	258,000	597.5	281,000	598.4	304,000	599.6	335,000
541.8	588.9	130,000	591.5	173,000	593.2	200,000	595.3	234,000	596.5	258,000	597.6	281,000	598.6	304,000	599.7	335,000
542.6	589.2	130,000	591.7	173,000	593.5	200,000	595.5	233,000	596.8	257,000	597.8	281,000	598.8	304,000	599.9	334,000
543.3	589.4	130,000	592.0	173,000	593.7	200,000	595.7	233,000	597.0	257,000	598.1	281,000	599.0	304,000	600.2	334,000
543.7	589.6	130,000	592.2	173,000	593.9	200,000	595.9	233,000	597.2	257,000	598.3	281,000	599.2	304,000	600.4	334,000
544.3	589.9	130,000	592.5	173,000	594.2	200,000	596.2	233,000	597.4	257,000	598.5	281,000	599.4	304,000	600.6	334,000
544.8	590.1	130,000	592.7	173,000	594.4	200,000	596.4	233,000	597.6	257,000	598.6	281,000	599.6	304,000	600.8	334,000
545.4	590.2	130,000	592.9	172,000	594.6	200,000	596.6	233,000	597.7	257,000	598.8	280,000	599.7	303,000	600.9	333,000
546	590.4	129,000	593.1	172,000	594.8	200,000	596.8	233,000	597.9	257,000	598.9	280,000	599.9	303,000	601.0	333,000
546.4	590.5	129,000	593.2	172,000	594.9	200,000	596.9	233,000	598.1	257,000	599.1	280,000	600.0	303,000	601.2	333,000
547	590.7	129,000	593.5	172,000	595.2	200,000	597.2	233,000	598.3	257,000	599.3	280,000	600.3	303,000	601.5	333,000
547.5	590.9	129,000	593.6	172,000	595.4	200,000	597.4	233,000	598.5	257,000	599.5	280,000	600.5	303,000	601.7	333,000
548.1	591.1	129,000	593.9	172,000	595.6	200,000	597.7	233,000	598.8	257,000	599.8	280,000	600.8	303,000	602.0	333,000
548.6	591.2	129,000	594.0	172,000	595.8	200,000	597.8	233,000	599.0	257,000	600.0	280,000	601.0	303,000	602.2	333,000
549.1	591.4	127,000	594.3	169,000	596.0	196,000	598.0	229,000	599.2	252,000	600.3	275,000	601.3	298,000	602.5	328,000
549.7	591.6	127,000	594.5	169,000	596.2	196,000	598.2	229,000	599.5	252,000	600.5	275,000	601.5	298,000	602.7	328,000
550.05	591.7	127,000	594.7	169,000	596.3	196,000	598.4	229,000	599.6	252,000	600.7	275,000	601.7	298,000	602.8	328,000
550.4	591.8	127,000	594.8	169,000	596.4	196,000	598.5	229,000	599.7	252,000	600.8	275,000	601.8	298,000	602.9	328,000
551	591.9	127,000	594.9	169,000	596.5	196,000	598.6	229,000	599.8	252,000	600.9	275,000	601.9	298,000	603.0	328,000
552	592.1	127,000	595.1	169,000	596.7	196,000	598.8	229,000	600.0	252,000	601.1	275,000	602.1	298,000	603.2	327,000
552.8	592.3	127,000	595.3	169,000	596.9	196,000	598.9	229,000	600.2	252,000	601.2	275,000	602.2	298,000	603.4	327,000
553.3	592.5	127,000	595.4	169,000	597.1	196,000	599.1	229,000	600.3	252,000	601.4	275,000	602.4	298,000	603.5	327,000
554	592.7	127,000	595.6	169,000	597.2	196,000	599.3	229,000	600.5	252,000	601.5	275,000	602.5	298,000	603.7	327,000
554.5	592.8	127,000	595.7	169,000	597.3	196,000	599.4	229,000	600.6	252,000	601.6	275,000	602.6	298,000	603.8	327,000

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River Mile	0.5 AEP		0.2 AEP		0.1 AEP		0.04 AEP		0.02 AEP		0.01 AEP		0.005 AEP		0.002 AEP	
	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)	WSE (ft NAVD88)	Flow (cfs)
555.2	592.9	127,000	595.8	169,000	597.4	196,000	599.5	229,000	600.7	252,000	601.7	275,000	602.7	298,000	603.9	327,000
555.7	593.0	127,000	595.9	169,000	597.5	196,000	599.6	228,000	600.8	252,000	601.8	275,000	602.8	298,000	604.0	327,000
556.2	593.1	127,000	596.0	169,000	597.7	196,000	599.7	228,000	600.9	252,000	601.9	275,000	602.9	298,000	604.1	327,000
556.6	593.2	127,000	596.1	169,000	597.7	196,000	599.8	228,000	601.0	252,000	602.0	275,000	603.0	298,000	604.2	327,000
556.65	593.2	127,000	596.1	169,000	597.8	196,000	599.8	228,000	601.0	252,000	602.1	275,000	603.0	298,000	604.2	327,000
556.7	593.2	127,000	596.1	169,000	597.8	196,000	599.8	228,000	601.0	252,000	602.1	275,000	603.0	298,000	604.2	327,000

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3.5 Tributaries

3.5.1 Elk River

Elk River flows into Pool 13 at the upstream end of the study area at Mississippi River Mile 528.7 from the west. The Elk River watershed is 77 square miles in area with predominantly agricultural land cover. At the Mississippi River–Elk River confluence, the Elk River contributes less than 1% of river flow to the Mississippi River (assuming 0.5 annual exceedance probability (AEP) flow for each river) (https://streamstats.usgs.gov/ss/).

3.5.2 Plum River

Upstream of the HREP study area, at Mississippi River Mile 537, the Plum River flows into Pool 13 from the east. The Plum River watershed is 298 square miles in area with predominantly agricultural land cover. At the Mississippi River–Plum River confluence, the Plum River contributes approximately 3% of river flow to the Mississippi River (at 0.5 AEP flow for each river) (https://streamstats.usgs.gov/ss/).

3.5.3 Maquoketa River

Also upstream of the HREP study area, at Mississippi River Mile 548.5, the Maquoketa River flows into Pool 13 from the west. The Maquoketa River watershed is 1,870 square miles in area with predominantly agricultural land cover. At the Mississippi River–Maquoketa confluence, the Maquoketa River contributes approximately 11% of river flow to the Mississippi River (at 0.5 AEP flow for each river) (https://streamstats.usgs.gov/ss/).

4. WIND

4.1 Windspeed

Ten-minute instantaneous windspeed data is collected at Lock and Dam 13 by anemometer. This gage is maintained by USACE Rock Island District. An exceedance duration curve was developed for the available data (2014–2019) during the growing season (May 1–September 30) (Figure A-4, Table A-8). When the 10-minute instantaneous windspeed data is averaged hourly, the hourly averaged Lock and Dam 13 exceedance duration curve (2014–2019 growing season data) results in only minor differences (Figure A-4).

Windspeed data is also collected at Savanna, IL (5-second instantaneous measurement, averaged on a 2-minute timestep, reported every 20 minutes, then averaged hourly) and available on Iowa Mesonet ASOS Network (https://mesonet.agron.iastate.edu). Averaged 2-minute wind speeds less than 2.3 mph were reported as “calm” (0 mph) (NOAA, 1998). An exceedance duration curve for 2014–2019 growing season data was developed for this gage and is included in Figure A-4 for comparison purposes.

All exceedance duration curves were computed in HEC-SSP version 2.2 (Bartles et al., 2019).

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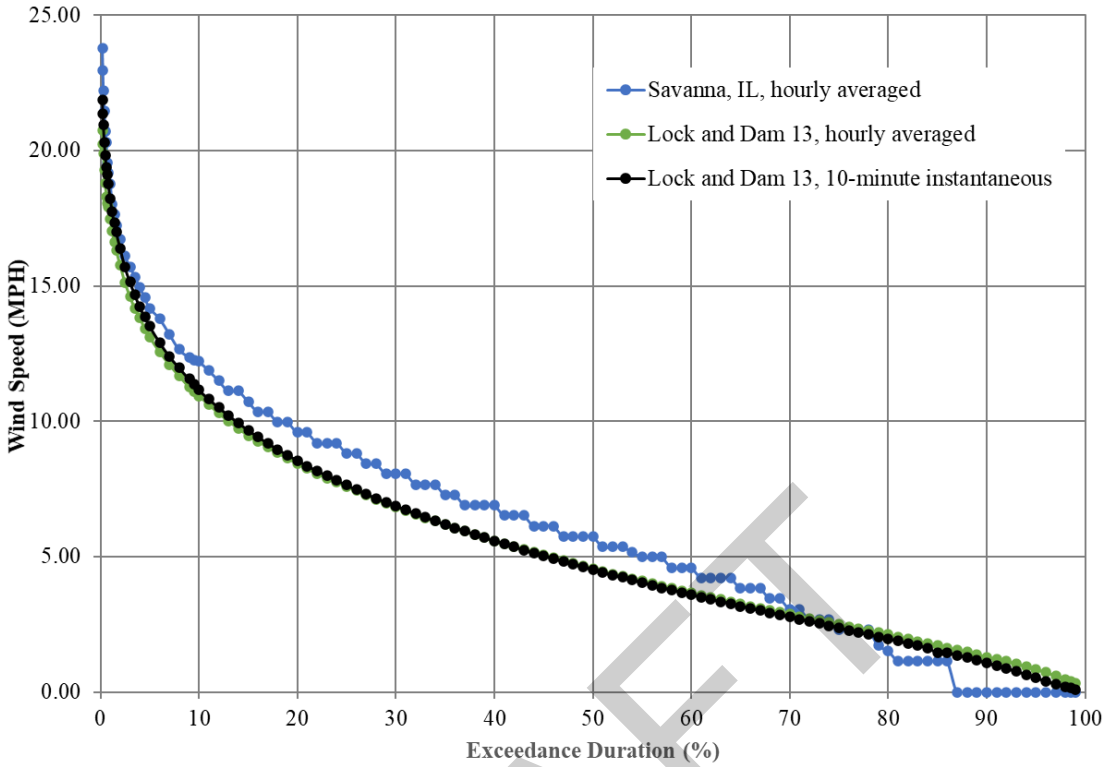

Figure A-4. Exceedance Duration Curves for Windspeed

Hourly Averaged Windspeed at Savannah, IL (blue); Hourly Averaged Windspeed at Lock and Dam 13 (green); and 10-minute Instantaneous Windspeed at Lock and Dam 13 (black). All curved computed from 2014–2019 growing season data.

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Table A-8. Exceedance Duration Curve (Tabular Form) for 2014–2019 (Growing Season Data Only) 10-minute Instantaneous Wind Speed Readings Collected at Mississippi River Lock and Dam 13 Anemometer

Exceedance Duration, %	Wind Speed, mph	Exceedance Duration, %	Wind Speed, mph	Exceedance Duration, %	Wind Speed, mph	Exceedance Duration, %	Wind Speed, mph
99	0.10	71	2.69	42	5.36	13	10.22
98.5	0.14	70	2.77	41	5.47	12	10.51
98	0.20	69	2.85	40	5.59	11	10.82
97	0.30	68	2.93	39	5.70	10	11.16
96	0.40	67	3.01	38	5.82	9.5	11.36
95	0.52	66	3.09	37	5.95	9	11.56
94	0.65	65	3.17	36	6.06	8	11.97
93	0.76	64	3.26	35	6.19	7	12.40
92	0.87	63	3.34	34	6.32	6	12.92
91	0.97	62	3.42	33	6.45	5	13.51
90	1.07	61	3.51	32	6.59	4.5	13.85
89	1.17	60	3.59	31	6.73	4	14.22
88	1.27	59	3.68	30	6.87	3.5	14.67
87	1.36	58	3.77	29	7.01	3	15.14
86	1.45	57	3.85	28	7.16	2.5	15.69
85	1.45	56	3.95	27	7.31	2	16.39
84	1.63	55	4.04	26	7.47	1.6	17.00
83	1.71	54	4.13	25	7.64	1.4	17.33
82	1.79	53	4.23	24	7.81	1.2	17.74
81	1.88	52	4.32	23	7.99	1	18.22
80	1.96	51	4.41	22	8.17	0.8	18.77
79	2.04	50	4.52	21	8.35	0.7	19.10
78	2.12	49	4.62	20	8.55	0.6	19.40
77	2.20	48	4.72	19	8.75	0.5	19.81
76	2.28	47	4.82	18	8.96	0.4	20.29
75	2.37	46	4.92	17	9.19	0.3	20.94
74	2.45	45	5.03	16	9.42	0.25	21.37
73	2.53	44	5.13	15	9.67	0.2	21.87
72	2.61	43	5.25	14	9.94		

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4.2 Wind Direction

Ten-minute instantaneous wind direction data is collected at the USACE Lock and Dam 13 gage. A wind rose was developed for the 2014–2019 growing season (May 1–September 30) growing season using R scripting (RStudio, 2020) with the openair package (Carslaw & Ropkins, 2012) (Figure A-5). The portion (%) of the dataset corresponding to each wind direction interval is listed in Table A-9. For both the wind rose and table, the wind direction shown indicates the direction from which the wind originated. For example, an eastern, 90-degree wind would blow from east to west.

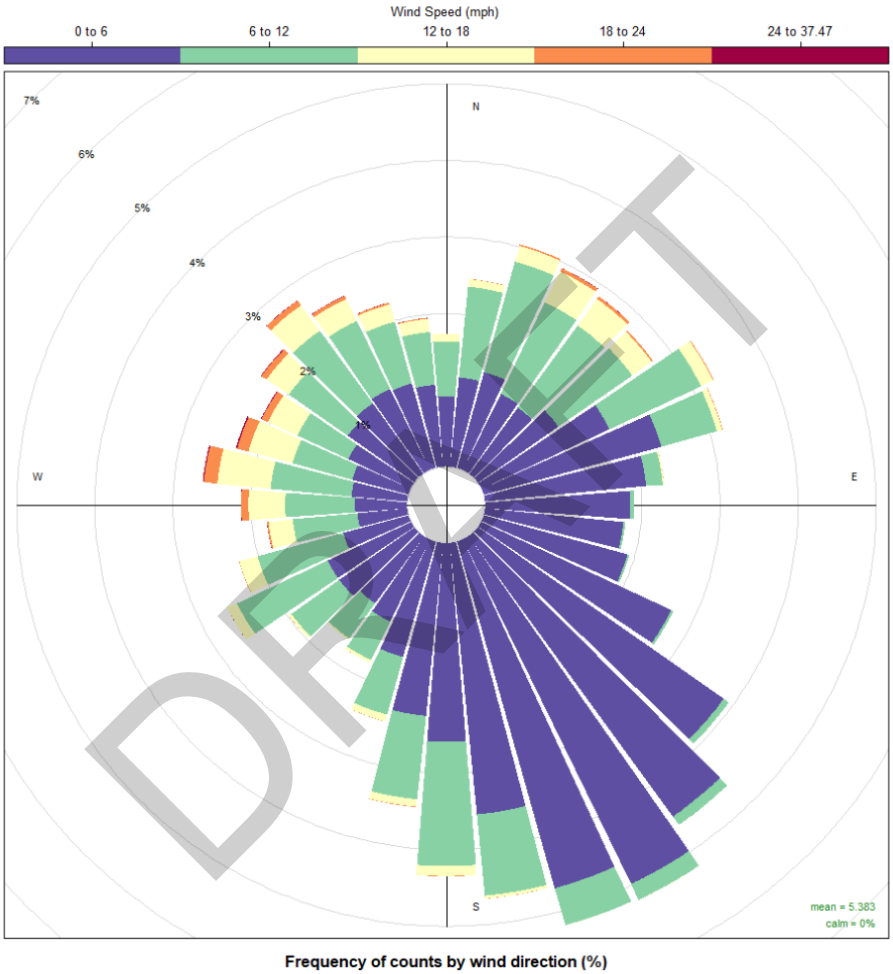

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Figure A-5. Wind Rose at Lock and Dam 13 Developed with 10-minute Instantaneous Data Collected 2014–2019 (Growing Season Only)

Table A-9. Portion of Wind Direction Dataset Corresponding to Each Wind Direction Interval. 10-minute Instantaneous Data Collected 2-14–2019 (growing season only) at Lock and Dam 13

Wind Direction Interval, Degrees	Portion of Dataset, %	Wind Direction Interval, Degrees	Portion of Dataset, %	Wind Direction Interval, Degrees	Portion of Dataset, %
5-15	2.5	125-135	3.9	245-255	2.3
15-25	3.0	135-145	4.6	255-265	1.8
25-35	2.9	145-155	5.2	265-275	2.1
35-45	2.9	155-165	5.2	275-285	2.6
45-55	2.7	165-175	4.7	285-295	2.3
55-65	3.3	175-185	4.4	295-305	2.1
65-75	3.2	185-195	3.5	305-315	2.4
75-85	2.3	195-205	2.4	315-325	2.8
85-95	1.9	205-215	1.8	325-335	2.5
95-105	1.8	215-225	1.7	335-345	2.2
105-115	1.9	225-235	2.0	345-355	2.0
115-125	2.7	235-245	2.6	355-365	1.7

5. SEDIMENT DEPOSITION

5.1 Dredging

The Upper Mississippi River and Maquoketa River are the largest contributors of sediment to Pool 13. At the upstream end of the study area, Elk River is a potential sediment source. Table A-10 summarizes the historic dredging activity near the study area and Figure A-6 illustrates the dredging locations. Within the study area, three dredging events have taken place within recent years (1999–2022). Historically, a total of 7 dredging events have taken place (1940–2022). Immediately upstream of the study area, dredging needs are considered chronic.

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Table A-10. Dredge Cuts (1940–2021) Near Lower Pool 13 HREP Study Area, Dredge Cuts Within Study Area Shown in Grey

Year	CY	Dredging Location	Placement Site	Placement Type
1940	334,995	528.7-529.9	528.6-529.2L, 529.3L, 529.5L, 529.6-529.7L	
1954	74,423	528.7-529.1	528.8L, 528.9-529.1L	
1961	56,231	533.6-533.9	533.6-533.8L	
1961	122,309	532.9-533.4	532.9-533.3L	
1961	104,755	525.1-525.6	525.1-525.8L	
1971	47,489	531.0-531.3	531.2-531.4L	
1972	96,134	532.5-533.4	532.4-532.5R, 533.3-533.5L	
1972	60,429	525.2-525.6	525.1-525.4L	
1973	118,599	533.0-533.9	533.2-533.4L, 533.5L, 533.6-533.9L	
1973	49,677	531.0-531.3	531.1L, 531.2-531.4L	
1977	24,039	533.5-533.9	532.8-533.1L, 533.5L	
1991	153,867	533.0	534.0L, 533.2L	Levee repair
1999	9,273	533.7-533.9	534.4R	Inland
2001	4,542	533.0-533.3	538.5T	Thalweg
2002	21,817	533.1-534.1	539.4L, 538.5T	Beach/Thalweg
2003	13,179	533.6-534.0	538.3T	Thalweg
2004	13,575	533.4-533.9	538.3T	Thalweg
2005	67,041	532.9-533.8	531.7-531.9T	Thalweg
2006	24,970	527.1-527.4	526.0-526.2L (Pelican Is.)	Island/Open water
2007	57,194	532.8-533.5	531.7-532.0T	Thalweg
2009	7,704	533.0-533.2	531.7-532.0T	Thalweg
2009	60,028	532.1-532.4	531.7-531.9T	Thalweg
2011	26,694	533.0-533.2	531.7-531.9T	Thalweg
2012	18,384	532.8-533.2	539.4L	Beach
2012	39,090	530.9-531.6	531.7-532.0T	Thalweg
2012	56,229	529.8-530.6	531.3-531.5L	Bankline
2013	18,337	531.0-531.4	531.2-531.7L	Bankline
2014	22,665	531.1-531.5	531.3-531.7L	Bankline
2015	17,860	528.7-529.9	531.3-531.5L	Bankline
2016	15,943	529.9-530.6	531.3-531.7L	Bankline
2017	28,481	529.7-530.1	531.3-531.7L	Bankline
2017	4,730	522.5-522.6 (LD 13)	548.8R	Inland
2018	22,931	530.0-530.3	532.0L	Thalweg
2019	14,671	529.9-530.3	532.3T	Thalweg
2019	20,471	529.9-530.4	531.3-531.7L	Bankline
2019	9,478	529.1-529.3	527.9R (Cormorant Islands)	Bankline/Open Water
2020	23,542	529.9-530.4	531.3-531.7L	Bankline
2021	30,908	533.0-533.4	531.9-532.0	Thalweg
2021	14,873	529.9-530.4	531.9-532.0	Thalweg
2021	22,949	529.8-530.2	531.9-532.0	Thalweg
2021	54,664	529.8-530.2	531.3-531.7L	Bankline

Table A-11. Summary of Dredge Cut Data (1940–2021) near Lower Pool 13 HREP Study Area

Summary	
Vicinity of study, RM 522.5–RM 533.9:	**Study Area, RM 522.5–RM 529.0**
Total cubic yards: 1,985,170	Total cubic yards: 622,162
Number of events: 41	Number of events: 7
Average CY per event: 48,419	Average CY per event: 88,880

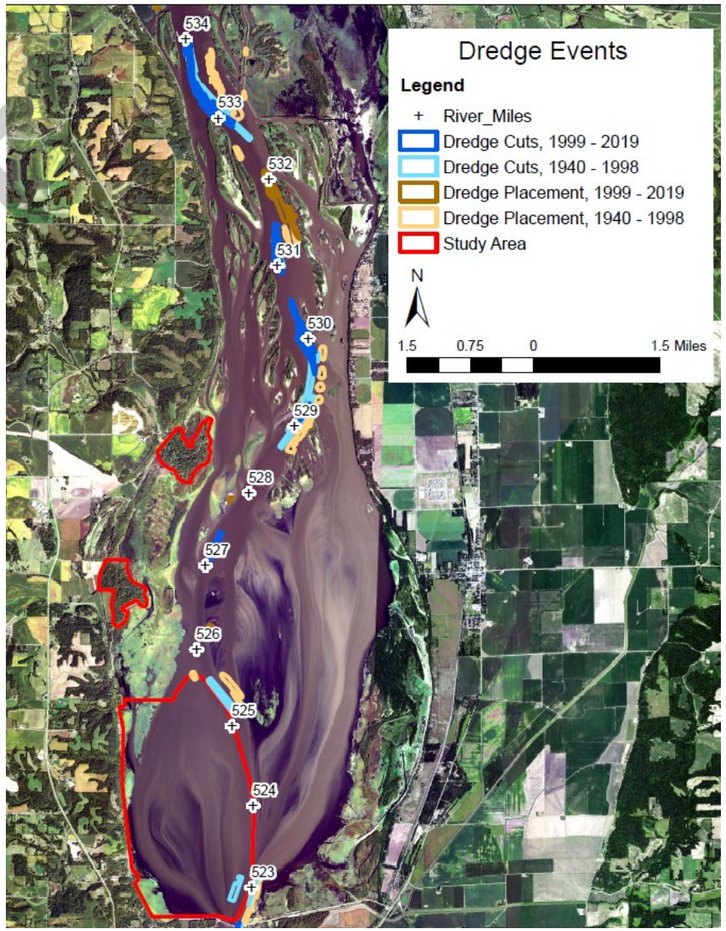

Figure A-6. Recent Dredge Cuts (dark blue), Historic Dredge Cuts (light blue), and Placement Sites near Aquatic Portion of Study Area (red outline)

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5.2 Observed Sedimentation Rates

Temporal and spatial variability are inherent in the numerous processes that drive sediment deposition; therefore, sediment deposition rates are also dynamic. Some of the watershed features impacting backwater sediment deposition rates include geology and soils, land use, and natural impoundments. A summary of backwater sedimentation studies within the Upper Mississippi River is shown in Table A-12. Sediment deposition rates determined in these studies vary widely.

Table A-12. Sediment Deposition Rates Estimated by Various Studies in the Upper Mississippi River. Rates Specific to Pool 13 shown in Gray

Source	Notes	Location	Estimated Sediment Deposition Rate	
			in/year	cm/year
Eckblad et al., 1977	1974 bathymetric survey of backwater lake compared to 1896 Mississippi River Commission map transects, Cesium-137 dating of 12 sediment core samples.	Pool 9	0.380.83	0.992.11
McHenry et al., 1984	Cesium-137 dating of 47 profiles	Pools 4-10	0.711.34	1.83.4
Korschgen et al., 1987	1983 bathymetric survey of backwater lake compared to 1933 pre-impoundment ground survey	Pool 7	0.08	0.20
Aspelmeir, 1994	Computed from observed transect data, 1985, 1987–1990, 1994 at Dark Slough	Pool 13	0.56	1.42
Rogala & Boma., 1996	Computed 42 backwater transects	Pool 4	0.11	0.29
		Pool 8	0.05	0.12
		Pool 13	0.31	0.80
Rogala et al., 1997	Rate of sediment accumulation estimated by measuring depth of fine sediment overlaying pre-impoundment soil from 147 sediment cores.	Pool 8	0.110.22	0.290.57
WEST Consultants, Inc., 2000	Backwater sediment deposition rates derived from sediment budget	Pools 12-19	0.02	0.05
		Pools 20-26	0.12	0.31
Rogala et al., 2003	Computed from observed transect data, 1997-2001. Impounded backwaters not investigated.	Pool 4	-0.03	-0.08
		Pool 8	0.09	0.24
		Pool 13	0.19	0.47
Theis & Knox, 2003	Particle size, organic carbon, and carbondate analysis of 4 backwater sediment cores	Pool 10	0.250.29	0.630.73
Belby, 2005	Particle size, carbonate, and organic matter analysis of 3 backwater sediment cores	Pool 11	0.330.39	0.83-1.00
USACE, 2018	2017 bathymetric survey compared to as-build drawings for Potters Marsh HREP fish overwintering channels	Pool 13	2.2	5.6
Rogala et al., 2020	Computed from observed transect data, 1997–2017, follow-up study to Rogala et al. 2003. Pool 13 not included in effort.	Pool 4	0.11	0.27
		Pool 8	0.20	0.51

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The following data specific to Mississippi River Pool 13 was available:

5.2.1 Aspelmeir Transects

Twelve backwater sites within Pool 13 were monitored for sediment deposition from 1984 through 2000 by former IADNR biologist, Bill Aspelmeir (Aspelmeir, 1994). The transect closest to the study area was Station 8 in Dark Slough (Mississippi River Mile 532, right descending backwater) (Figure A-7). Measurements were collected in 1985, annually from 1987 to 1990 and again in 1994 at five stations along the transect. During this observation period, flooding occurred in 1986 and 1993. The average deposition rate at this location was 0.56 in/year (1.42 cm/year).

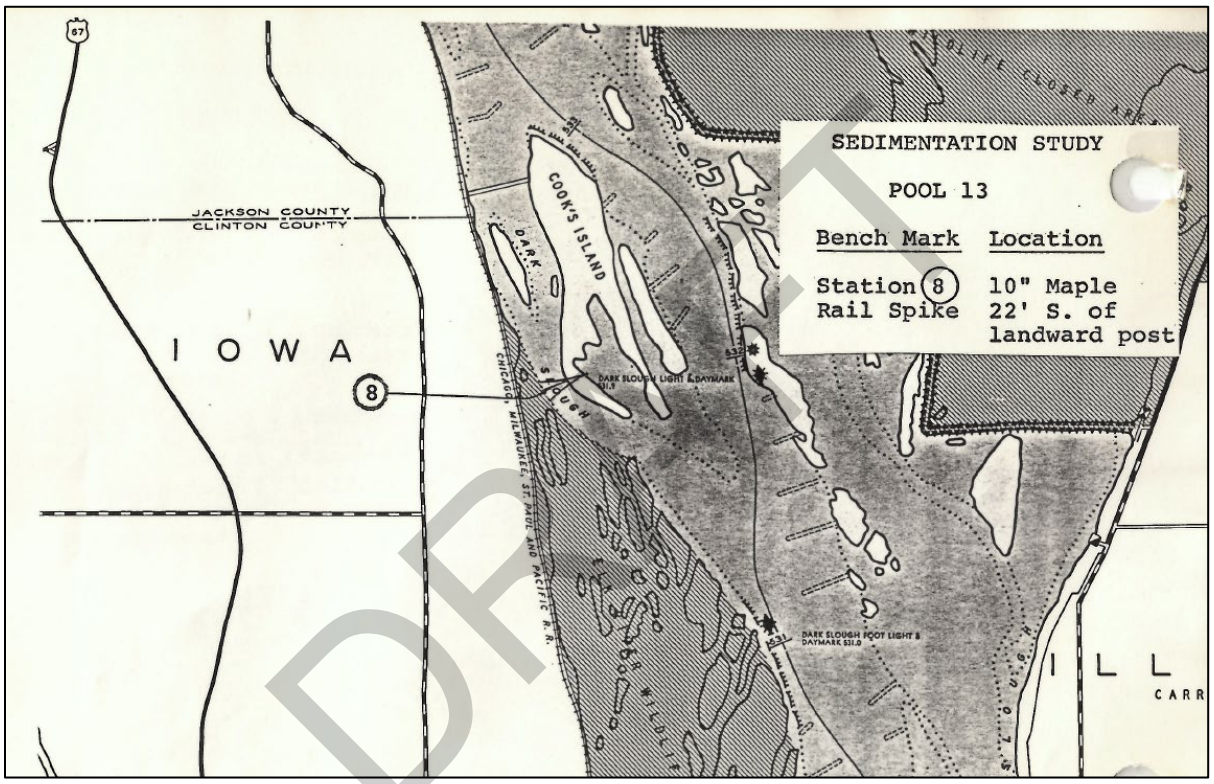

Figure A-7. Location of Aspelmeir Pool 13 Station 8, Mississippi River Mile 532 (Aspelmeir 1994)

5.2.2 Rogala et al. Transects

The Upper Midwest Environmental Sciences Center monitored sediment deposition at 17 sites within Pool 13 (Mississippi River Miles 531–551) (Rogala et al., 2003). Measurements were collected annually from 1997 to 2001. The average deposition rate across aquatic portions of these transects was 0.19 in/year (0.47 cm/year) with a 0.10 in/year (0.26 cm/year) standard error. This study did not include impounded backwaters and therefore no observations were conducted within the Lower Pool 13 HREP study area. Re-survey of these transects is planned, but not yet completed due to weather delays.

5.2.3 Potters Marsh HREP

Adjacent to the study area, Potters Marsh HREP was hydraulically dredged in 1994 to create

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fish overwintering in the left descending backwater of Mississippi River Miles 522.5–526. Comparison between as-built plans and 2017 bathymetry suggest an average sediment deposition depth of 4.3 feet between 1994 and 2017 in the dredged channels (USACE, 2018). A sedimentation rate of 2.2 in/year (5.7 cm/year) is estimated for this location. While near the Lower Pool 13 HREP study area, the Potters Marsh HREP site is much less hydraulically connected to the main channel and experiences lower flows; therefore, sedimentation in the study area is not anticipated to be similar to observed sedimentation in Potters Marsh.

5.3 Sedimentation Rate Assumed for Lower Pool 13 HREP

As a result of the variability in reported values and the inherent variability in sediment deposition rates, a representative annual sediment deposition rate of 0.4 in/year (1 cm/year) was assumed for the study.

6. 2D HYDRAULIC MODELING

The PDT has determined that the velocities less than 15 cm/sec or 0.5 ft/sec are ideal for both maintaining and growing new beds of wild celery, a type of submerged aquatic vegetation (SAV) (see Appendix A, *Environmental*).

The hydraulic modeling software HEC-RAS version 5.0.7 (Brunner 2019) and version 6.0 (Brunner, 2021) were used to simulate both the existing condition and various built feature conditions in Pool 13. A two-dimensional unsteady model was used to evaluate the impact of these features on velocities in the study area.

6.1 Model Development

Components required for 2D hydraulic model development are detailed below.

6.1.1 Model datum

Horizontal datum for this model was Albers Equal Area Conic, USGS version. Vertical datum for this work was NAVD1988. Horizontal and vertical units are in feet.

6.1.2 Geometry

Geometry of the 2D HEC-RAS model extended from immediately upstream of Lock and Dam 13 (RM 522.6) to just upstream of Sabula, IA (RM 537.2). Model extent is shown in Figure A-8 with the Lower Pool 13 HREP study area shown for reference in yellow. The standard mesh cell size was 100 feet. Break lines were added to the mesh to capture the influence of channels and wing dams in the pool. In the area immediately surrounding wing dams, mesh cell size was reduced to 10 feet. In areas a substantial distance from the study area boundary or from areas of interest for calibration, mesh cell size was increased to 1,000 feet. “Near Spacing” and “Far Spacing” options were used in the mesh development to create a smoother transition between areas with different cell sizes. Mesh sensitivity testing was conducted to determine that the model cell size used does not impact model output.

Model terrain was compiled from two components. Within the study area, the Lower Pool 13 HREP topobathy surface developed for this study was applied. This topobathy surface was developed by the PDT in 2020 using the most recent and accurate available data. Sources include USACE hydrosurvey (1999 through 2019), Seaside Engineering & Surveying, LLC

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(SEAS) survey (2014), USGS Upper Midwest Environmental Sciences Center (UMESC) bathymetric survey (1990, ’91, ’97), and IA DNR LiDAR (2007) as described in Appendix E, *Engineering*, Attachment E, *Survey, Mapping and Geospatial Data.* Raster cell size is 1 meter. Outside the study area, terrain data developed in 2016 for the CWMS Mississippi River 1D RAS model extending from Lock and Dam 10 to Lock and Dam 22 was applied (USACE, 2018). Raster cell size is 2 meters. It should be noted that in many areas outside of the main channel, survey data points are fairly sparse and out of date. This terrain was determined sufficient for a feasibility level of effort. Rather than collecting new, detailed bathymetry survey of the entirety of this large study area, the PDT recommends detailed survey in the vicinity of proposed features once those locations have been determined. Any new survey data should be incorporated into the 2D HEC-RAS model terrain during Design Phase of this effort.

Storage areas and lateral structure data from the CWMS 1D RAS model were imported into this 2D RAS model. Lateral structures were converted to storage area–2D area connections (see Figure A-8).

A Manning’s n roughness layer was produced through model calibration (final values provided later in report, Table A-13 and Figure A-12).

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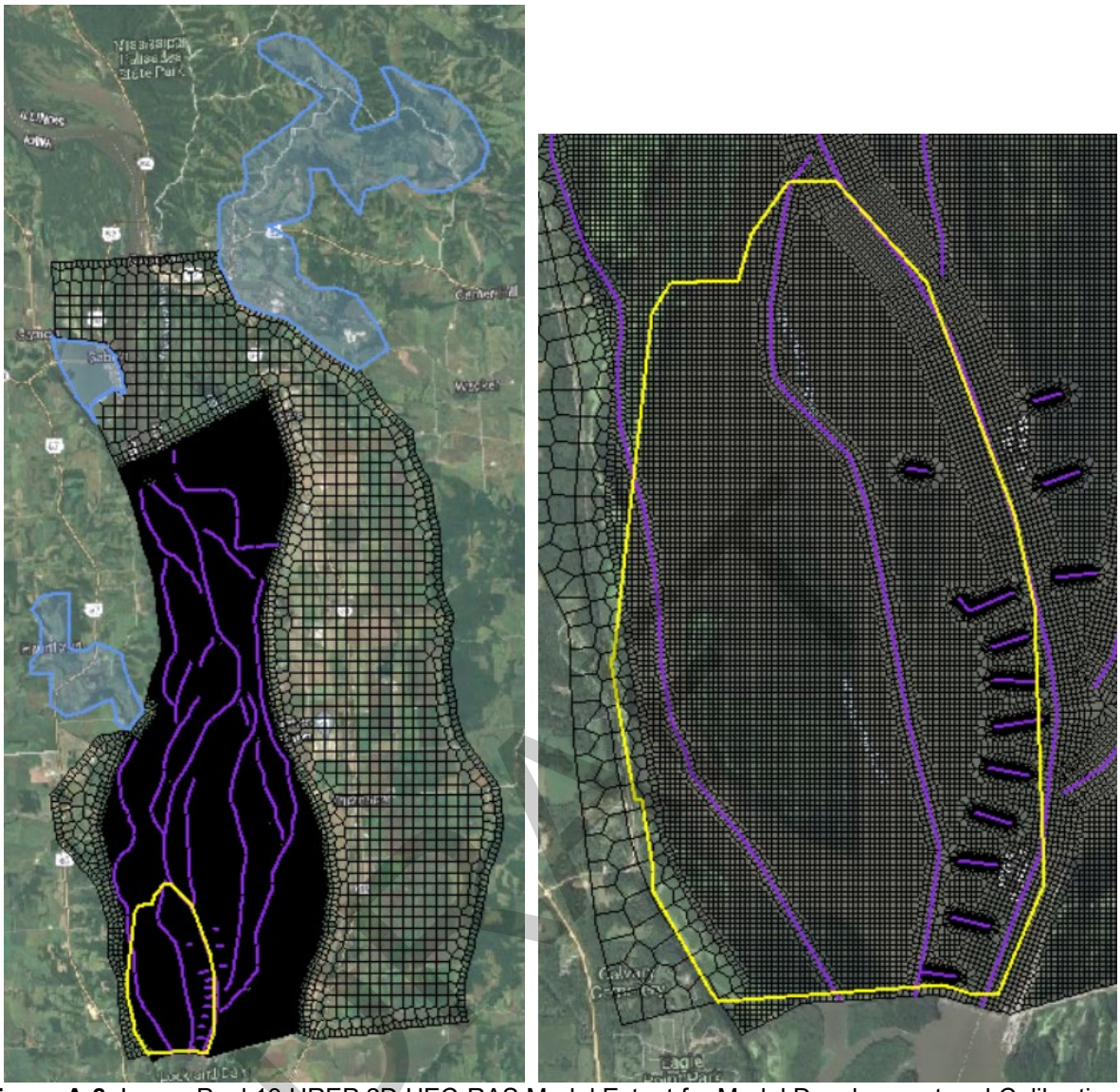

Figure A-8. Lower Pool 13 HREP 2D HEC-RAS Model Extent for Model Development and Calibration.

Used for model development and calibration. Full model extent shown on left. Study Area shown on right. Model cells are drawn in black, storage areas are drawn in blue, model break lines are drawn in purple, and Lower Pool 13 HREP Study Area boundary is drawn in yellow.

6.1.3 Boundary Conditions

A flow hydrograph boundary condition was applied to the upstream end of the 2D HEC-RAS model. Observed discharges at Lock and Dam 13, Fulton, IL gage can be applied to this boundary. Alternatively, a “flat” hydrograph (one constant discharge for the entire simulation period) can be applied.

A water surface elevation boundary condition was applied to the downstream end of the 2D HEC-RAS model. Observed water surface elevations at Lock and Dam 13, Fulton, IL gage can be applied to this boundary. Alternatively, a “flat” hydrograph (one constant water surface elevation for the entire simulation period) can be applied.

6.1.4 Computational Settings

All simulations utilized a two-week runup period prior to the model output date of interest, the Full Momentum equation solver, and a 20-second simulation timestep. Sensitivity tests were conducted to confirm that these settings did not impact model output.

6.2 Model Calibration

6.2.1 Observed ADCP Data

Acoustic Doppler Current Profiler (ADCP) measurements in Pool 13 were collected under two flow regimes. On June 17, 2019 and September 4, 2020, the ADCP unit was deployed to collect depth and velocity measurements. Discharge at Lock and Dam 13 was approximately 149,00 cfs on June 17, 2019 and 61,000 cfs on September 4, 2020. During the growing season (May 1–Sept 30), these flows correspond to the 6% and 55% exceedance durations respectively. The June 2019 flow is equivalent to the 34% annual chance exceedance (ACE) discharge while the September 2020 flow is well below the 0.5 AEP discharge (USACE, 2004). Locations of ADCP transects utilized for 2D HEC-RAS model calibration are shown in Figure A-9.

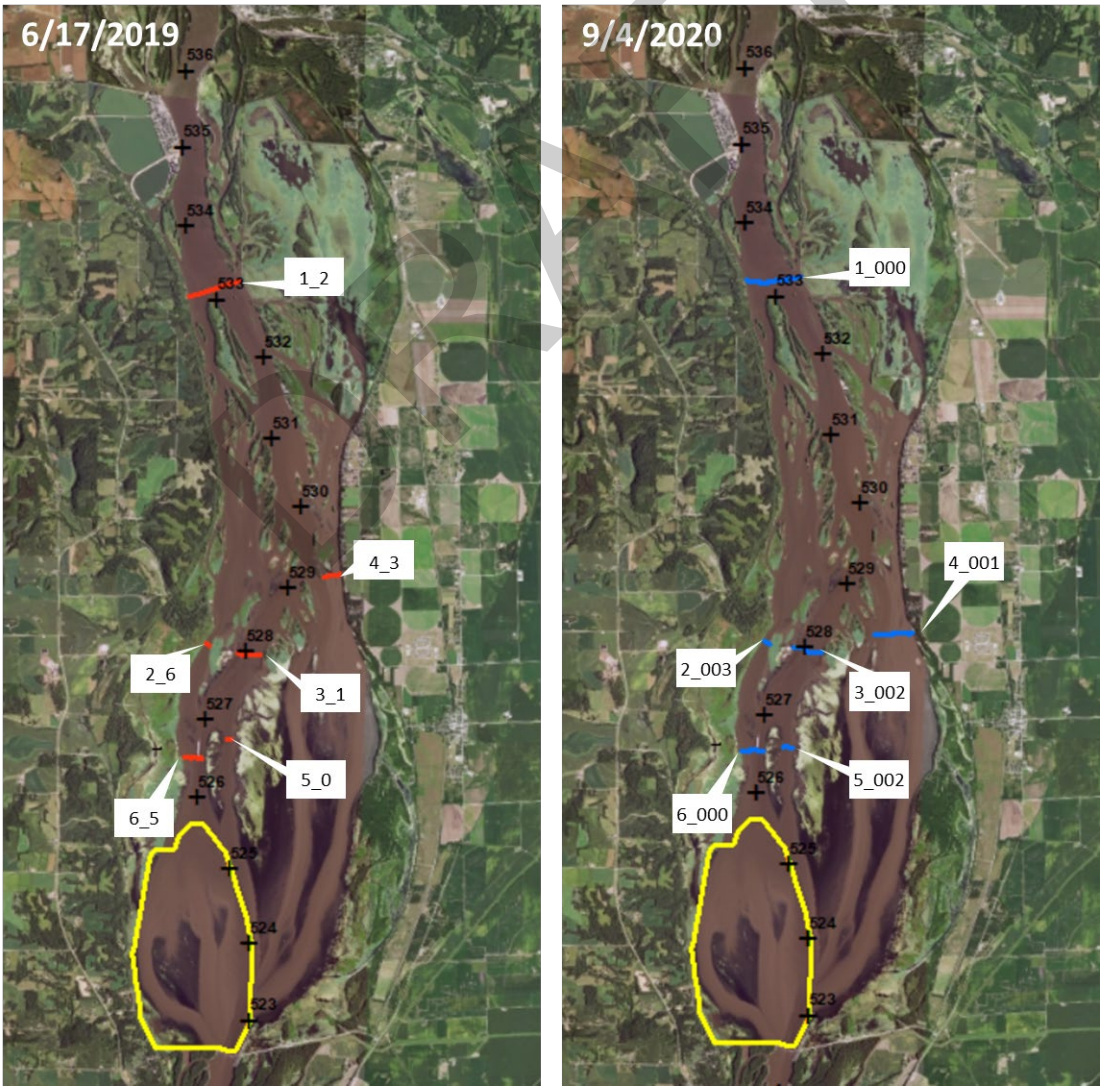

Figure A-9. Transect Locations for ADCP Data Collected in Lower Pool 13.

June 17, 2019 transects are shown on left in red. September 4, 2020 transects are shown on right in blue. Lower Pool 13 HREP Study Area boundary is shown in yellow.

6.2.2 High Flow Simulations for Calibration

2D HEC-RAS simulations were run for the time period June 10–17, 2019 so that model results on June 17, 2019 could be compared and calibrated to the observed ADCP data. Figure A-10 (left) shows 30-min discharges collected at Lock and Dam 13 gage for the simulation time period. These were applied to the upstream model boundary. Figure A-11 (right) shows 30-min water surface elevations collected at Lock and Dam 13 gage for the simulation time period. These were applied to the downstream model boundary. Model geometry and computational settings were consistent with those described in Section VIII. A.

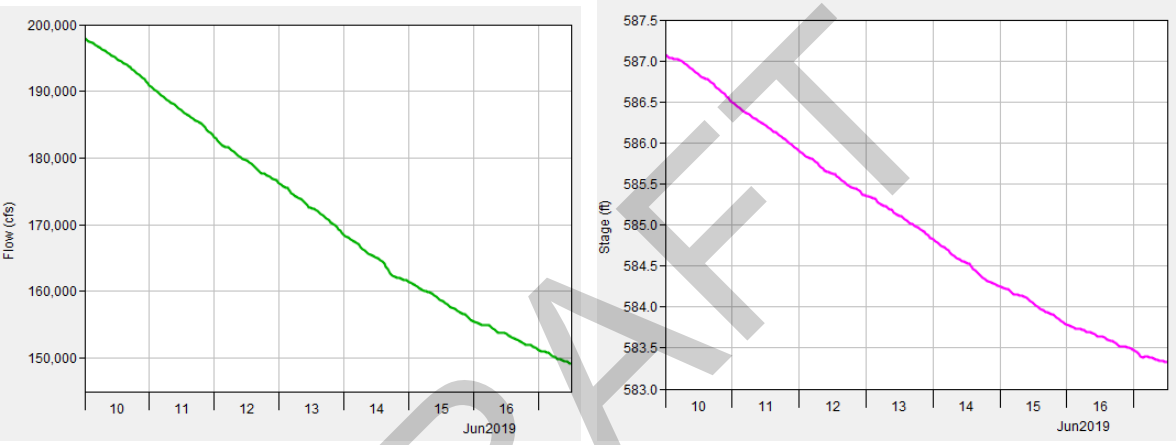

Figure A-10. 30-min Data Applied to 2D HEC-RAS Model Boundary Conditions for June 17, 2019 Calibration Simulation

Discharge (cfs) is shown on left and was applied to the upstream end of the model extent. Water surface elevation (feet NAVD88) is shown on the right and was applied to the downstream end of the model extent.

6.2.3 Median Flow Simulations for Calibration

2D HEC-RAS simulations were also run for the time period August 28–September 4, 2020 so that model results on September 4, 2020 could be compared and calibrated to the observed ADCP data. Again, Figure A-11 shows 30-min discharges (left) and water surface elevations (right) collected at Lock and Dam 13 gage for the simulation time period. These datasets were assigned to the upstream and downstream model boundaries, respectively. Model and geometry and computational settings were consistent with those described in Section 6.1.2.

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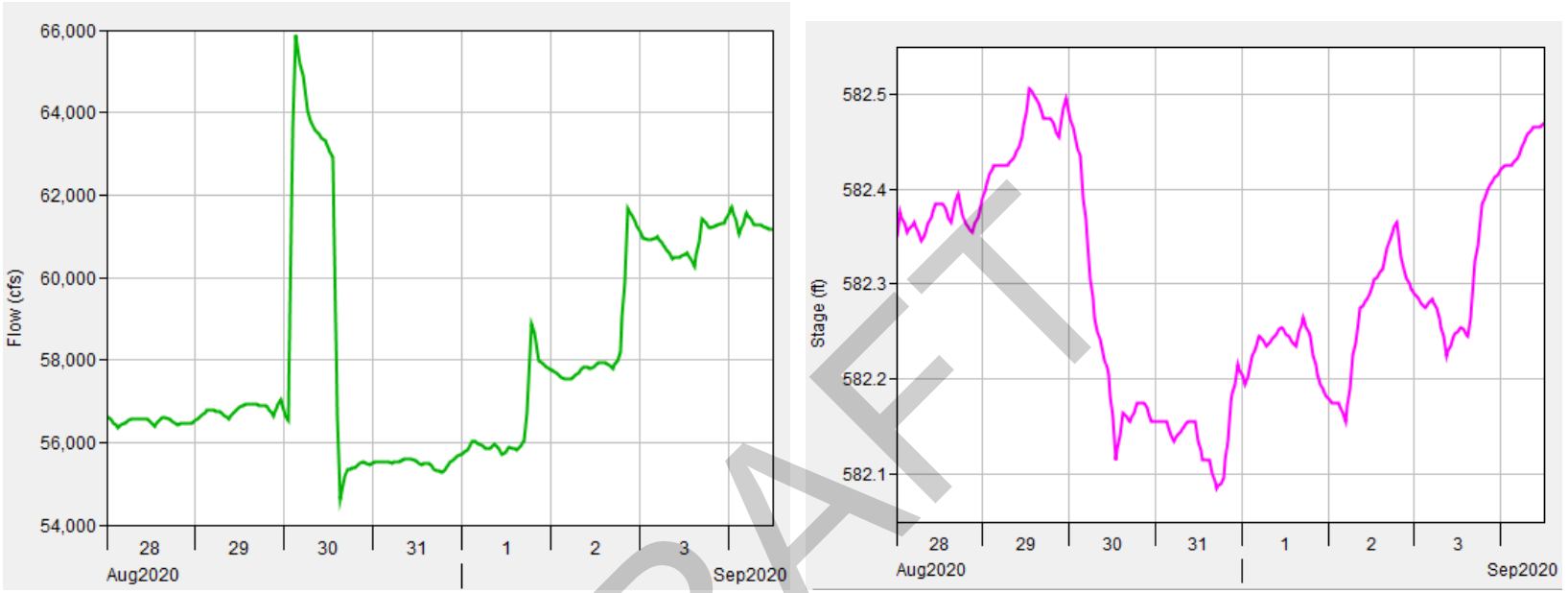

Figure A-11. 30-min Data Applied to 2D HEC-RAS Model Boundary Conditions for September 4, 2020 Calibration Simulation

Discharge (cfs) is shown on left and was applied to the upstream end of the model extent. Water surface elevation (feet NAVD88) is shown on the right and was applied to the downstream end of the model extent.

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6.2.4 Adjustment of Manning's n Roughness Values

To calibrate the Lower Pool 13 HREP 2D HEC-RAS model, Manning's n roughness values were adjusted such that simulated model output fit observed depths and velocities across each ADCP transect as closely as possible. Final Manning's n roughness values are listed in Table A-13 and shown in Figure A-12. Areas delineating each land use type were created manually.

Table A-13. Final Manning's n Roughness Values for Lower Pool 13 HREP 2D HEC-RAS Model

Land Use	Manning's n
Channel	0.029
Floodplain	0.032
Islands	0.040
Wing dams	0.050

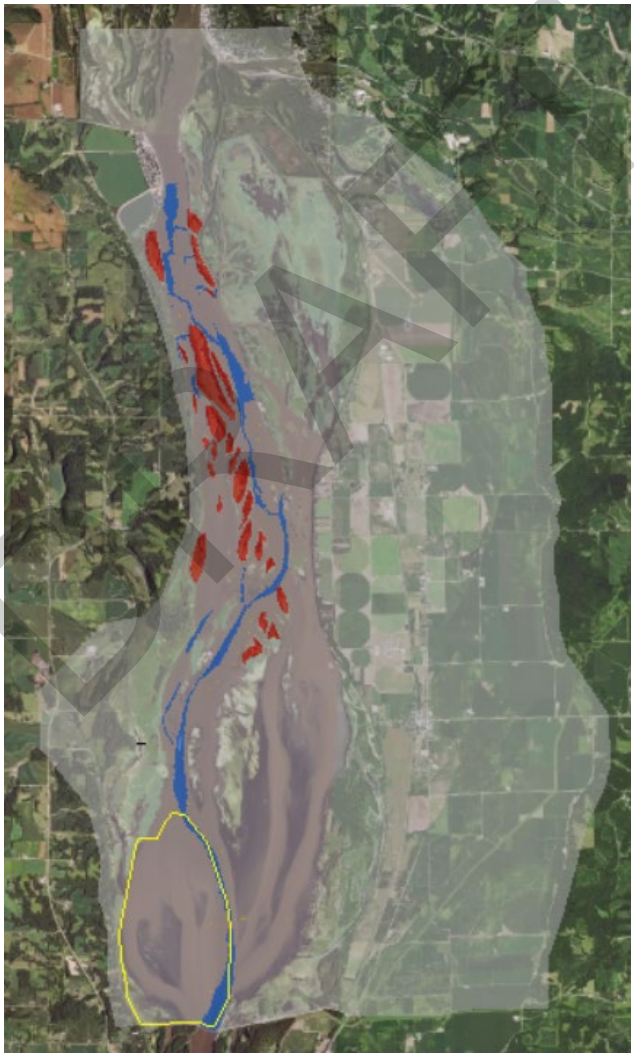

Figure A-12. Final Manning's n Roughness Values Assigned to Lower Pool 13 HREP 2D HEC-RAS Model.

Blue areas are assigned n value of 0.029 (channel), grey areas assigned n value of 0.032 (floodplain), red areas are assigned n value of 0.04 (islands), and orange areas are assigned n value of 0.05 (wing

dams). Lower Pool 13 HREP Study Area boundary shown in yellow.

6.2.5 Calibration Results

Total discharge computed across each transect from (1) observed ADCP data and (2) 2D HEC-RAS simulations are shown in Table A-14. Percent errors are also shown in the table and range from -26% to +8%. Observed ADCP depths and velocities across each transect are plotted against those simulated in 2D HEC-RAS in Figure A-13(June 17, 2019 event) and Figure A-14 (September 4, 2020 calibration).

Overall, observed ADCP and HEC-RAS simulated total discharges, depths, and velocities compare reasonably well in reference to other recent 2D hydraulic modeling efforts. Velocity calibrations are consistently “better” for transects that lie within the main channel (1_2, 3_1, 6_5, 1_000, 3_002, 6_000). This is likely due to the availability of more recent and more detailed bathymetry data in the main channel. For September 4, 2020 Transect 4_001, the 2D HEC-RAS model does not match depths or velocities to a reasonable degree. This is likely due to poor quality of the terrain surface at this location. However, Transect 4_001 is a substantial distance from the anticipated area of interest for this Study, so a poor quality calibration here is not a large concern considering the reasonable quality of fit for the remaining transects.

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Table A-14. Observed ADCP flow (cfs) Across Each Calibration Transect, Simulated 2D HEC-RAS Flow Across Each Calibration Transect, and Percent Error Between Simulated and Observed Flows. All flows rounded to the nearest 100 cfs.

Calibration Date	Transect	Type	Observed ADCP Flow (cfs)	Simulated 2D HEC-RAS Flow (cfs)	% Error
6/17/2019 High flow condition	1_2	main channel	169,600	127,000	-25
	2_6	side channel	26,000	20,000	-23
	3_1	main channel	69,300	73,700	6
	4_3	backwater stump field	23,800	20,800	-13
	5_0	side channel.	17,100	14,200	-17
	6_5	main channel	59,600	59,600	0
9/4/2020 Median flow condition	1_000	main channel	61,000	56,300	-8
	2_003	side channel	11,200	8,500	-24
	3_002	main channel	34,400	37,300	8
	4_001	backwater stump field	13,000	9,800	-26
	5_002	side channel	6,700	5,700	-14
	6_000	main channel	35,400	31,400	-11

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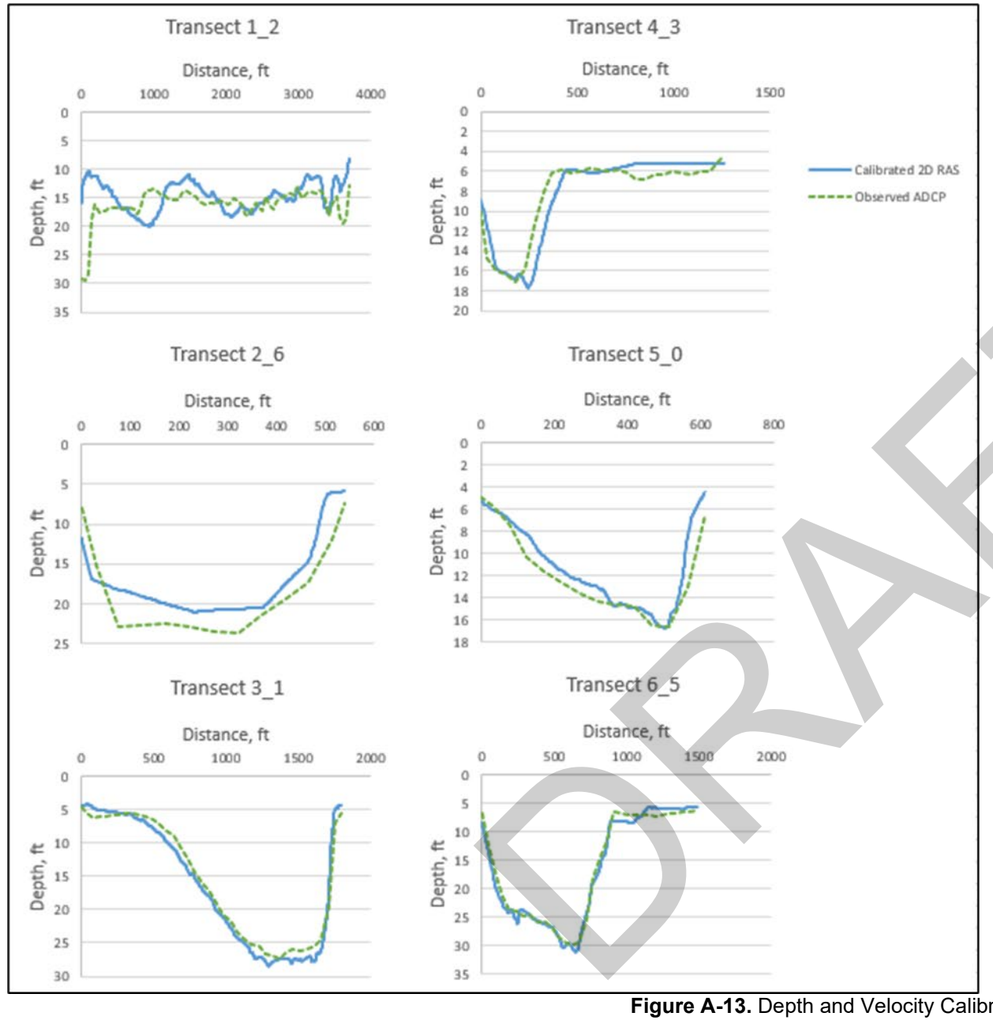
6/17/2019: Depth Calibration



6/17/2019: Velocity Calibration

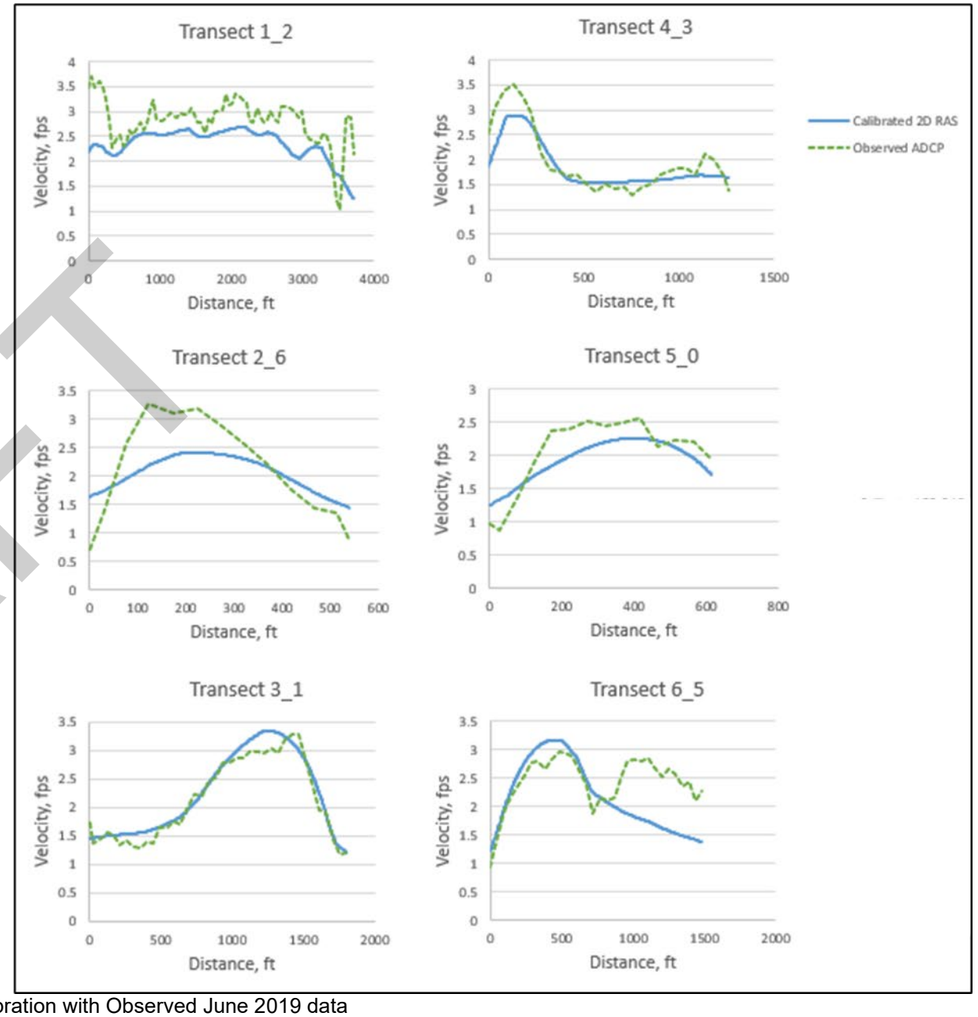


Figure A-13. Depth and Velocity Calibration with Observed June 2019 data

Left: Observed ADCP and Simulated 2D HEC-RAS Depths (in feet) on June 17, 2019. Right: Observed ADCP and simulated 2D HEC-RAS velocities (in feet/second) on June 17, 2019. All distances are measured along the ADCP transect from left descending bank to right descending bank.

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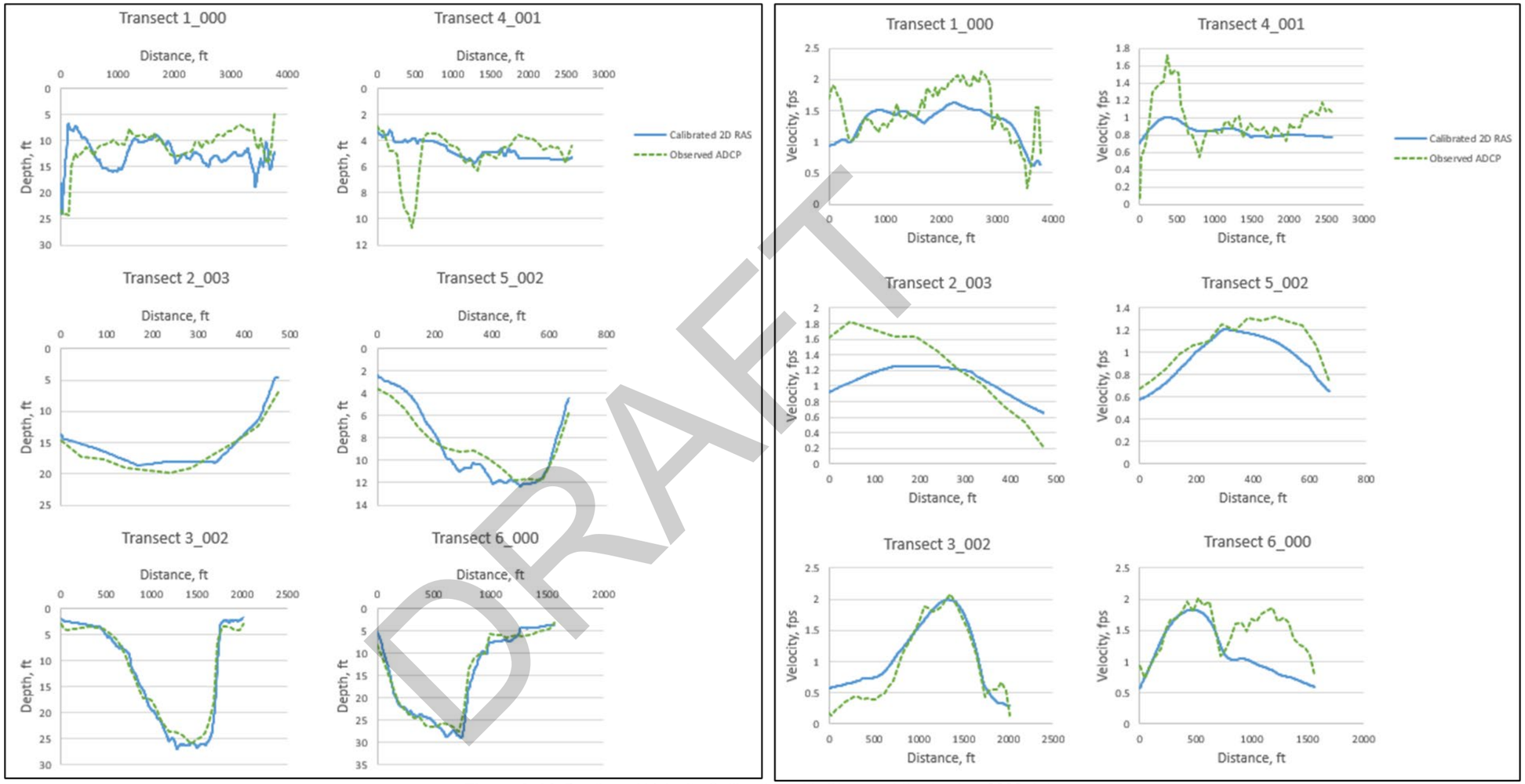

Figure A-14. Depth and Velocity Calibration with Observed September 2020 data

Left: Observed ADCP and Simulated 2D HEC-RAS Depths (in feet) on September 4, 2020. Right: Observed ADCP and simulated 2D HEC-RAS velocities (in feet/second) on September 4, 2020. All distances are measured along the ADCP transect from left descending bank to right descending bank.

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6.3 Existing Condition Simulations

The PDT has determined that the target velocity in Lower Pool 13 for wild celery (a species of submersed aquatic vegetation) is less than 15 cm/sec or 0.5 ft/sec (see Appendix A, *Environmental*). This velocity limit is thought to be ideal for both maintaining resiliency of the existing vegetation and for growing new beds. It is not known how often this requirement must be met. To determine the most appropriate existing condition boundary conditions for wild celery habitat benefit comparison, a variety of Lock and Dam 13 flow exceedance durations for the May 1–Sept 30 growing season were applied to the existing condition model geometry. Table A-15 lists the discharge applied to the upstream boundary and the water surface elevation applied to the downstream boundary for each flow exceedance duration tested. Model geometry and computational settings were consistent with those described in Section 6.1.2. Roughness values were consistent with those determined in Section 6.2.4. All simulations were run for a two-week time period to a steady state solution with constant "flat" flow and stage hydrographs.

Table A-15. Boundary Conditions (Upstream Discharge and Downstream Water Surface Elevation) Tested. Boundary conditions proposed as most appropriate for determination of wild celery habitat benefits highlighted in gray.

Flow exceedance duration (May 1–Sept 30)	Upstream boundary condition (Discharge, cfs)	Downstream boundary condition (water surface elevation, ft NAVD88)
60%	55,000	582.4 (flat pool)
55%	60,000	582.4 (flat pool)
50%	65,000	582.4 (flat pool)
45%	70,000	582.4 (flat pool)
40%	77,000	582.4 (flat pool)

6.3.1 Existing Condition for Wild Celery Habitat Benefits

Velocity results for each existing condition simulation were compared to 2015 NAIP imagery in Lower Pool 13. The 55% exceedance duration simulation (60,000 cfs applied to the upstream model boundary and 582.4 ft NAVD88 water surface applied to the downstream model boundary) produced velocities that most closely match the observed vegetation distribution in the Lower Pool as shown in 2015 NAIP imagery. The collection data of the imagery in this area was 8/12/2015 and the discharge at Lock and Dam 13 on that was 39,839 cfs. As shown in Figure A-15, areas with computed velocities less than 0.5 ft/sec (purple, blue, green) visually line up reasonably well with the size, shape, and location of vegetation shown in the imagery. Therefore, the 55% flow exceedance duration boundary conditions were applied to the existing condition and proposed geometries for determination of wild celery habitat benefits. It should be noted that this approach is considered acceptable by the PDT in part because the habitat benefits analysis that the 2D HEC-RAS modeling supports is a comparative analysis.

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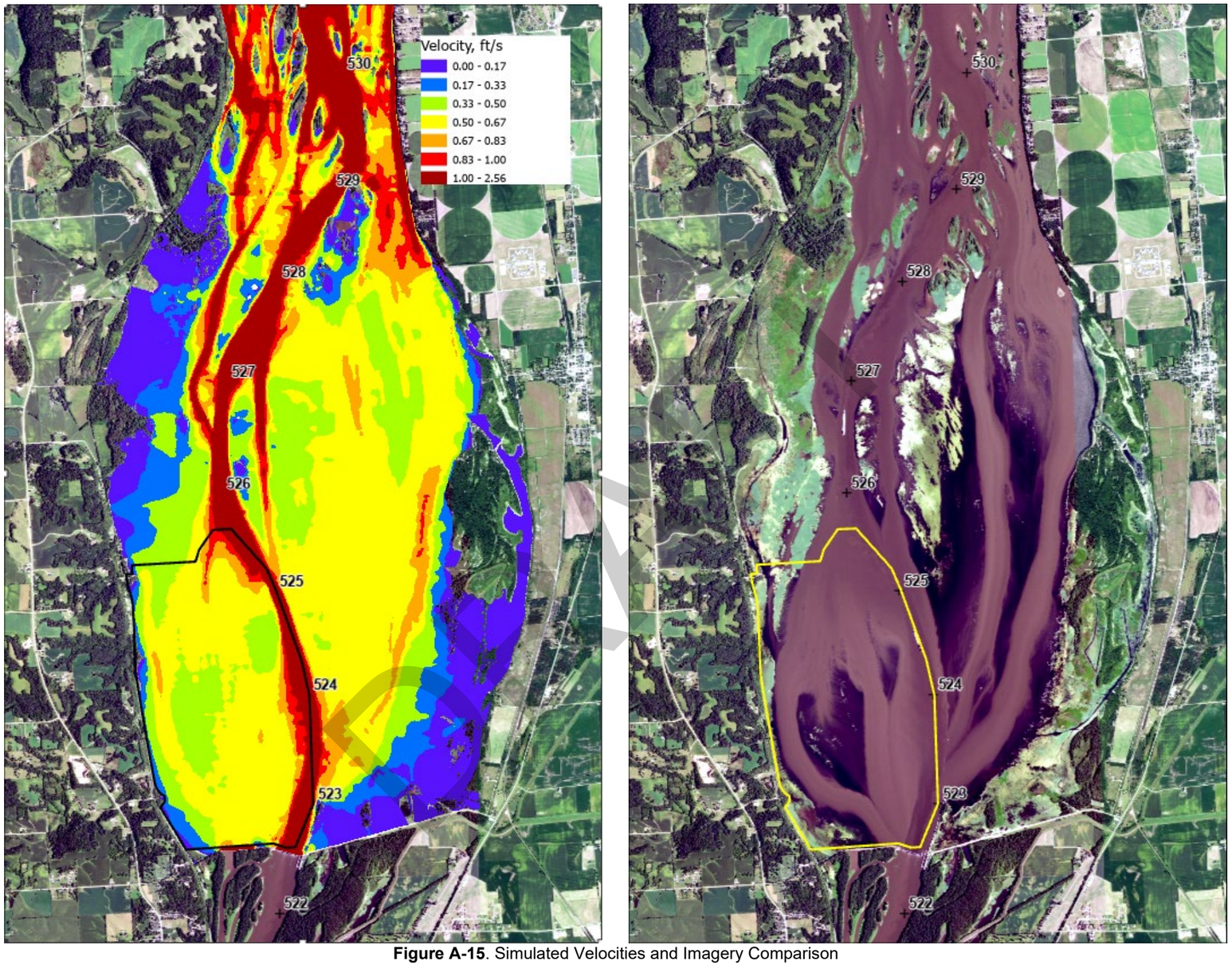

Figure A-15. Simulated Velocities and Imagery Comparison

Left: Existing Condition Velocities Simulated in 2D HEC-RAS for the 55% Duration Flow Condition (60,000 cfs). Colors represent velocities in feet/second. Target wild celery velocity is less than 15 cm/sec or 0.5 ft/sec. Study Area outlined in black. Right: 2015 NAIP imagery demonstrating typical location of vegetation in the Study Area. Study Area outlined in yellow.

6.3.2 Comparison to LTRM Velocity Data

UMRR Long Term Resource Monitoring (LTRM) velocity grab measurements are available within the study area (USGS, 2008). Figure A-16 compares 55% duration flow condition (60,000 cfs) simulated velocities to observed velocities within the study area. On 8/1/1994, 7/30/2002, and 7/23/2008, discharges at Lock and Dam 13 Fulton, IL gage were 61,120 cfs, 62,594 cfs, and 61,741 cfs, respectively. Of the 25 total observations, 8 measured velocities were higher than simulated, 7 measured velocities were lower than simulated, and 7 measured velocities were simulated within the correct velocity bin shown in Figure A-16. Velocities observed to be higher or lower than simulated were not typically off by more than one "bin". 3 measured velocities were recorded to be 0 ft/s. It is not known if these measurements are valid (i.e., 0 ft/s velocity was measured within a wild celery bed) or if there was an error in these records. It should be noted that dates of field observations are (1) during the identified wild celery growing season and (2) several years apart. Wild celery growth, bathymetry, and other unknown factors are likely to impact differences in observed measurements.

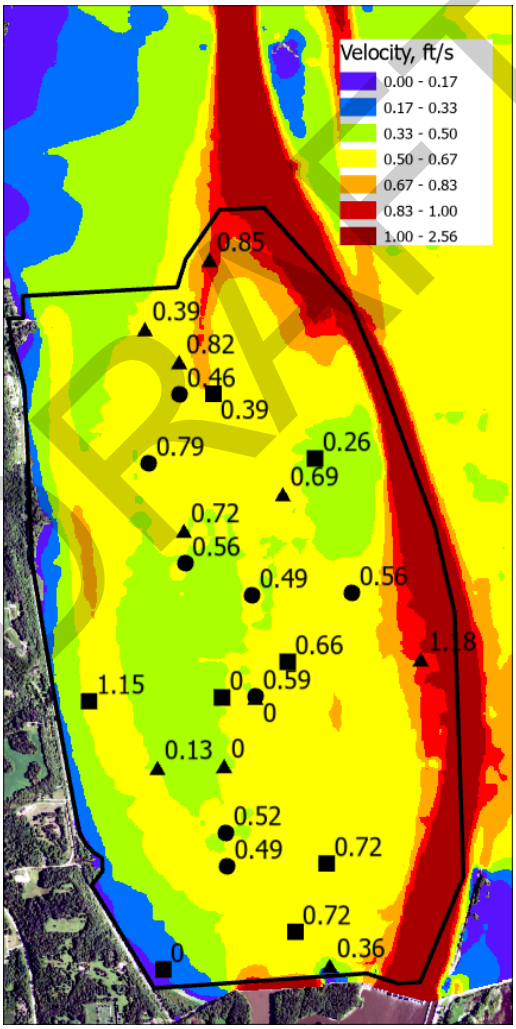

Figure A-16. Observed LTRM Velocities and Simulated Velocities Comparison

Text Indicates LTRM Observed Velocities in ft/s on 8/1/1994 (black circles), 7/30/2002 (black squares), and 7/23/08 (black triangles). Colors represent existing condition velocities in ft/sec simulated in 2D HEC-RAS for the 55% duration flow condition.

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6.4 Alternative Analysis

Three proposed feature alternatives were developed by the PDT as described in the main report and Appendix E, *Engineering.* As shown in Table A-16, the "Maximum", "Efficient", and "SAV" (submerged aquatic vegetation) alternatives include chevron(s), rock mounds, an island, access dredging, dredge material placement sites, and timber stand improvement. Locations of these features are shown in Figures A-18 to A-20 (left).

Table A-16. Features Included in Each Proposed Alternative

Feature Type	Feature	Top Width, Ft	Top Elevation, Ft NAVD88	Side Slopes, H:V	Maximum Alternative	Efficient Alternative	SAV Alternative
Chevrons	CV-H6	10	582.4	2	x	x	x
	CV-H10	10	582.4	2	x		
Rock Mounds	RM-H9A_MAX	10	584.9	2	x		x
	RM-H9A_EFFI	10	582.4	2		x	
	RM-H9B	10	582.4	2	x	x	x
	RM-H3A	10	582.4	2	x	x	x
	RM-H3B	10	582.4	2	x	x	x
	RM-H3C	10	582.4	2	x	x	x
	RM-H6	10	582.4	2	x	x	x
	RM-H7	10	582.4	2	x		x
	RM-H10	10	582.4	2	x	x	x
	RM-H11	10	582.4	2	x	x	x
	RM-H12	10	582.4	2	x		
Island	I-H4	150	584.9	2 U/S, 6 D/S	x	x	x
Access Dredging	Not included in 2D velocity modeling – velocity outputs don't count toward SAV benefits						
Dredge Material Placement Sites	Not included in 2D velocity modeling – velocity outputs don't count toward SAV benefits						
Timber Stand Improvement	Not included in 2D velocity modeling, not relevant						

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6.4.1 Alternative Simulations

For each alternative, RAS Mapper v. 6.0 terrain building tools were used to update the existing condition terrain (Section 6.1.2). The model grid was updated to include breaklines aligning with each of the proposed features to ensure that they were appropriately captured (Figure A-17). Grid cell size in the vicinity of these features varied between 2.5 and 10 feet. The 55% exceedance duration flow condition was applied to each proposed simulation: a 60,000 cfs flow at the upstream boundary and a 582.4 ft NAVD88 water surface elevation at the downstream boundary. All simulations were run for a one-week period to a steady state solution with constant "flat" flow and stage hydrographs. In addition to each proposed alternative, the existing condition was re-run with the updated model grid and run period detailed here for consistency.

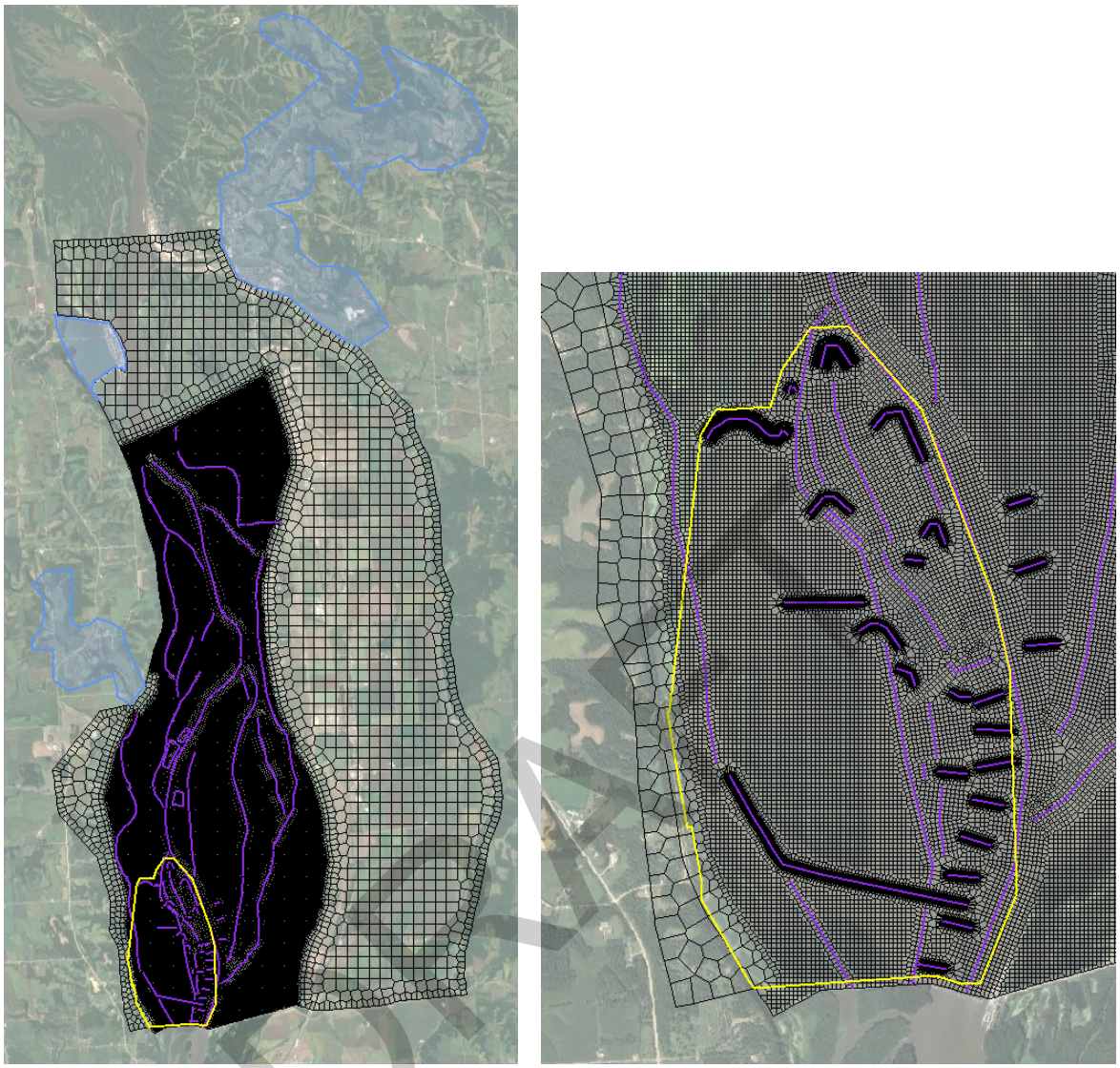

Figure A-17. Updated Lower Pool 13 HREP 2D HEC-RAS model grid.

Used for all alternative simulations and final existing condition simulation. Full model extent shown on left. Study Area (not including forestry areas) shown on right. Model cells are drawn in black, storage areas are drawn in blue, model break lines are drawn in purple, and Lower Pool 13 HREP boundary is drawn in yellow.

6.4.2 Results

Velocities simulated with the Lower Pool 13 HREP 2D HEC-RAS model are shown for the Maximum, Efficient, and SAV Alternative in Figures A-18 to A-20(center). Existing condition results are also shown in each figure for comparison (right). Velocities shown are in ft/s. As with the existing condition, velocities less than 0.5 ft/s (purple, blue, and green) were assumed ideal for wild celery growth. For all cases, the island, chevron(s), and rock mounds reduced velocities downstream of each feature and within a smaller area upstream of each feature. Velocities increased east and west of each feature. RM-H7 (included in the Maximum and SAV Alternatives) increased velocities in the existing flow path along the southwestern boarder of the study area. It should be noted that the primary intent of RM-H7 was not to reduce velocities, but

rather to reduce sediment resuspension caused by wind driven waves.

6.4.3 Impact of Vegetation

It should be noted that SAV observed within the Lower Pool 13 HREP boundary appears to impact velocities within the bed itself and immediately downstream. This process was not simulated by the 2D HEC-RAS model. It is therefore possible that velocities in and adjacent to the SAV beds are smaller than simulated. If the model overestimates velocities in and adjacent to SAV beds, other areas where higher velocities have been simulated may have larger velocities than simulated. Adjusting manning's n values to represent the location of wild celery was considered, but not attempted, as the location and extent of the vegetation varies drastically from year to year.

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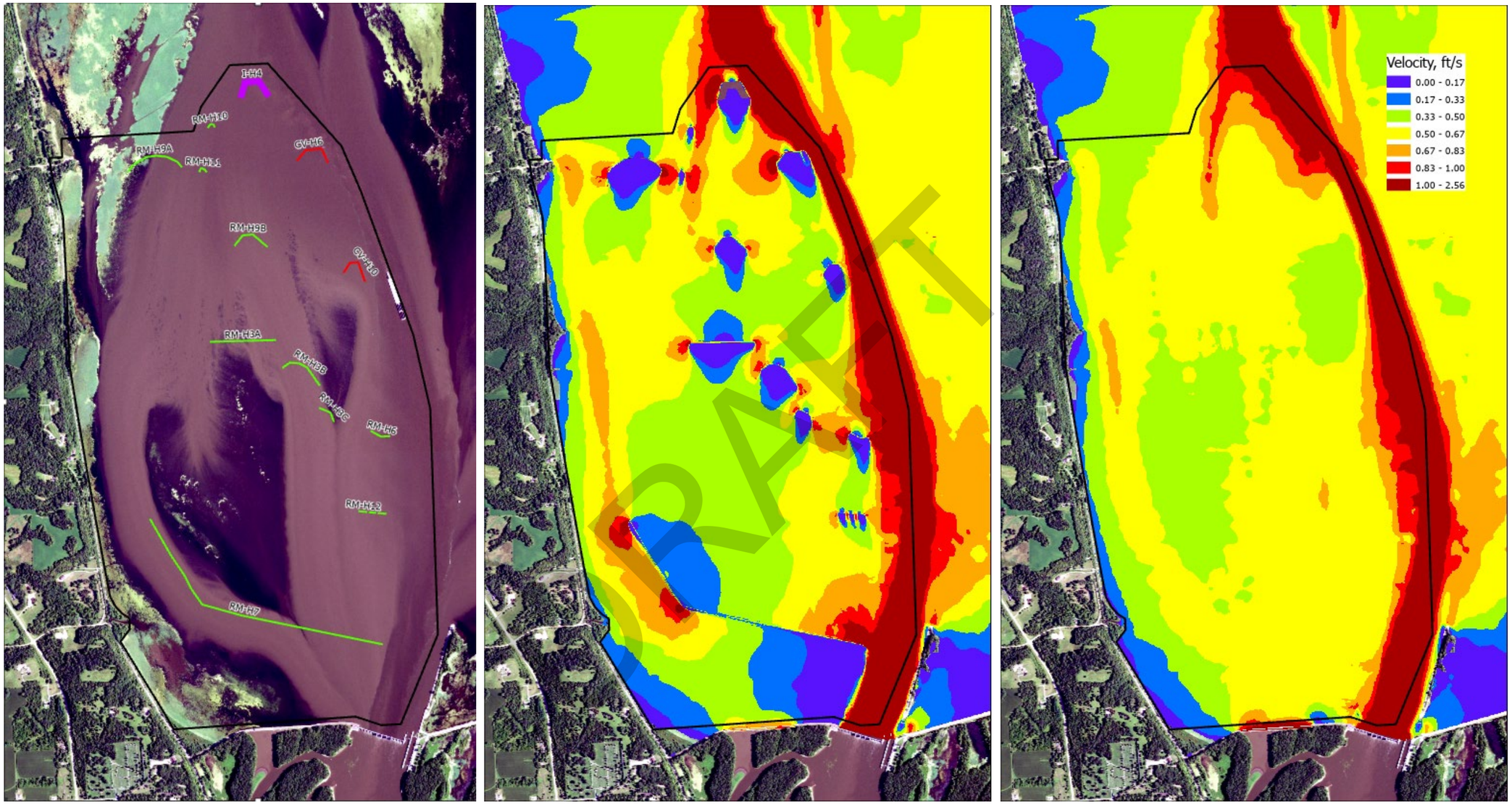

Figure A-18. Velocity Results for the Maximum Alternative.

Left: Features included in Maximum Alternative 2D HEC-RAS simulation (chevrons in red, rock mounds in green, island in purple). Center: Velocity results for Maximum Alternative for the 55% duration flow condition. Right: Velocity results for existing condition (shown for comparison). All velocities in ft/s. Study Area (not including forestry) shown in black.

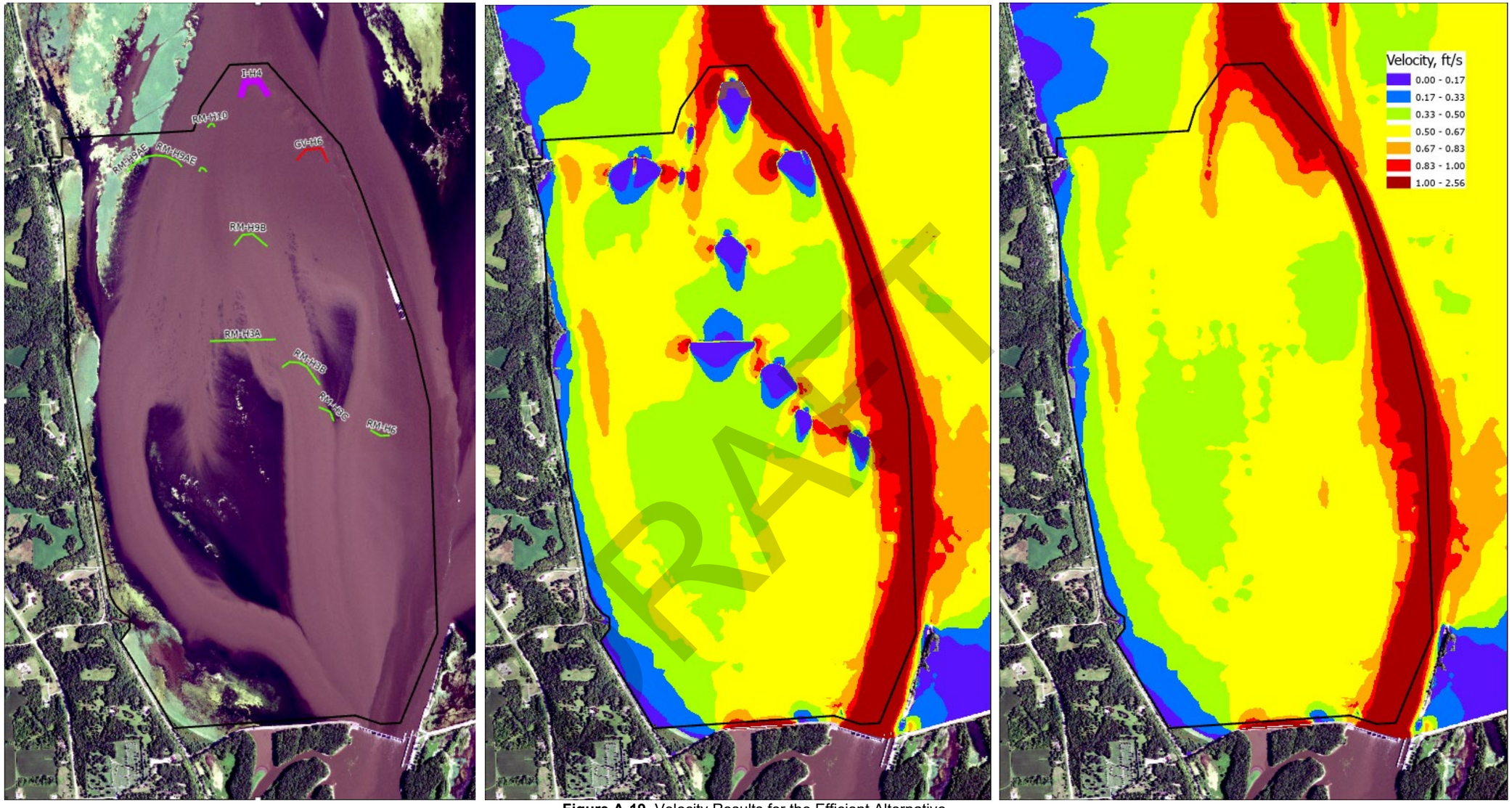

Figure A-19. Velocity Results for the Efficient Alternative.

Left: Features included in Efficient Alternative 2D HEC-RAS simulation (chevrons in red, rock mounds in green, island in purple). Center: Velocity results for Efficient Alternative for the 55% duration flow condition. Right: Velocity results for existing condition (shown for comparison). All velocities in ft/s. Study Area (not including forestry) shown in black.

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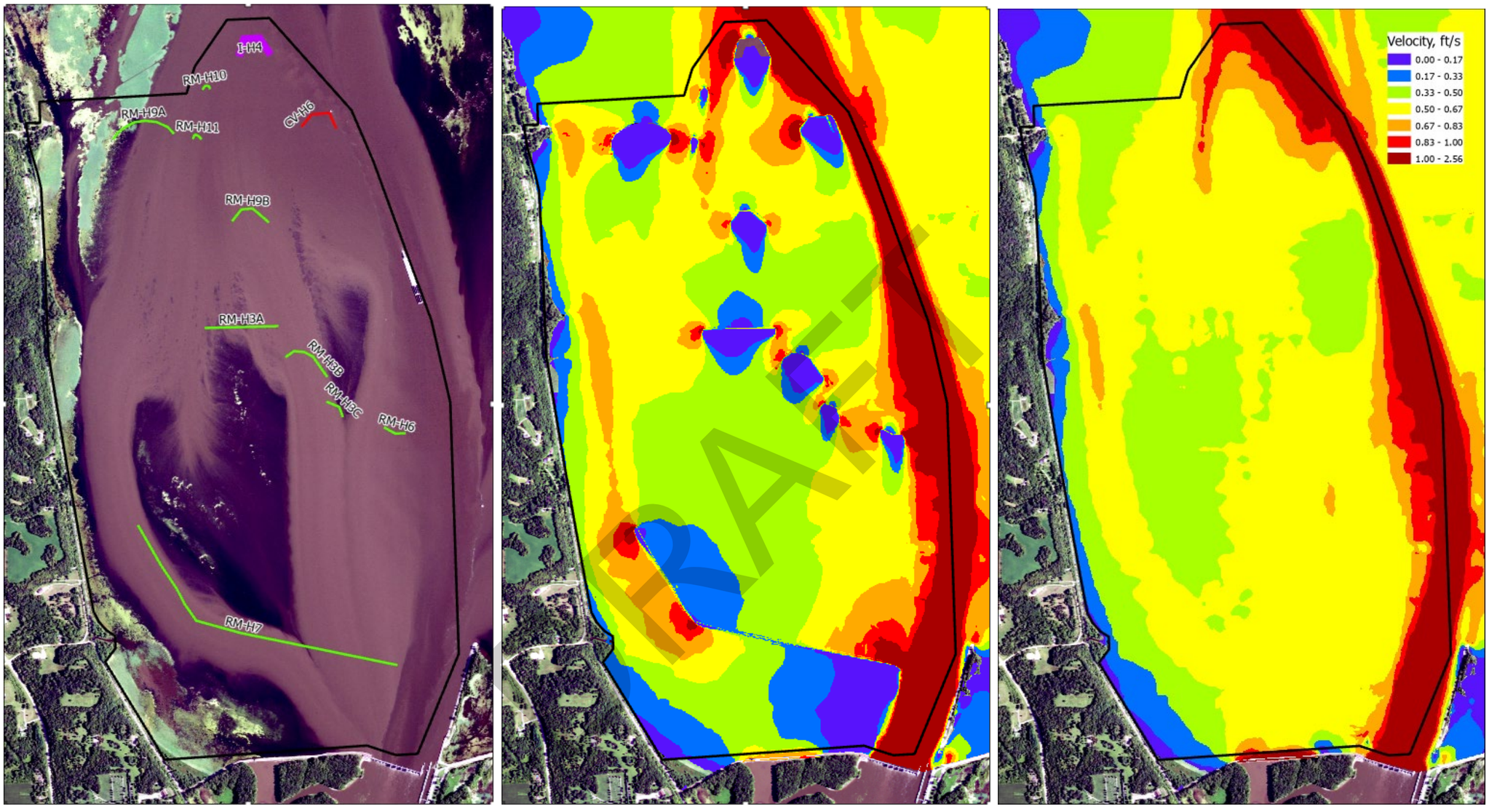

Figure A-20. Velocity Results for the SAV Alternative.

Left: Features included in SAV Alternative 2D HEC-RAS simulation (chevrons in red, rock mounds in green, island in purple). Center: Velocity results for SAV Alternative for the 55% duration flow condition. Right: Velocity results for existing condition (shown for comparison). All velocities in ft/s. Study Area (not including forestry) shown in black.

7. WIND-WAVE MODELING AND SEDIMENT RESUSPENSION

The PDT has determined that increases in turbidity due to wind-driven wave action in Lower Pool 13 are likely reducing the resiliency and growth of wild celery in the study area (see Appendix A, *Environmental*).

The modeling software STWAVE version 6 (Massey et al., 2011) computes wind-wave generation and nearshore transformation (refraction, shoaling, and breaking). This software was used to simulate significant wave height and period for both the existing condition and proposed feature conditions in Lower Pool 13. Raster functions in ArcPro version 2.8 (ESRI, 2021) were then used to compute maximum orbital wave velocity and determine how proposed features can be anticipated to impact sediment resuspension.

Turbidity assumption: It should be noted that turbidity at any given location within the study area is driven by both (1) upstream sediment load and (2) local resuspension of sediment. Sufficient data is not available to determine which driver is most substantial in Lower Pool 13; however, reduction of upstream sediment load is outside of the Study scope. This analysis assumes that reducing localized resuspension of sediment due to wind driven wave action will cause enough of a localized reduction in turbidity to improve the resiliency of existing wild celery and encourage new growth.

7.1 Model Development

Components required for STWAVE model development are detailed below. Simulation files were generated primarily using SMS 13.0.8 (Aquaveo, 2019) and run on the USACE-ERDC High Performance Computer, Onyx.

7.1.1 Model datum

Horizontal datum for this model was NAD 1983 UTM Zone 15N. Vertical datum for this work was NAVD88. Horizontal and vertical units are in meters.

7.1.2 Geometry

Extent of the Lower Pool 13 HREP STWAVE model grid is shown in Figure A-21. Grid cells are oriented parallel and perpendicular to the extent boundary with square, 5-meter x 5-meter cells. Model extent is such that wind fetch will reach land in every direction. “x0” and “y0” were set to 739797.0 and 4642056.0, respectively. “n_cell_i” and “n_cell_j” were set to 2770 and 1347, respectively.

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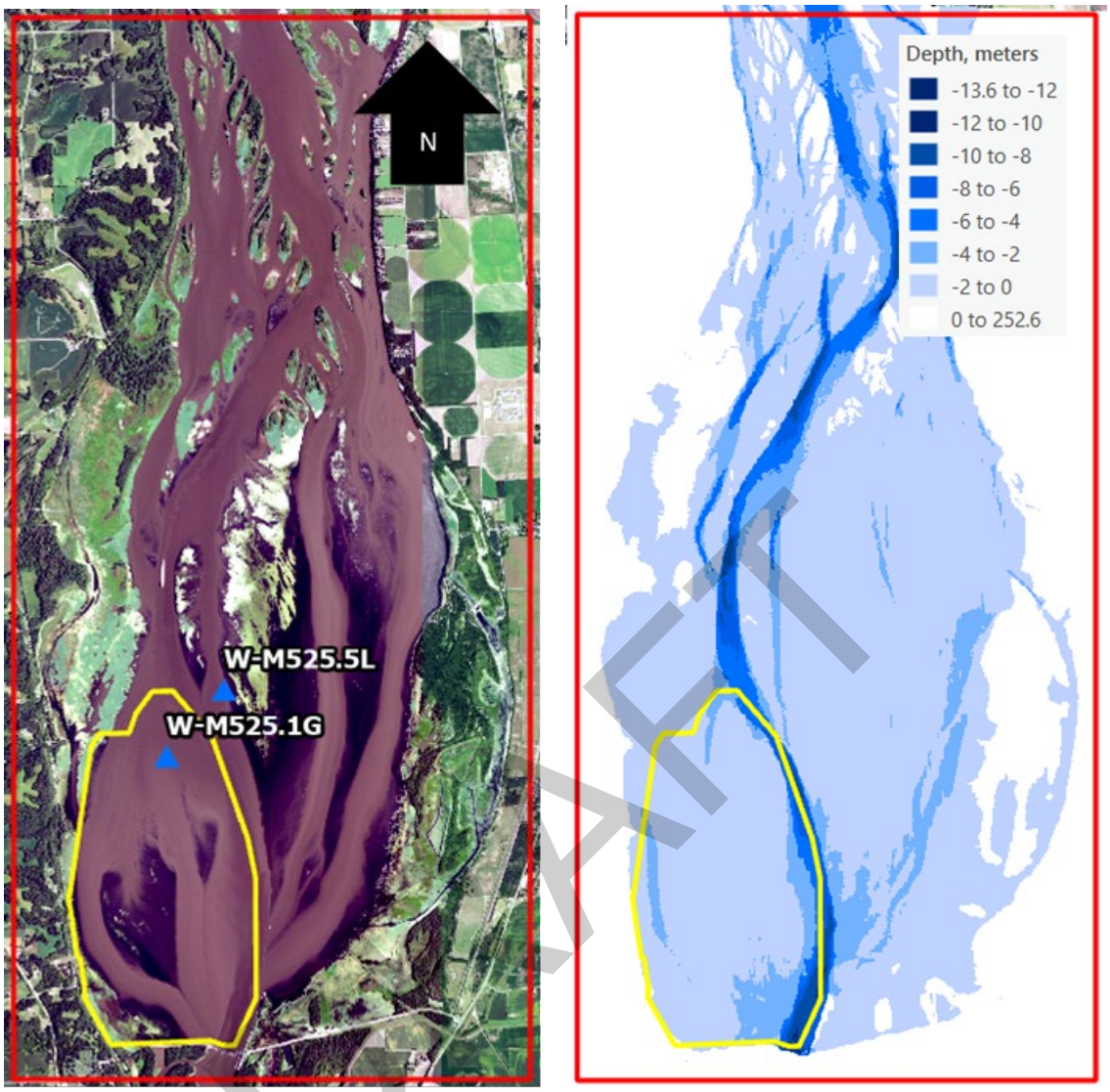

Figure A-21. STWAVE model grid extent

Left: Lower Pool 13 HREP STWAVE model grid extent shown in red. Blue triangles indicate locations of localized windspeed measurements and wave height estimates. Study Area (not including forestry areas) shown in yellow. As shown by North arrow, north is oriented "up" in all figures that follow. Right: Existing condition depths (in meters) applied to STWAVE model.

7.1.3 Parameters

"Full plane" and "source terms and propagation" options were selected within the STWAVE model settings to allow (1) simulations of winds from any direction and (2) simulation of the impact of wind on the wave field, respectively. Bottom friction was set to a manning's n value of 0.03 for the entire simulation area. Spectral grid settings were specified as 41, 0.02 hertz, and 0.2 hertz for "number", "delta", and "minimum", respectively. These are considered appropriate for this shallow riverine setting because they allow the model to resolve wave periods ranging from 1.0–5.0 seconds. Water level was held constant. Iteration settings were specified as 50, 0.1, 100.0%, 50, 0.05, and 99.8% for "maximum number of initial iterations", "initial iterations stop value", "initial iterations stop percent", "maximum number of final iterations", "final iterations

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stop value", and "final iterations stop percent", respectively. Per the STWAVE User's Manual, these values allow a simulation partitioned across multiple processors to yield the closest solution to a serial simulation (Massey et al., 2011)

Eighteen combinations of wind direction and windspeed were simulated (Table A-17). Wind was applied in each of the four cardinal directions and with windspeeds ranging from 5 to 20 miles/hour. Additional simulations were conducted with northeast and southeast, 20 miles/hour winds. Exceedance durations for each windspeed simulated are also shown in Table A-17. Values shown were computed from 10-minute instantaneous windspeed readings at Lock and Dam 13, May 1–September 30 (growing season), 2014–2019.

Table A-17. Wind direction and wind speed combinations applied to STWAVE simulations. Wind originates from the direction indicated. For example, a south wind originates from the south and blows northward. Exceedance duration for each windspeed also provided and was computed from 10-minute instantaneous windspeed readings at Lock and Dam 13, May 1–September 30 (growing season), 2014–2019.

Combination	Wind Direction	Windspeed (meters/second)	Windspeed (miles/hour)	Exceedance Duration for 10-min Instantaneous Windspeed (%)
1	South	8.9	20	0.5
2	South	6.7	15	3.5
3	South	4.5	10	14.0
4	South	2.2	5	45.0
5	West	8.9	20	0.5
6	West	6.7	15	3.5
7	West	4.5	10	14.0
8	West	2.2	5	45.0
9	North	8.9	20	0.5
10	North	6.7	15	3.5
11	North	4.5	10	14.0
12	North	2.2	5	45.0
13	East	8.9	20	0.5
14	East	6.7	15	3.5
15	East	4.5	10	14.0
16	East	2.2	5	45.0
17	Northeast	8.9	20	0.5
18	Southeast	8.9	20	0.5

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7.1.4 Post-processing

STWAVE spatial inputs and outputs (northing, easting, depth, wave height, and wave period) were exported to tab delineated text files using SMS. ArcGIS Pro v. 2.8 was used to generate raster files for significant wave height and period. Also in ArcGIS Pro, maximum orbital wave velocity (MOWV) was computed according to the following formula (derived from Rohweder et al. p. 24-25):

$$MOWV = [\pi * H_{mo}] / \left[T_P * \sinh \frac{4 * \pi^2 * d_f}{g * {T_P}^2} \right]$$

Where $MOWV$ is maximum orbital wave velocity at the channel bottom in m/s, H_{mo} is significant wave height in meters, T_P is spectral peak wave period in seconds, d_f is water depth in meters, and g is acceleration due to gravity in m/s. Maximum orbital wave velocities greater than 0.1

m/s are assumed to indicate areas of sediment resuspension (Rohweder et al., 2012, p. 40). More scientific research is needed to refine this parameter, but “gut check” comparison of existing condition MOWV results suggest that 0.1 m/s is an appropriate value for this location. The MOWV equation assumes that resuspension is driven by both wave parameters and depth. Areas with higher wave height and smaller depth can be expected to be more “vulnerable” to resuspension.

Impact of Wild Celery: It should be noted that field observations within Lower Pool 13 suggest the presence of a large wild celery bed may reduce the impact of wind drive waves and resuspension of sediment. This process was not simulated in STWAVE or included in the MOWV computations.

7.2 Existing Condition Simulation

For the existing condition, the 50% exceedance duration depth grid generated by the Lower Pool 13 HREP 2D HEC-RAS model was exported with a 2-meter cell size, converted to the STWAVE projection and units (NAD 1983 UTM Zone 15N, meters), and then applied to the STWAVE grid (Section 7.1.2). STWAVE model output had a 5-meter cell size resolution.

7.2.1 Wave Height

Resulting wave heights simulated by windspeed; wind direction combinations 1–16 (Table A-17, above) are listed in Table A-18 for the two locations designated in Figure A-21 (above, W-M525.5L and W-M525.1G). W-M525.5L is outside the study area, east of the navigation channel. W-M525.1G is in the northern portion of the study area. At W-M525.5L, the largest simulated wave height was 30.5 cm, generated by a 20-mph south wind. The smallest simulated wave height was 4.6 cm, generated by a 5-mph west wind. At W-M525.1G, the largest simulated wave height was 29.0 cm, generated by a 20-mph south wind. The smallest simulated wave height was 4.2 cm, generated by a 5-mph south wind.

Table A-18. Wave Height Results at Locations W-M525.5L and W-M525.1G from STWAVE Existing Condition Simulations. Wave heights shown for (1) each wind speed and direction combination and (2) the average for each windspeed. All wave heights provided in centimeters.

Location	Simulated Windspeed (mph)	Existing Condition Simulated Wave Height (cm)				
		South Wind	West Wind	North Wind	East Wind	Average
W-M525.5L	20	30.5	18.1	24.0	21.4	23.5
	15	23.5	13.0	19.0	15.5	17.8
	10	15.8	8.4	13.3	9.6	11.8
	5	7.4	4.6	6.4	4.7	5.8
W-M525.1G	20	29.0	17.5	27.7	28.8	25.8
	15	22.0	12.7	21.1	16.8	18.2
	10	14.6	7.9	14.1	10.8	11.9
	5	6.9	4.2	6.6	5.2	5.7

7.2.2 Wave Height “Gut Check”

To approximately verify the existing condition STWAVE wave height results, the average wave height for each windspeed (Table A-18 above, far right column) was compared to observed data

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collected at W-M525.5L and W-M525.1G. Plots of this comparison are shown in Figure A-22. Observed data was collected by USACE Rock Island District Water Quality Section between June and September of 2019–2021. Windspeed was measured by handheld anemometer. Wave height was determined visually. Simulated wave heights fit reasonably within the range of wave heights observed. No windspeed – wave height observed data is available for larger windspeeds due to unsafe boating conditions at these windspeeds.

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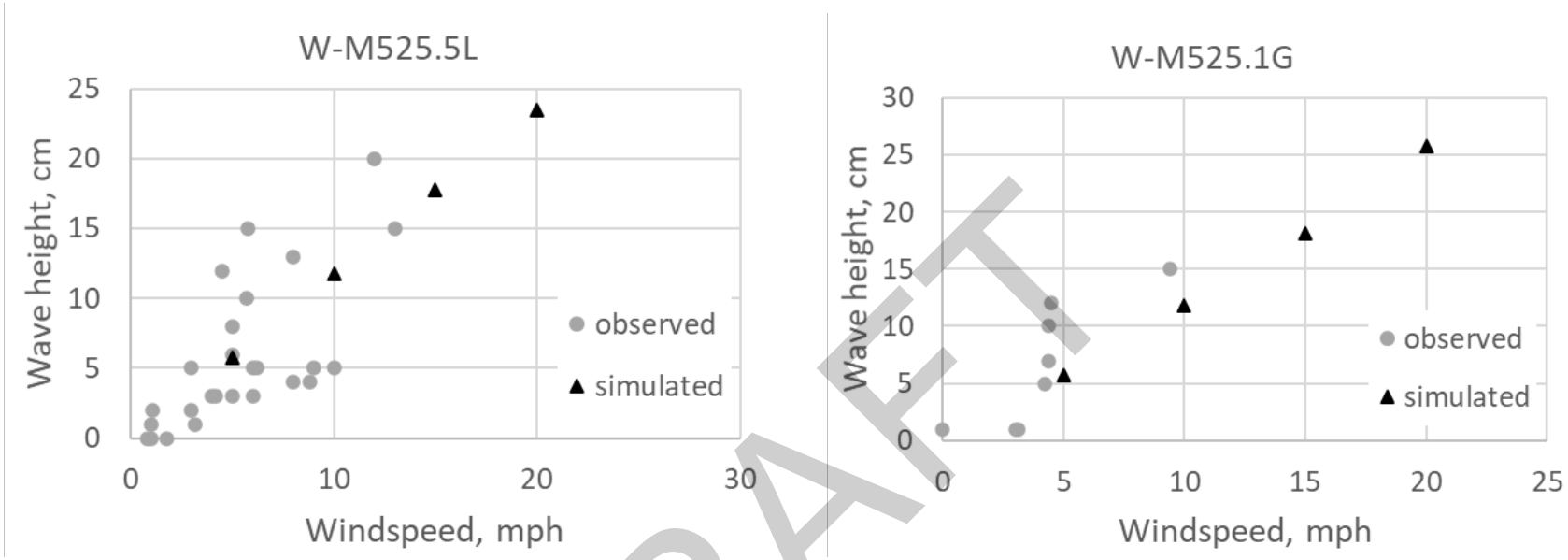

Figure A-22. Simulated and Observed Wave Heights

Average wave height simulated by STWAVE for each windspeed (black triangles) compared to observed data collected by USACE Rock Island 2019–2021 (June–September). Location W-M525.5L shown on left. Location W-M525.1G shown on right.

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7.2.3 Wind Driven Wave Resuspension of Sediment

Computed existing condition maximum orbital wave velocity values corresponding to each windspeed; wind direction combination was classified as “protected” from resuspension (MOWV < 0.1) or “vulnerable” to resuspension (MOWV > 0.1) for each combination. Results are shown in Figure A-23, A-24, A-25, and A-26 for south, west, north, and east winds respectively and indicate the following:

- For windspeeds 5 mph and 10 mph, the entire study area is protected from all directions.
- For windspeed 15 mph, the entire study area is protected from east and west winds.
- For windspeed 15 mph, the southern two-thirds of the study area is protected from south winds. Roughly half of the study area is protected from north winds.
- For windspeed 20 mph, the entire study area is protected from west winds.
- For windspeed 20 mph, the southern half of the study area is protected from south winds. Roughly half of the study area is protected from east winds. Only deeper channels are protected from north winds.

7.2.4 Wind Driven Wave Resuspension Of Sediment “Gut Check”

On October 5, 2020, Iowa DNR (Kirk Hansen) observed the following:

> “The afternoon of 10/5 we had south winds at 17 mph with gusts into the 20's. The lower pool was brown. There was a pocket of clear water out from the ramp and north (where the water is deeper). The line between clean and turbid water is evident in the photos. I walked down to the point south of the boat ramp where sediment was being resuspended along the shoreline. There weren't violent waves crashing into the shore here, just small slow rollers coming through the vegetation. I was surprised how much sediment was stirred up by these small waves, but this area is pretty shallow (< 1 ft).”

These observations support the computed results shown in Figure A-25 for 20 mph and 15 mph winds.

On October 8, 2020, Kirk observed, “There was a light [6 mph] east wind and lower pool was smooth as glass with sky blue water.” This observation supports the computed results shown in Figure A-26 for 10 mph and 5 mph winds. Photographs on these dates provided by the Iowa DNR are shown in Section 1.2 of Appendix E, *Engineering*, Attachment B, *Civil and Environmental Engineering.*

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Figure A-23. Existing condition wind-wave driven resuspension results computed for South wind: 20 mph (far-left), 15 mph (center-left), 10 mph (center-right), 5 mph (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.



Figure A-24. Existing condition wind-wave driven resuspension results computed for West wind: 20 mph (far-left), 15 mph (center-left), 10 mph (center-right), 5 mph (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.

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Figure A-25. Existing condition wind-wave driven resuspension results computed for North wind: 20 mph (far-left), 15 mph (center-left), 10 mph (center-right), 5 mph (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.

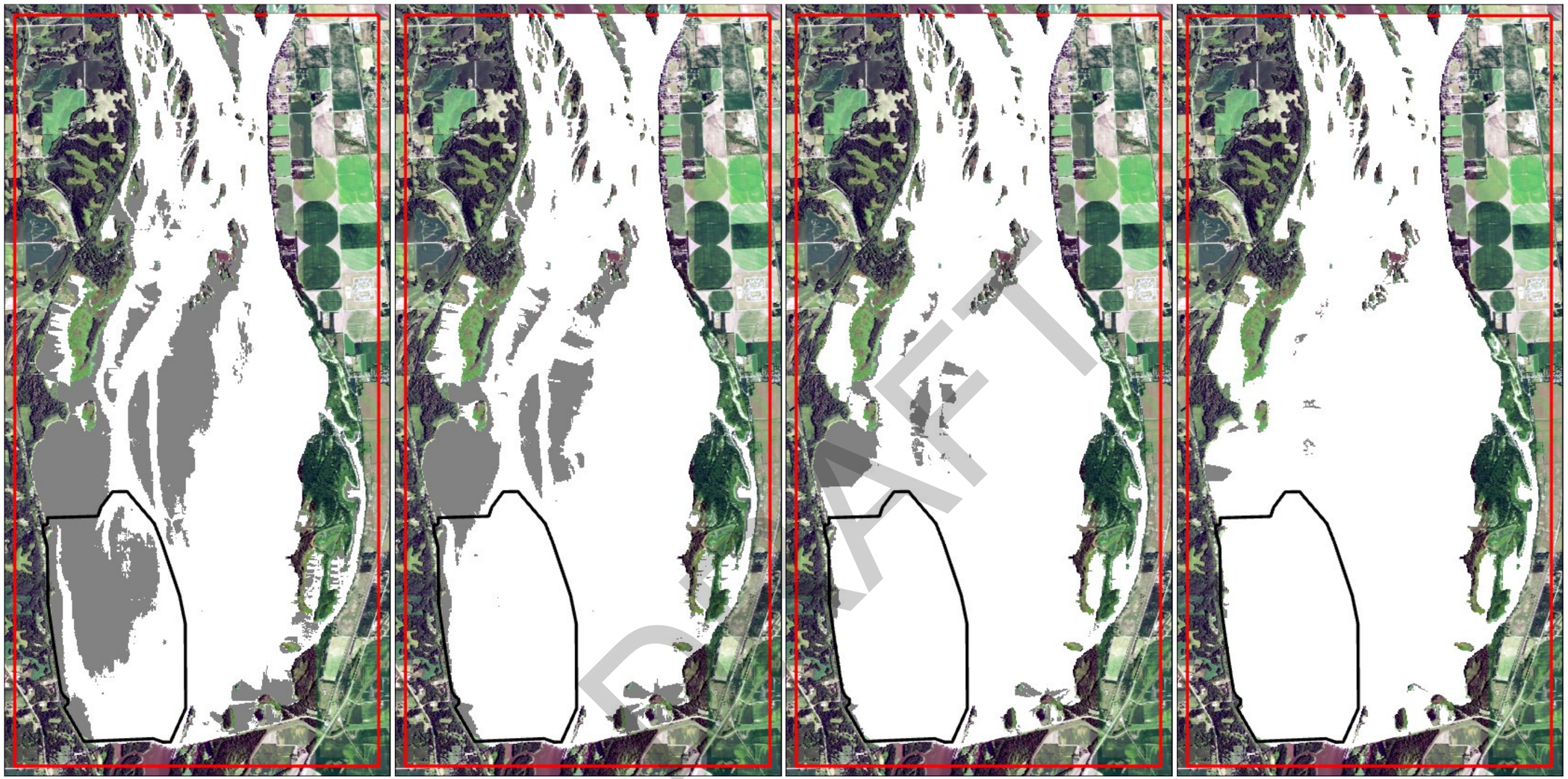

Figure A-26. Existing condition wind-wave driven resuspension results computed for East wind: 20 mph (far-left), 15 mph (center-left), 10 mph (center-right), 5 mph (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.

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7.3 UMESC Wind Fetch/Wave Models

The study also investigated the capabilities of another wind-wave model to determine the appropriate wind-wave analysis approach for (1) understanding the existing condition, (2) placing features in the study area.

The Upper Midwest Environmental Sciences Center (UMESC) of the USGS developed geospatial models to model wind fetch length, wave outputs, and the probability that fine unconsolidated particles would be suspended due to wind-generated waves (Rohweder et al., 2012). The input parameters to the model are wind fetch, wind direction, wind speed, and water depth.

The purpose of this model is to show differences in wave characteristics throughout the study area, and ultimately what areas have the probability of sediment resuspension based on those wave characteristics, to help determine where to locate features that will enhance and protect aquatic vegetation. The UMESC and STWAVE models make different assumptions, which result in different strengths. The UMESC model is suitable for understanding the existing condition and laying out project features; however, it cannot adequately simulate the impacts of subsurface features. The STWAVE model is suitable for determining the wave impacts of subsurface features; however, it cannot adequately simulate sediment resuspension caused by wind-wave energy.

The model calculates wave characteristics of each cell, not how wave growth happens over the entire modeled area. If a piece of land is in the middle of the geometry, the model doesn't know there is a shoreline impacting wave development.

The model can be used to see where it is most likely that there could be sediment resuspension, but the model won't consider vegetation. This model neglects bathymetry on wave growth, and neglects refraction, diffraction, reflection, wave-wave interactions, and wave-current interactions. The equations used are for a deep-water model which will slightly over predict the true wave height for scenarios in this project.

The UMESC model is suitable for understanding the existing condition and laying out study features; however, it cannot adequately simulate the impacts of subsurface features. The best comparison achievable is above surface STWAVE to above surface UMESC. This will show how the differences in underlaying model equations are impacting results.

This model was only used for existing conditions to calculate wind fetch to determine location of features and to compare the evaluation of the proposed design.

Refer to the model report *Application of Wind Fetch and Wave Models for Habitat Rehabilitation and Enhancement Projects* for additional details (Rohweder et al., 2012).

7.3.1 UMESC Wind Fetch/Wave Model Development

Components required for UMESC model development are detailed below. Simulation files were generated primarily using ArcGIS 10.7 (ESRI, 2019), Spatial Analyst License, Python, and Pywin32.

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7.3.2 UMESC Wind Fetch/Wave Model Datum

Horizontal datum for this model was NAD 1983 UTM Zone 15N. Vertical datum for this work was NAVD88. Horizontal and vertical units are in meters.

7.3.3 UMESC Wind Fetch/Wave Model Geometry

Extent of the Lower Pool 13 HREP UMSEC model grid is similar to the STWAVE model shown in Figure A-21. Grid cells are oriented parallel and perpendicular to the extent boundary with square, 10-meter x 10-meter cells. Model extent is such that wind fetch will reach land in every direction.

7.3.4 UMESC Wind Fetch/Wave Model Parameters

The wind input into the model was created from data from Station FLT12, Mississippi River at Fulton Lock and Dam 13. The time frame of the wind data was May to September 2018 with a time step of ten minutes. The wind data input for the wind fetch model includes the wind direction and the percentage of time the wind is coming from that direction during the period of analysis. The wind data input for the wave model is the wind direction, wind speed, and date during the period of analysis.

The depth grid input into the model was the 50% exceedance duration water surface elevation raster that was output from the Corps Water Management Systems HEC-RAS model.

In addition to evaluating the wind fetch to lay out study features, the existing conditions and Max Proposed alternative were rerun for comparison. The proposed features in the alternative all assumed a width of 150 feet.

7.3.5 UMESC Wind Fetch/Wave Model Results

The UMESC wind fetch model and probability of suspended sediments results for the existing conditions were utilized to help determine that most suitable locations for study features. The wind fetch results are shown in Figure A-27 and the percentage of days sediment is suspended is shown in Figure A-28.

Figure A-29 provides a comparison between the STWAVE results and the UMESC model for the existing and max alternative scenario. The UMESC model was rerun with the most recent terrain data and the fetch input was 0 degrees (North Wind), 100% of the time, and 1-day duration. The wave input was 0 degrees (North Wind), 20 miles per hour, and 1-day duration. As shown in the figures in Section 7.2.4 the results are shown in terms of maximum orbital wave velocity values corresponding to each windspeed – wind direction combination classified as “protected” from resuspension (MOWV < 0.1) or “vulnerable” to resuspension (MOWV > 0.1).The comparison shows the UMESC model for the max alternative over predicted the impacts when compared to the STWAVE model.

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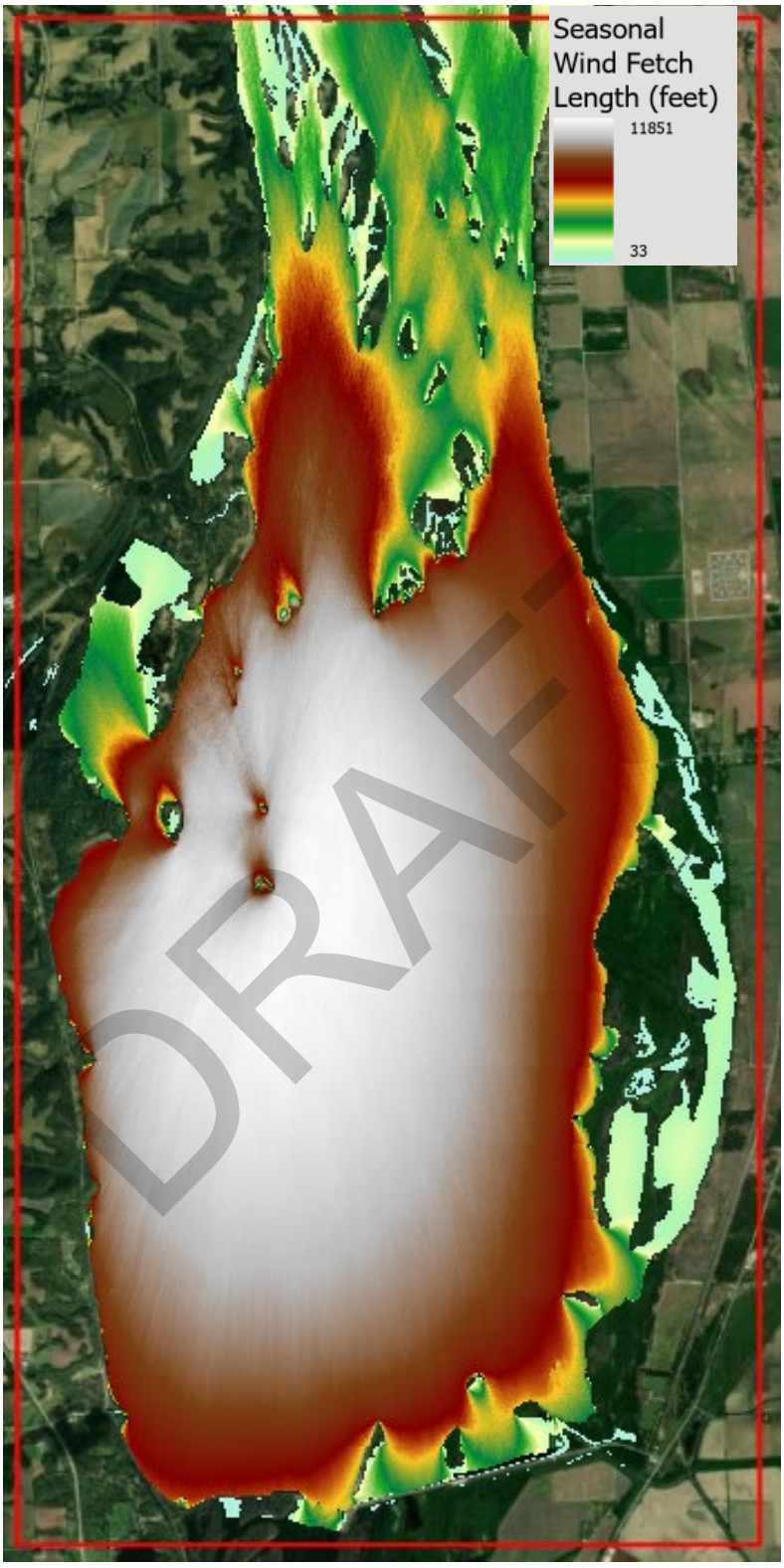

Figure A-27. Seasonal Wind Fetch Length (feet)

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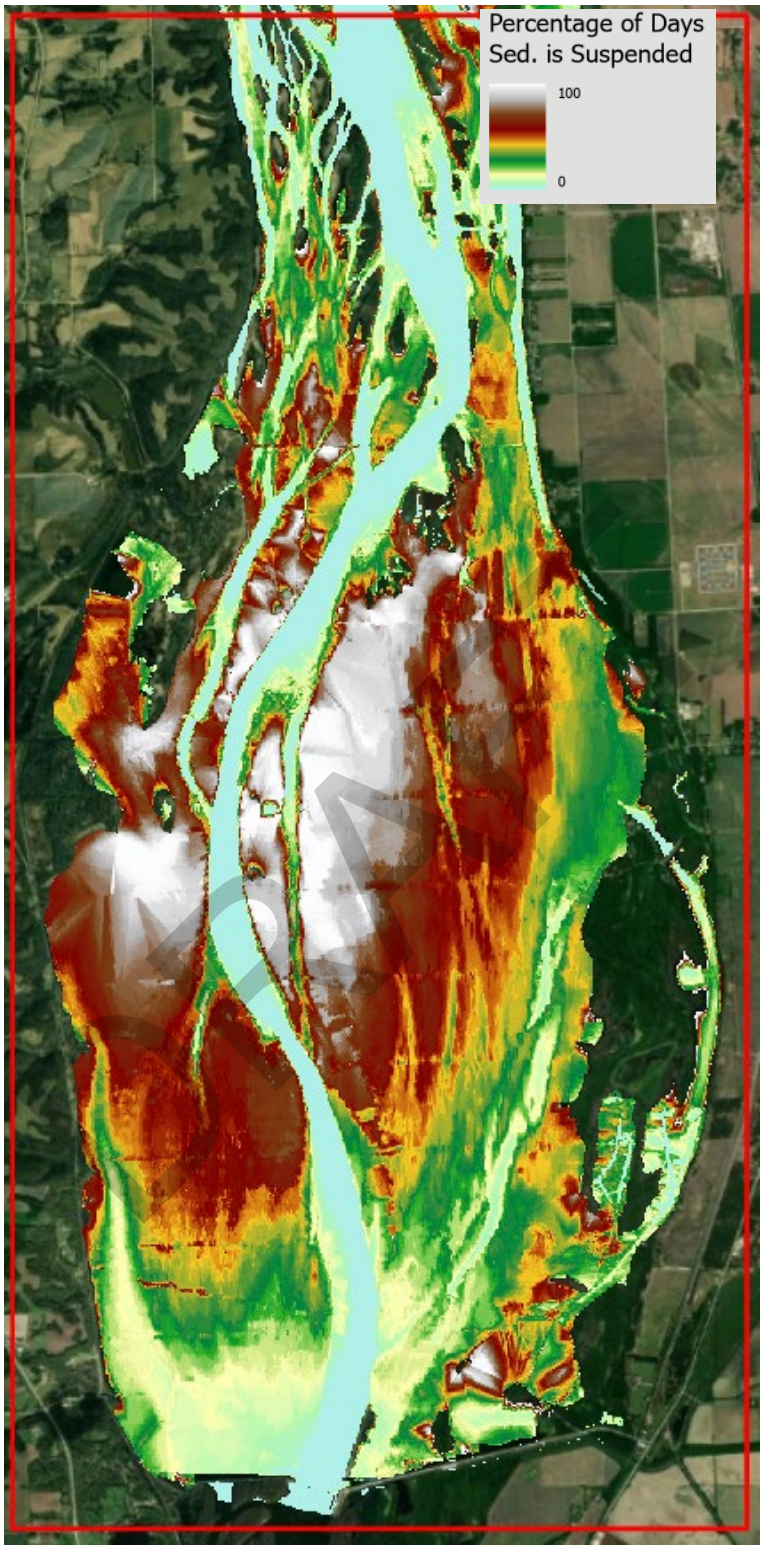

Figure A-28. Percentage of Days Sediment is Suspended Based on the Probability of Suspension (Daily Probability) for the Input Period of Record

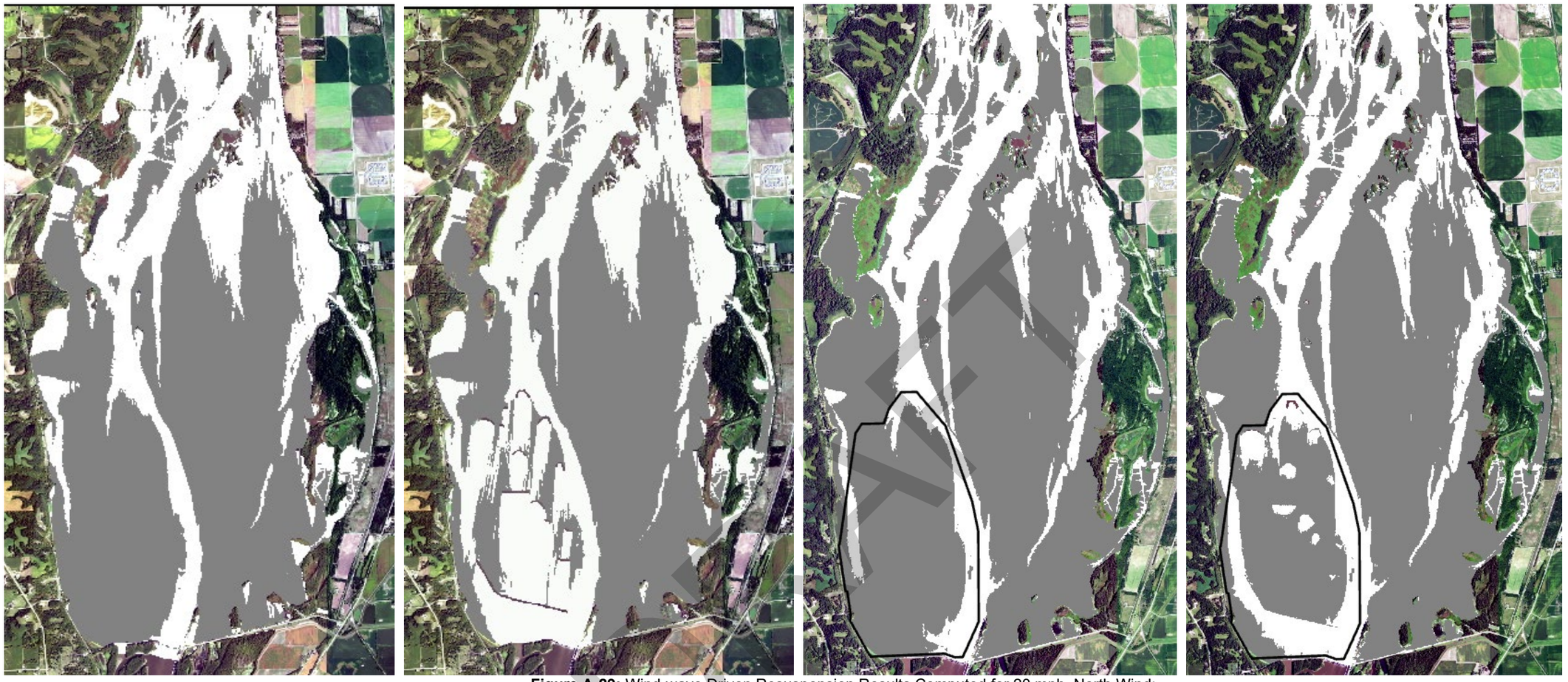

Figure A-29: Wind-wave Driven Resuspension Results Computed for 20 mph, North Wind:

UMESC model existing condition (far-left),

UMSEC model max alternative (center-left),

STWAVE existing condition (center-right), and STWAVE max alternative (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white.

Areas vulnerable to resuspension (MOWV > 0.1) shown in grey

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7.4 Alterative Analysis

Full descriptions of each of the three proposed alternatives developed by the PDT are detailed in the main report and Appendix E, *Engineering.*

7.4.1 Maximum Alternative

The 50% exceedance duration depth grid applied to the STWAVE existing condition simulations was altered to simulate the impact of the Maximum Alternative (features shown below in Figure A-30. A 150-ft width was maintained for I-H4, but all other features were widened to 50-ft to accommodate the 5-meter cell size resolution of the STWAVE model grid. I-H4 and RM-H9_MAX were assigned a top elevation of 584.9 feet NAVD88 (2.5 feet above flat pool elevation) and all other features were assigned a top elevation of 582.4 feet NAVD88 (flat pool elevation). Side slopes were neglected for all features.

7.4.2 SAV Alternative

Comparison between maximum alternative and existing condition classified MOWV output showed that the impacts of each feature could be separated effectively. Therefore, rather than simulating the impacts of the SAV alternative in STWAVE and computing MOWV values in ArcGIS Pro, classified MOWV maximum alternative raster output was edited to remove the impacts of CV-H10 and RM-H12.

7.4.3 Efficient Alternative

Like the SAV alternative, rather than simulating the impacts of the efficient alternative in STWAVE and computing MOWV values in ArcGIS Pro, classified MOWV maximum alternative raster output was edited to remove the impacts of CV-H10, RM-H12, and RM-H7. RM-H9_EFF was assumed to have similar MOWV impacts to RM-H9_MAX.

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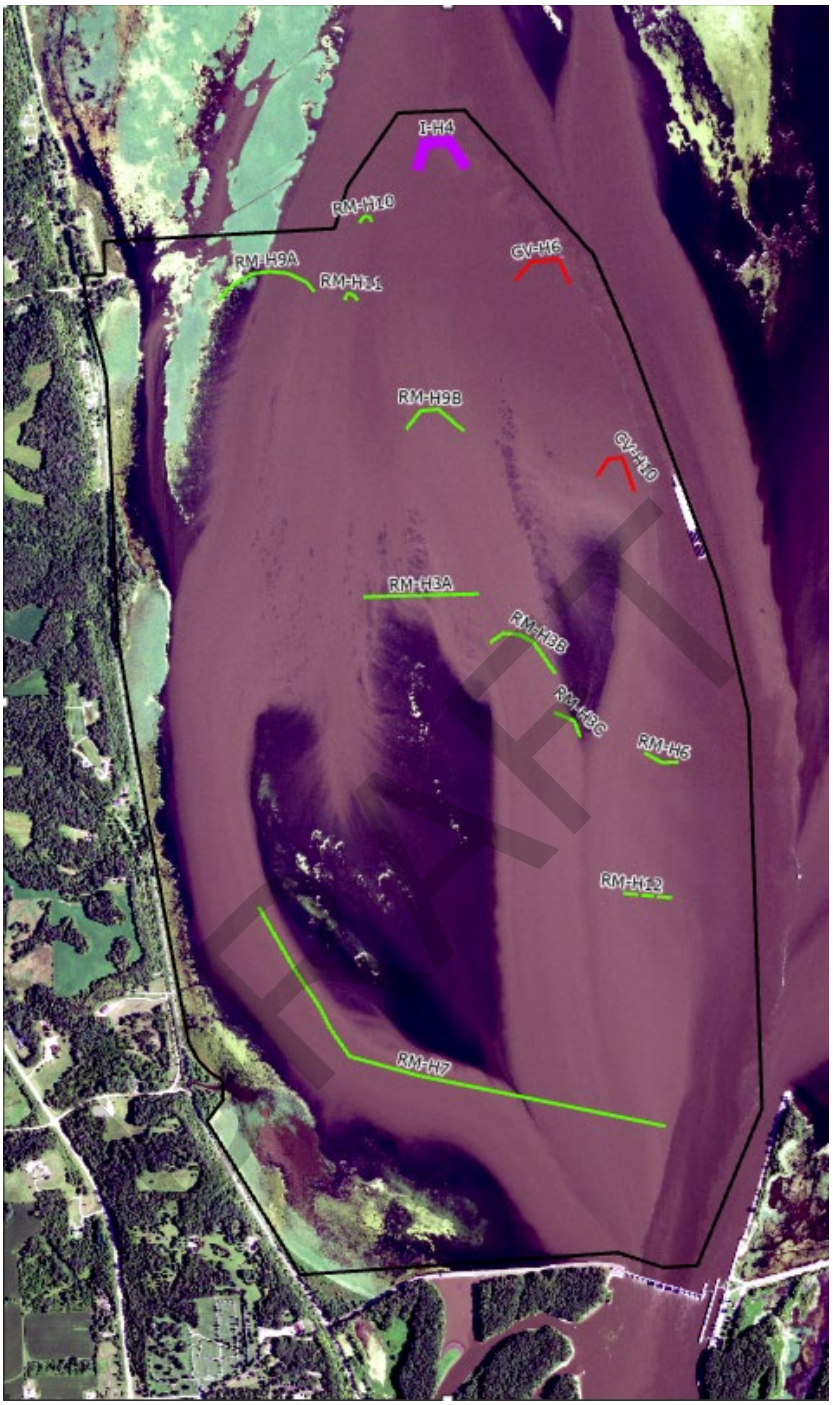

Figure A-30. Features Included in Maximum Alternative STWAVE Simulation

Chevrons are in red, rock mounds in green, and the island in purple. Study Area (not including forestry) shown in black.

7.4.4 Wind Driven Wave Resuspension of Sediment

Maximum alternative STWAVE simulations were conducted and MOWV classifications were determined for windspeed – wind direction combinations 1 – 16 (Table A-19). Figures A-31 A-32, A-33, and A-34 show results for each alternative (Maximum, SAV,

and Efficient) and the existing condition for 20 mph south, west, north, and east winds respectively.

All comparisons between classified MOWV for the existing condition and three alternatives utilize simulations with 20 mph windspeeds. This approach was taken because:

- Existing condition classified MOWV Figures A-23 to A-26 (above) demonstrate that the study area is already fully "protected" from wind-wave driven resuspension of sediment from all wind directions for windspeeds of 5 mph and 10 mph.

- Existing condition classified MOWV Figures A-24 and A-26 (above) demonstrate that the study area is already fully "protected" from west and east winds of 15 mph. Existing condition Figure A-23 (above) demonstrates that the study area is already mostly "protected" from south winds of 15 mph.

- Comparison between existing condition and maximum alternative classified MOWV output for 15 mph north winds (not shown) and 20 mph north winds (Figure A-33, below) indicate that acreages of "new protected area" are similar.

- It is assumed that windspeeds above 20 mph would show differences in "protected" area between the existing condition and maximum alternative that is similar or lesser in area than the 20 mph results. Windspeeds of 20 mph are exceeded infrequently (0.5% exceedance duration during the growing season).

As summarized in Table A-19, Figures A-31 to A-34 indicate the following:

- CV-H10, RM-H9A, RM-H9B, RM-H3A, and RM-H3B create areas of "protection" from the south, north, and east for 20 mph winds.

- RM-H12 and I-H4 create areas of "protection" from the south and north 20 mph winds.

- CV-H6, RM-H3C, RM-H6, and RM-H7 create areas of "protection" from the north 20 mph wind only.

- RM-H10 and RM-H11 create areas of "protection" from the south 20 mph wind only.

- The entire study area is "protected" from a west 20 mph wind for the existing condition case; therefore, no features add protection from a west 20 mph wind.

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Table A-19. Directions from Which Each Feature Reduces Resuspension Vulnerability (20 mph windspeed). No features add protection from a west 20 mph wind, because the Study Area is not vulnerable to these winds in the existing condition case.

Feature	Reduces Resuspension Vulnerability from the Following Wind Directions		
	South	North	East
CV-H6		x	
CV-H10	x	x	x
RM-H9A	x	x	x
RM-H9B	x	x	x
RM-H3A	x	x	x
RM-H3B	x	x	x
RM-H3C		x	
RM-H6		x	
RM-H7		x	
RM-H10	x		
RM-H11	x		
RM-H12	x	x	
I-H4	x	x	

Wind-wave driven resuspension results combined for South, West, North, and East 20 mph winds are shown in Figure A-35 for each alternative (maximum, SAV, efficient) and the existing condition.

To ensure that the four cardinal directions sufficiently captured the impacts of each proposed feature on wind driven wave sediment resuspension, additional directions were investigated. Maximum alternative STWAVE simulations were conducted and MOWV classifications were determined for 20-mph northeast and 20-mph southeast winds (Table A-19, windspeed – wind direction combinations 17 and 18). MOWV results showed that “protection” created by proposed features from the northeast wind were already accounted for by maximum alternative north wind results and maximum alternative east wind results. Similarly, MOWV results showed that “protection” created by proposed features from the southeast wind were already accounted for by maximum alternative south wind results and maximum alternative east wind results.

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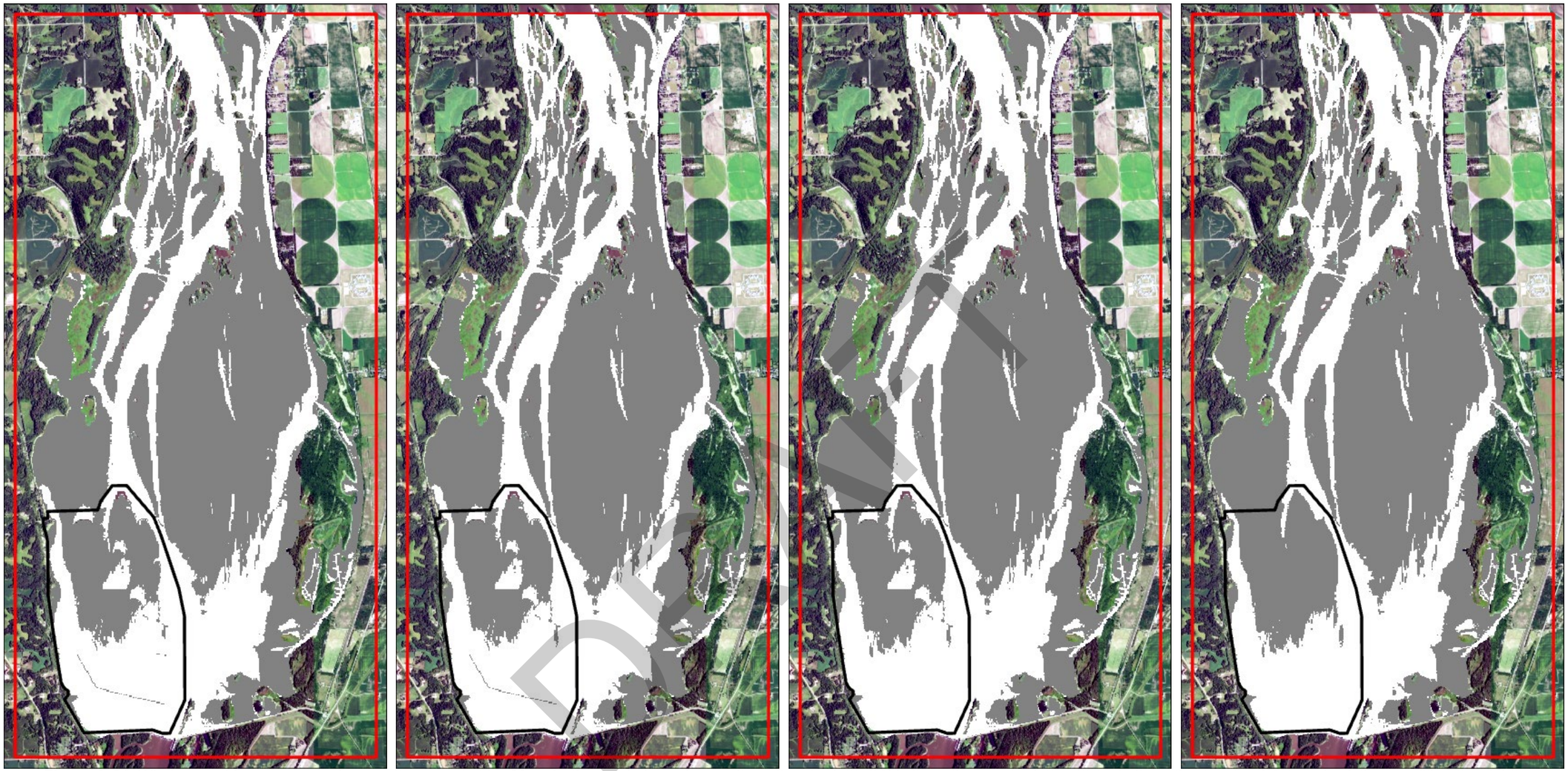

Figure A-31. Wind-wave driven resuspension results computed for 20 mph, South wind: maximum alternative (far-left), SAV alternative (center-left), efficient alternative (center-right), and existing condition (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.

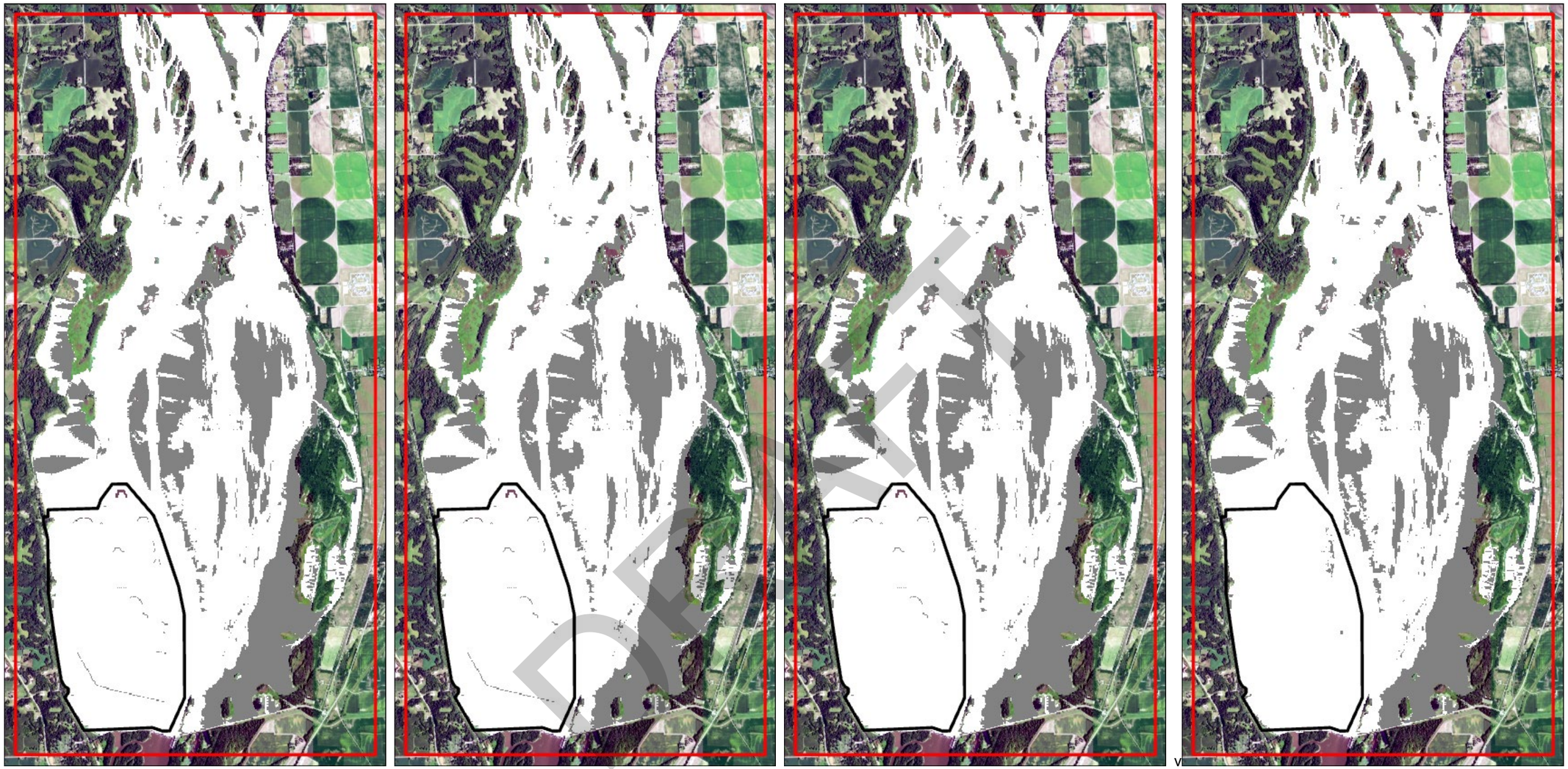

Figure A-32. Wind-wave driven resuspension results computed for 20 mph, West wind: maximum alternative (far-left), SAV alternative (center-left), efficient alternative (center-right), and existing condition (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.

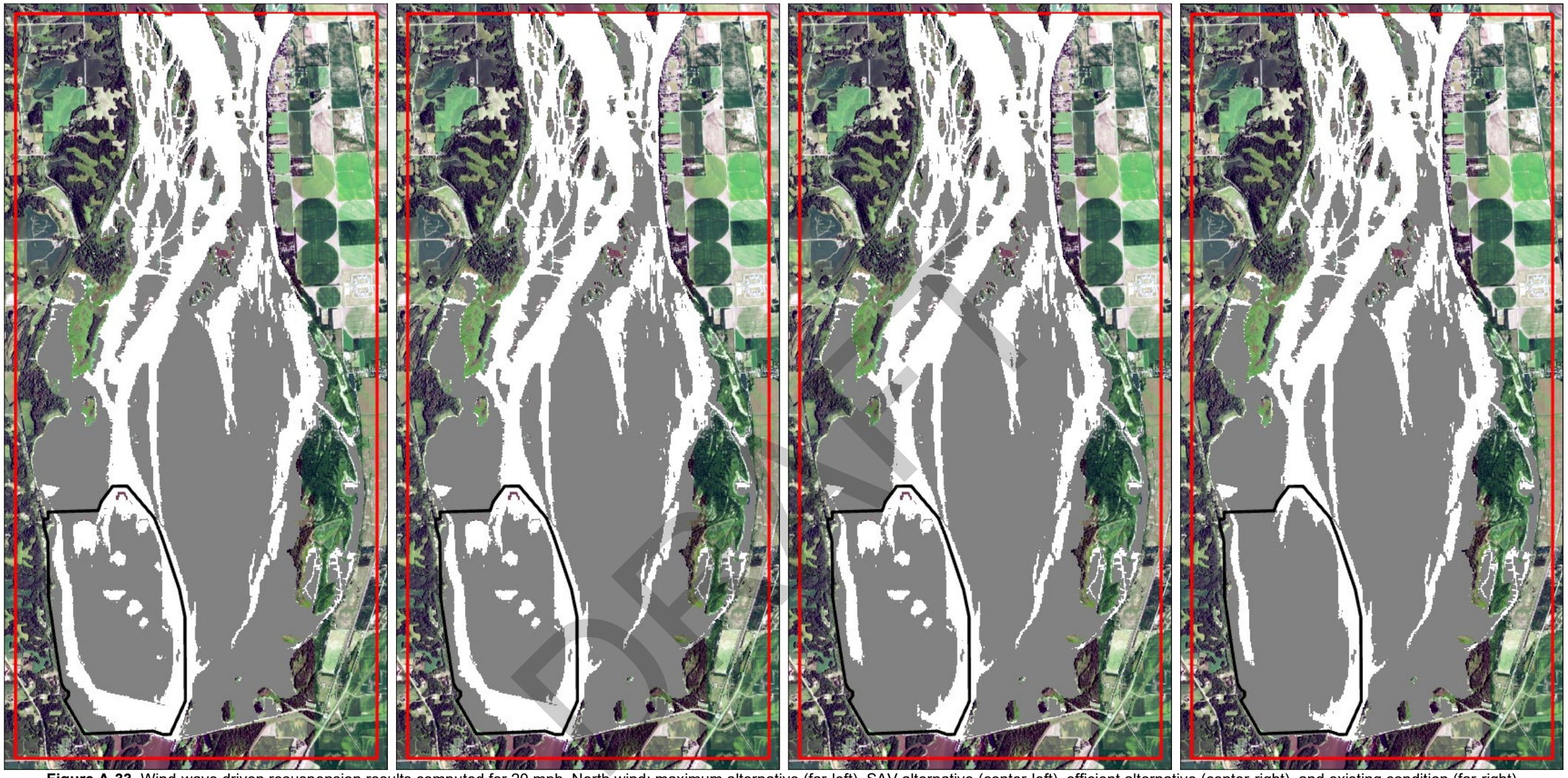

Figure A-33. Wind-wave driven resuspension results computed for 20 mph, North wind: maximum alternative (far-left), SAV alternative (center-left), efficient alternative (center-right), and existing condition (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.



Figure A-34. Wind-wave driven resuspension results computed for 20 mph, East wind: maximum alternative (far-left), SAV alternative (center-left), efficient alternative (center-right), and existing condition (far-right).

Areas protected from resuspension (MOWV < 0.1) shown in white. Areas vulnerable to resuspension (MOWV > 0.1) shown in grey. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.



Figure A-35. Wind-wave driven resuspension results combined for South, West, North, and East 20 mph winds: maximum alternative (far-left), SAV alternative (center-left), efficient alternative (center-right), and existing condition (far-right).

Lighter areas receive resuspension protection from more wind directions. Study Area (not including forestry) shown in black. STWAVE model boundary shown in red.

8. COMBINATION OF 2D VELOCITY RESULTS AND WIND-WAVE RESULTS FOR HABITAT MODELING

Depth, velocity, and wind-wave resuspension of sediment results were combined to support habitat benefit analysis (Appendix A, *Environmental*):

- **Depth:** The existing condition, 50% exceedance duration depth grid generated by the Lower Pool 13 HREP 2D HEC-RAS model is shown in Figure A-36. Depths between 1.5 and 6 feet were considered appropriate for wild celery growth.
- **Velocity:** For each alternative (maximum, SAV, efficient) and the existing condition, velocities less than 0.5 ft/s were considered appropriate for wild celery growth.
- **Resuspension:** For each alternative (maximum, SAV, efficient) and the existing condition, areas "protected" from resuspension of sediment (MOWV less than 0.1) for at least two cardinal directions were considered appropriate for wild celery growth.

Data was combined by raster analysis in ArcGIS Pro 2.8. As needed, all data was converted to Albers Equal Area Conic, USGS version horizontal projection and horizontal and vertical units were converted to feet. Vertical datum of NAVD88 was maintained. Final cell size of this analysis was 5-meters.

Shown in Figure A-40 for each alternative and the existing condition, areas with inappropriate depth or inappropriate velocity are not shaded. Darker grey areas have the appropriate depth and velocity, but are more vulnerable to wind-wave resuspension of sediment. Lighter areas also have the appropriate depth and velocity, but are more protected from wind-wave resuspension of sediment.

For habitat benefit analysis, a slightly reduced area of interest was used to count benefits (Appendix A, *Environmental*). This area is indicated by a white dashed line in Figure A-37.

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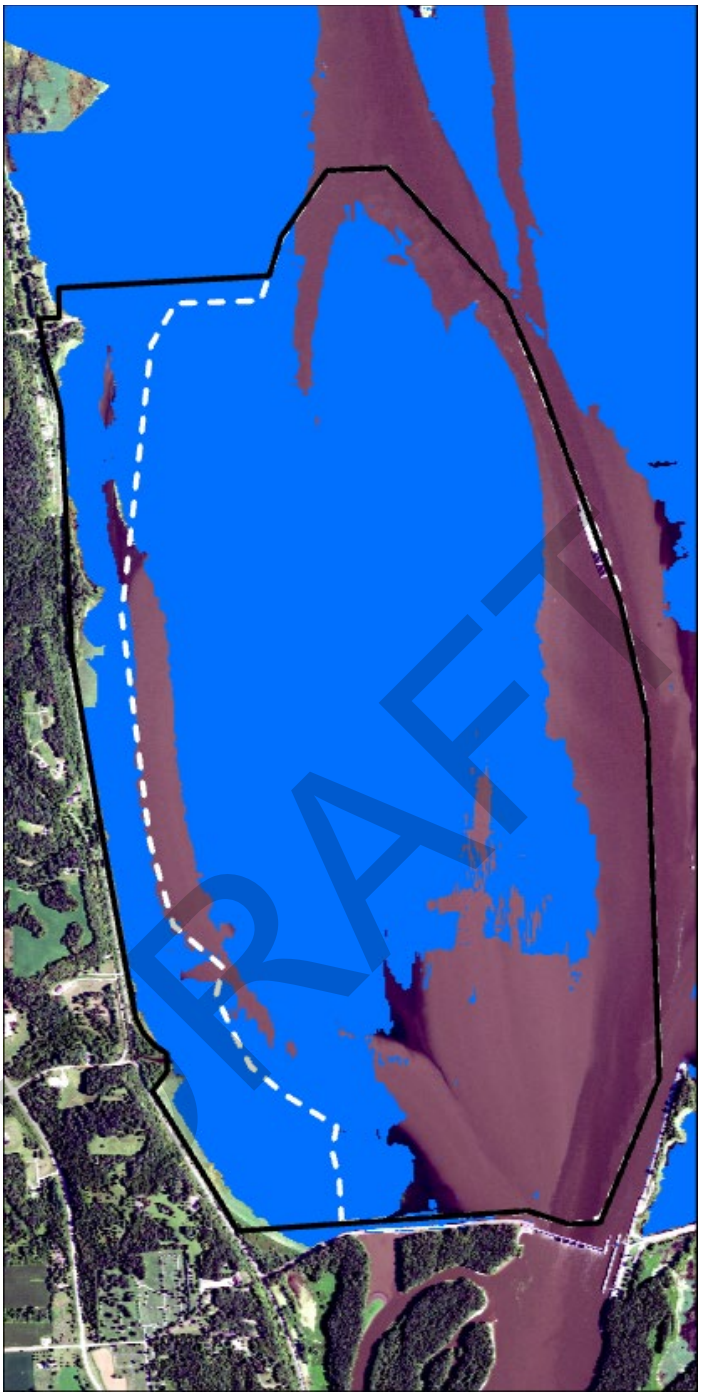

Figure A-36. Depth raster for the 50% exceedance duration during the growing season taken from Lower Pool 13 HREP HEC-RAS model output.

Classified such that depths between 1.5 and 6 feet are shown in blue. Study Area designated by black outline. Habitat benefits area of analysis designated by white dashed line.

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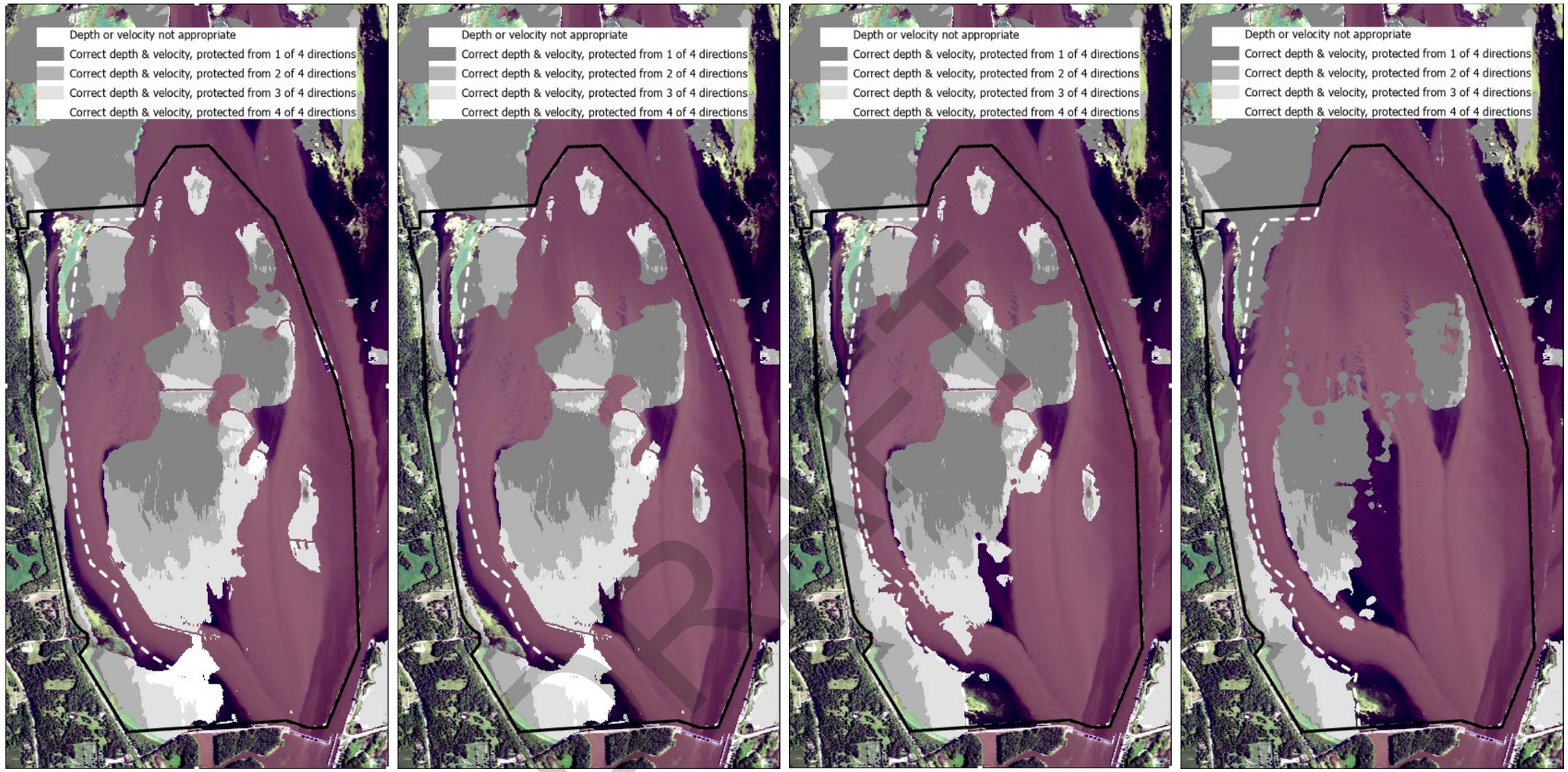

Figure A-37. Combined depth, velocity, and wind-wave driven resuspension results: maximum alternative (far-left), SAV alternative (center-left), efficient alternative (center-right), and existing condition (far-right).

Shaded areas designate that a given location has the correct depth and velocity for wild celery. For a 20-mph wind, darker areas receive protection from wind-wave driven resuspension of sediment from fewer of the four cardinal directions while lighter areas receive protection from more directions. Note: Existing condition simulations determined that the entire Study Area is always protected from a 20-mph west wind. Study Area designated by black outline. Habitat benefits area of analysis designated by white dashed line.

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9. CLIMATE CHANGE RESILIENCY

Engineering Construction Bulletin No. 2018-14, *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects,* (USACE 2018) provides guidance on conducting a qualitative assessment of climate change impacts related to inland hydrologic analyses for civil works studies, designs and projects. Figure A-38 is a flow chart illustrating the qualitative assessment process. The intent of the qualitative analysis is to assess potential climate change threats and impacts relevant to the specific hydrologic analyses used to support the study goals and engineering design. Consideration of both past (observed) changes as well as potential future (projected) changes to relevant climatic and hydrologic variables is required as part of this qualitative assessment.

According to USACE 2018, the three phases of this analysis are described as follows:

- **Phase I, Initial Scoping:**
  "…includes all tasks needed to decide which climate factors contribute to the problems, opportunities, and constraints."

- **Phase II, Vulnerability Assessment:**
  "…addresses whether changes (nonstationarities) are already occurring in the baseline climate and hydrologic conditions, and whether expected changes in climate and hydrologic conditions in the future will result in performance requirements significantly different from the present."

- **Phase III, Risk Assessment:**
  "…describes the resilience of the TSP to expected changes in climate and hydrology and identifies risks that have not been addressed during formulation due to knowledge and data uncertainties."

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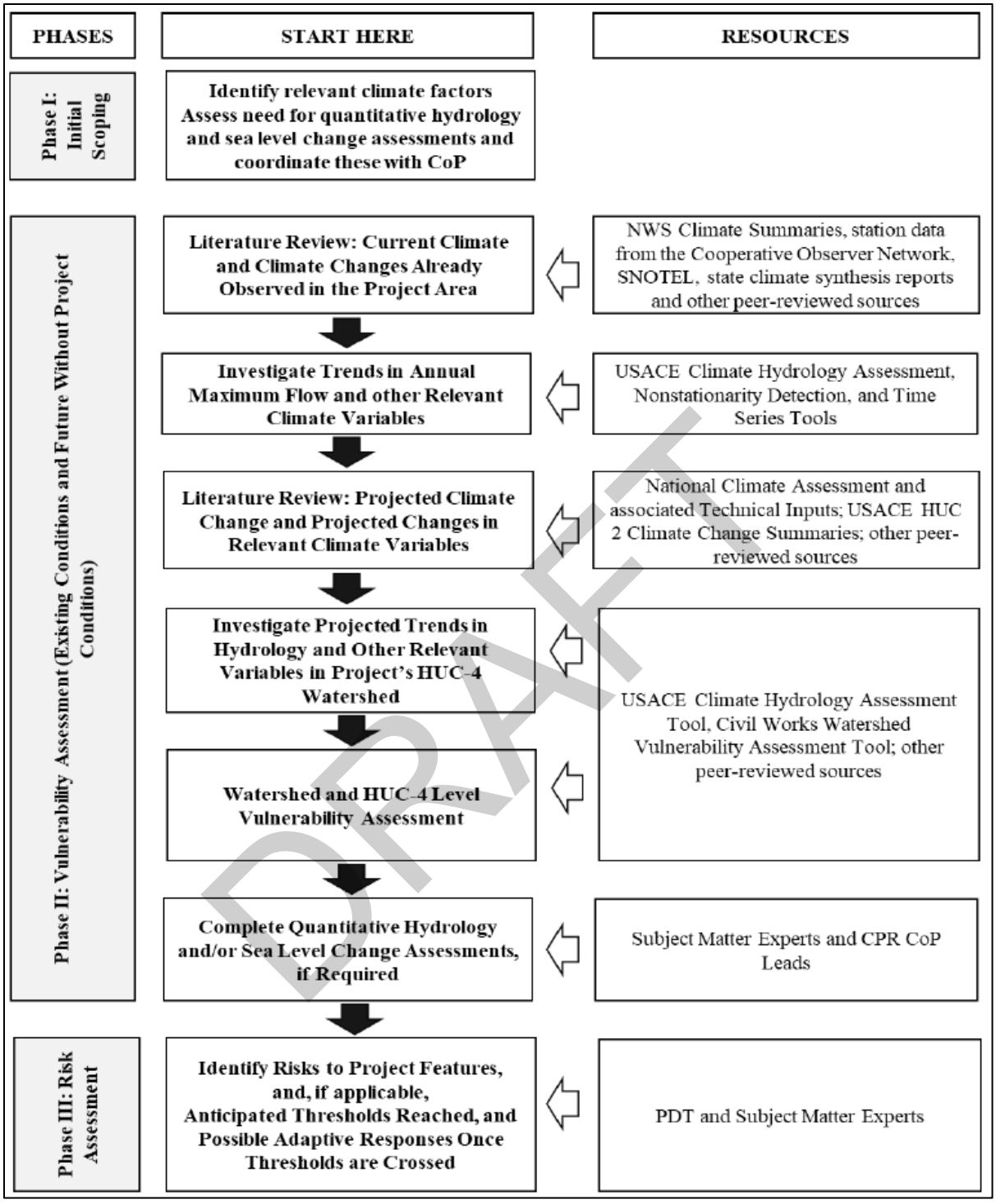

Figure A-38. Flowchart for Incorporating Climate Change Impacts to an Inland Hydrologic Analysis (USACE, 2018)

9.1 Phase I, Initial Scoping

Selected objectives and opportunities sensitive to climate factors are discussed below.

9.1.1 Study Objective: Floodplain Forest

Successful floodplain forest restoration and enhancement is dependent on limiting flood inundation duration and drought duration throughout the year. Flooding anytime from March to November is of particular and equal concern. Drought is of more concern from June to September, when temperatures are typically higher. The climate variables relevant to this objective include changes in temperature, precipitation, and hydrology that could result in increased flooding or increased drought conditions. While all floods and droughts could potentially threaten the quality and quantity of forest, floods and droughts of longer duration (particularly those lasting more than 40 consecutive days) are of most concern.

9.1.2 Study Objective: Submersed Aquatic Vegetation

Successful SAV restoration and enhancement is dependent on limiting suboptimal water velocities (primarily those that are too high) and promoting water clarity. This is important throughout the growing season (May 1–September 30), but especially so early on as plants are becoming established (May 1–July 1). The climate variables relevant to this objective include changes in temperature, precipitation, and hydrology that could result in increased flooding. While all floods would increase velocities and increase turbidity within the study area, floods of long duration are anticipated to have a more negative impact on SAV than floods of shorter duration with higher peak flows.

9.1.3 Study Opportunity: Mussel Habitat

Successful mussel habitat is dependent upon limiting (1) high temperatures and (2) drought events which reduce water elevations such that mussels are completely exposed to dry conditions around the edges of the water body. The climate variable relevant to this objective include changes in temperature alone and changes in temperature, precipitation, and hydrology that could result in increased drought conditions.

9.2 Phase II, Vulnerability Assessment: Literature Review of Observed and Projected Data

The literature review focused on observed and projected hydrometeorologic data relevant to the study area to assess potential changes to climate over the 50-year project life, considering the future, without the Project. Hydrometeorological variables with the potential to impact the performance of the Project were examined, including temperature, precipitation, and streamflow. Regional summary reports prepared by the Corps in 2015 summarize observed and projected trends reported in the literature. A summary of the Report's findings is shown in Figure A-39. Whenever possible, findings are specific to Water Resources Region 07, the Upper Mississippi Region (UMR), which includes the study area (USACE, 2015).

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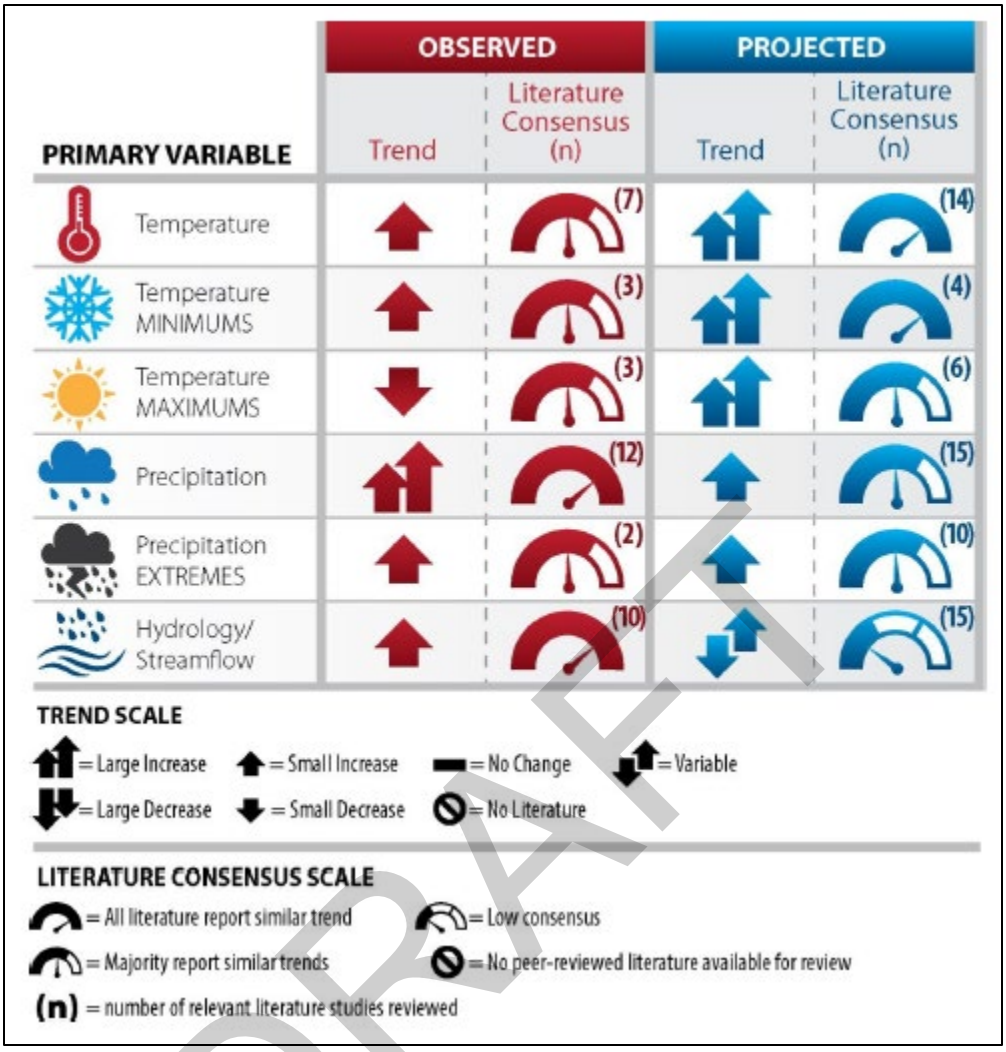

Figure A-39. Literature Consensus of Observed and Projected Trends in Hydrometeorological Variables Potentially Impacted by Climate Change (USACE 2015).

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9.2.1 Temperature Observations

Regarding observed temperature, the regional summary report concludes, “Increasing trends in observed air temperature in the [Upper Mississippi River] basin, including daily mean and minimum temperatures, were reported by multiple authors” (USACE 2015).

During the period 1950 to 2000, Wang et al (2009) found statistically significant increases in mean air temperature during winter, spring, and summer; however, a slight decreasing trend was observed for fall mean air temperatures (Wang et al., 2009). Westby et al. (2013) found during the period of 1949 to 2011, statistically significant increases in seasonal-mean temperatures occurred in the northern Upper Mississippi Region. Specific to the study area, a slight increase in seasonal-mean temperatures was observed.

In the Upper Mississippi Region, spring onset (first leaf date) is occurring at least a few days earlier for the current period (2001 to 2010), as compared to an earlier baseline reference

decade (1951 to 1960). This denotes an apparent small shift in seasons, with spring warming occurring earlier than in the past (Schwartz et al., 2013). Increases in air and water temperature across Minnesota over the past few decades have led to earlier ice-out dates and later ice-in dates for lakes and earlier spring runoff (Johnson and Stefan 2006).

Regional results from the U.S. Global Research Program's *Third National Climate Assessment for the Upper Midwest* (NCA3) and *Climate Science Special Report for the Fourth National Climate Assessment* (NCA4) suggest the rate of warming in the Midwest has markedly accelerated over the past few decades (Pryor et al., 2014, Vose et al., 2017). As shown in Figure A-40, Pryer et al. (2013) found that the average Midwest air temperature increased by more than 1.5°F over the period 1895 to 2012. Average temperature increased twice as fast over the period 1950 to 2010 and three times as quickly over the period 1980 to 2010 when compared to the 1900 to 2010 rate. At night and during the winter months, warming has increased at faster rates (Pryor et al., 2013, Pan et al., 2009).

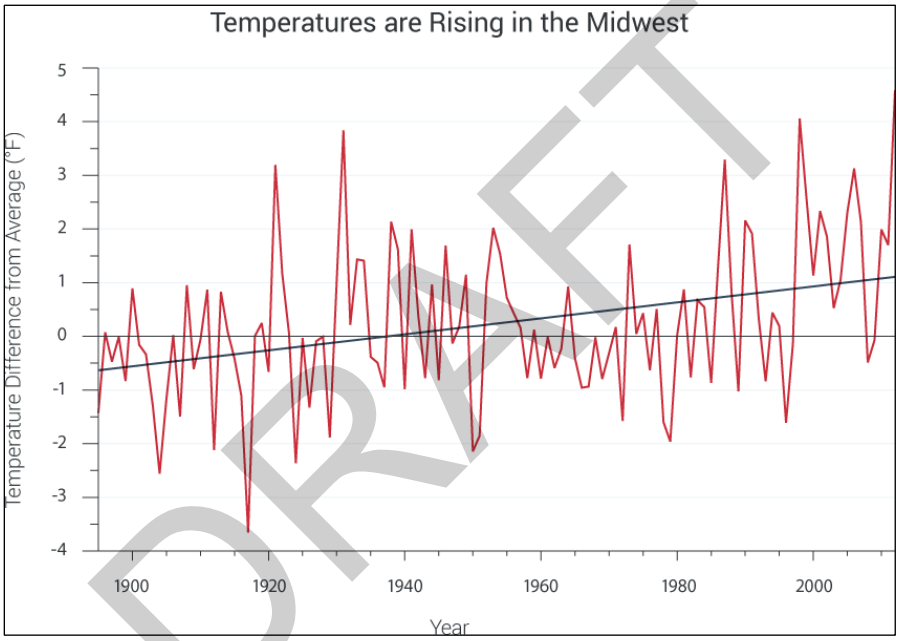

Figure A-40. Increasing Annual Average Temperatures in the Midwest (Pryor et al., 2014)

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9.2.2 Temperature Projections

Regarding projected temperature, the regional summary report concludes, "Strong consensus exists in the literature that projected temperatures in the [Upper Mississippi Basin] will rise over the next century" (USACE, 2015).

There is a high level of consensus across multiple Global Circulation Models (GCMs) and emissions scenarios projecting a significant warming trend across the entire UMR. Compared to the baseline time frame of 1971 to 2000, a study by Liu et al. (2013) using a single GCM and assuming an A2 greenhouse gas emissions scenario (worst case) projected an increase in maximum air temperature of 1.5 to 4.5 ºC (2.7 to 8.1 ºF) for a 2055 planning horizon in the UMR. Additionally, the study predicted an increase in the Keetch Byrum Drought Index, which is a measure of soil moisture deficit index.

Scherer and Diffenbaugh (2014) projected a steady increase in both summer and winter air temperatures throughout the whole 21st century for the UMR, using a multimember GCM and assuming an A1B emissions scenario (middle of the road case). Compared to a baseline timeframe of 1980 to 2009, the study projected that by the year 2090, the air temperature would increase by 5.7°C (10.3°F) in the summer and 3.6°C (6.5°F) during the winter. Cai et al. (2009) and Wilson and Weng (2011) both produced similar results when evaluating central Illinois using GCMs and shorter planning horizons.

Regarding extreme temperature events, Gao et al. (2012) used a planning horizon of 2058 and a single GCM with a high greenhouse gas emission assumption to project increases in heat wave intensity, duration, and frequency. Results show an increase of up to 4.0 ºC (7.2 ºF) in extreme heat wave temperatures in the UMR and the duration of heat waves is projected to increase by 2 to 4 days per event, compared to the baseline period of 2001 to 2004. The overall frequency of heat waves is projected to increase by 1 to 4 events per year. Using two different GCMs and assuming high greenhouse gas emissions (A2 and A1F), Kunkel et al. (2010) projected a 4.0 to 6.5 ºC (7.2 to 11.7 ºF) increase in three-day heat wave temperatures and a 15 to 50-day increase in the annual number of heat wave days for a 2090 planning horizon compared to a recent historical baseline (1980s and 1990s) for the UMR.

According to the NCA4, the amount of future warming will depend on changes in the atmospheric concentration of heat-trapping gases. Projections for regionally averaged temperature increases by the middle of the century (2021-2050) relative to 1976-2005 are approximately 2.5°F for a lower emissions scenario (RCP4.5) and 2.9°F for a higher emissions scenario (RCP8.5). The projections for the end of the century (2071-2100) are approximately 5.1°F for the lower emissions scenario and 8.9°F for the higher emissions scenario, indicating a large divergence in the two scenarios over time (Vose et al., 2017) (Figure A-41).

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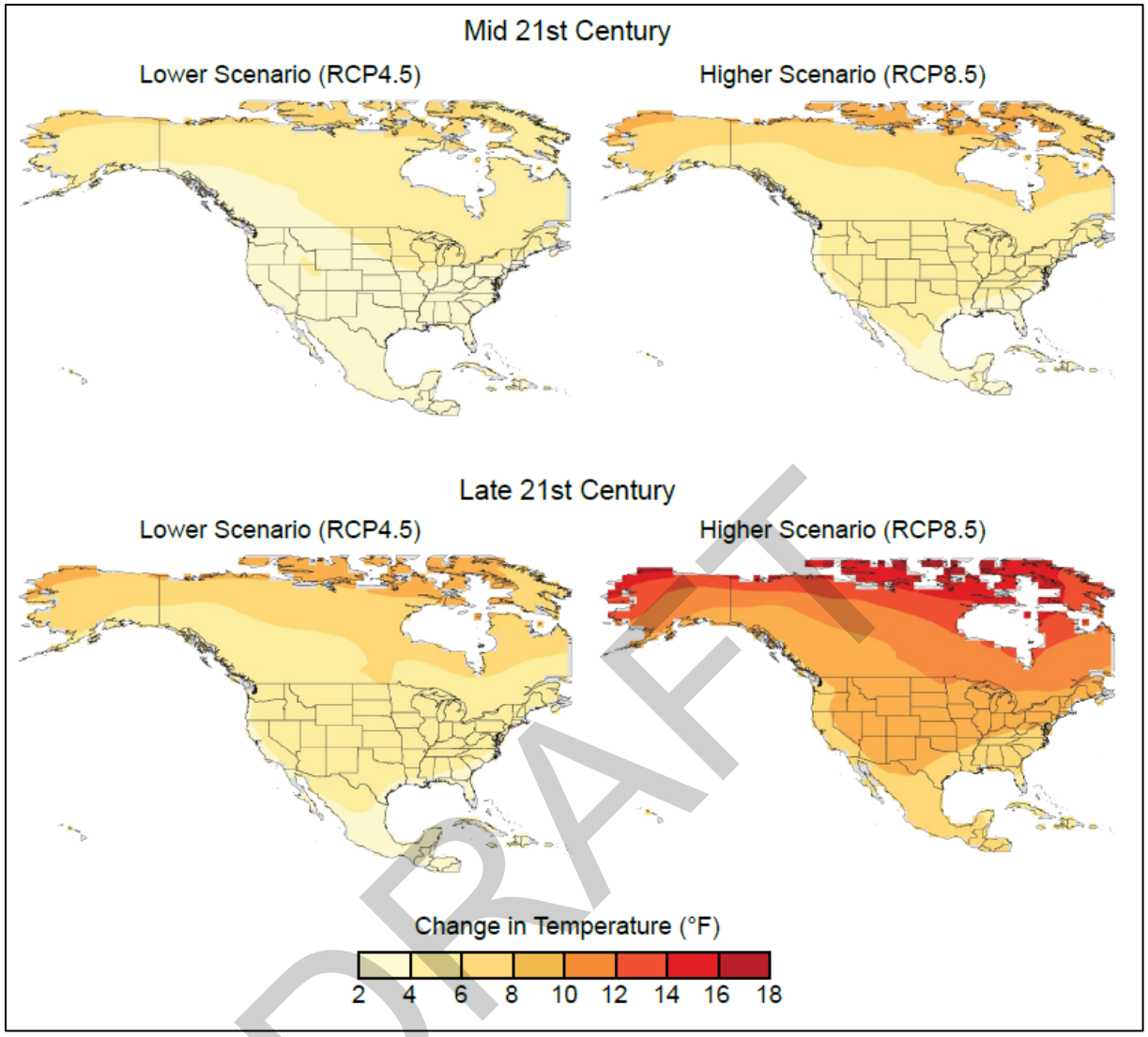

Figure A-41. Projected Changes in Annual Average Temperature (Vose et al., 2017)

Figure A-42 shows observed and projected temperature change data specific to Iowa and Illinois from the NOAA National Centers for Environmental Information State Climate Summaries 2022 website (statesummaries.ncics.org). Air temperatures in both Iowa and Illinois have risen 1ºF over the observed data period (1900–2020). Projected changes are shown for the period 2006–2100 for both a higher emissions and a lower emissions scenario. In Iowa, the coldest end-of-century (2100) projection is about 2ºF than the historical average and the hottest 2100 projection is about 12ºF warmer than the hottest year in the historical record (Frankson et al. 2022a). In Illinois, the coldest 2100 projection is about 2ºF than the historical average and the hottest 2100 projection is about 11ºF warmer than the hottest year in the historical record (Frankson et al. 2022b).

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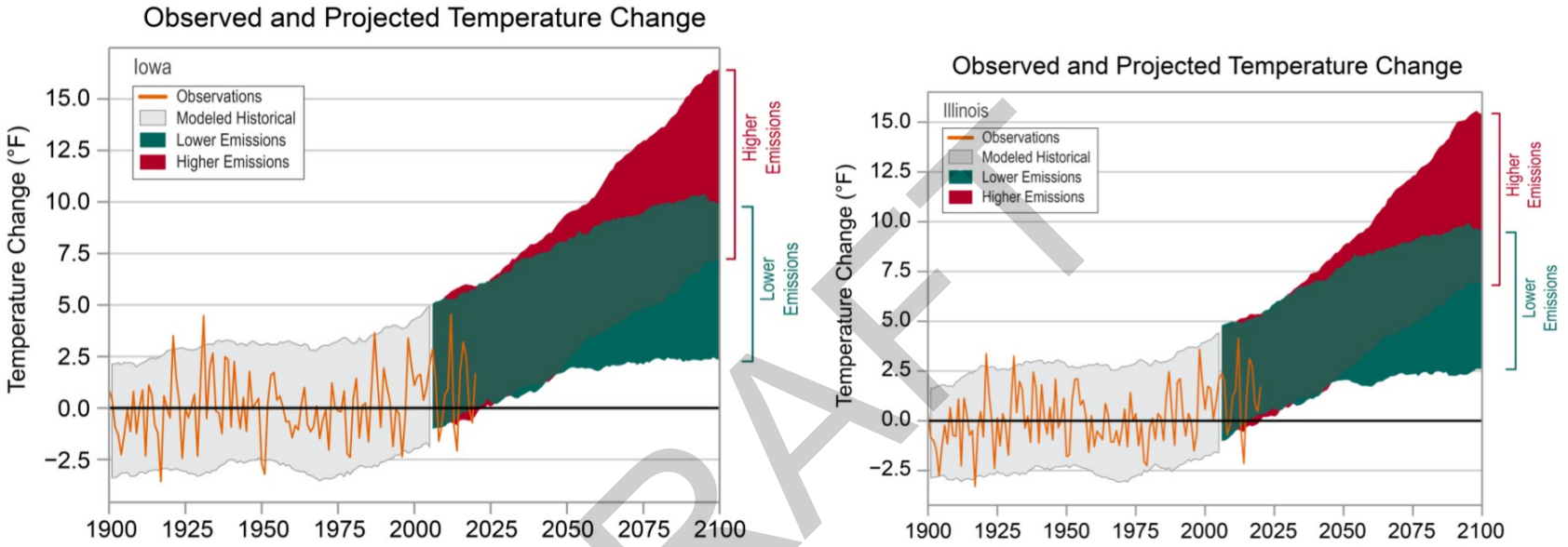

Figure A-42. Observed and Projected Temperature Change for Iowa (left) and Illinois (right) (https://statesummaries.ncics.org/, Franskson et al. 2022a and Frankson et al. 2022b)

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Regarding extreme temperature events, Gao et al. (2012) used a planning horizon of 2058 and a single GCM with a high greenhouse gas emission assumption to project increases in heat wave intensity, duration, and frequency. Results show an increase of up to 4.0 ºC (7.2 ºF) in extreme heat wave temperatures in the UMR and the duration of heat waves is projected to increase by 2 to 4 days per event, compared to the baseline period of 2001 to 2004. The overall frequency of heat waves is projected to increase by 1 to 4 events per year. Using two different GCMs and assuming high greenhouse gas emissions (A2 and A1F), Kunkel et al. (2010) projected a 4.0 to 6.5 ºC (7.2 to 11.7 ºF) increase in three-day heat wave temperatures and a 15 to 50-day increase in the annual number of heat wave days for a 2090 planning horizon compared to a recent historical baseline (1980s and 1990s) for the UMR.

9.2.3 Precipitation Observations

Regarding observed precipitation, the regional summary report concludes that, “Multiple authors have identified significant increasing trends in total annual precipitation in recent historical records for the [Upper Mississippi Basin] study region.” (USACE, 2015).

Palecki et al (2005) observed an increasing trend in winter storm precipitation total (1972-2002) while Grundstein (2009) identified positive linear trends in both total annual precipitation and soil moisture index during the 1895-2006 period. During the 1950 to 2000 period, a significant increasing trend in precipitation, particularly in the summer and fall, was observed for the Upper Mississippi Region (Wang et al., 2009). McRoberts and Nielsen-Gammon (2011) quantified an increasing trend in annual precipitation (1895-2009) for the Upper Mississippi Region between 5% to 20% per century. In the immediate study area, the trend quantified is 10 to 15% per century.

Regarding extreme precipitation events, when comparing the period 1949 to 1976, to the period 1977 to 1999. Wang and Zhang (2008) observed moderate increases (33%) in the frequency of 20-year storm events in the Upper Mississippi Region. Within the Upper Mississippi Region, statistical analysis of 20th century rainfall data showed generally increasing and statistically significant trends in total annual precipitation and the number of precipitation days per year (Pryor et al. 2009). For multiple climate stations in the Upper Mississippi Region with at least 50 years of historical record, Villarini et al. (2013) identified statistically significant increasing trends in the frequency of occurrence of heavy rainfall.

Regarding drought events, Cook et al. (2014) used tree ring data to identify a statistically significant decline in drought frequency and a general increase in soil moisture over the period 1000 to 2005 in the Central Plains Region, which includes the Upper Mississippi Region.

Figure A-43 from the NCA4 report demonstrates increases in observed heavy precipitation within the study area across a variety of metrics: (1) 5-yr maximum daily precipitation (1901–2016), (2) 99th percentile precipitation (1958–2016), (3) number of 5-yr, 2 day events (1901–2016), and (4) number of 5-yr, 2 day events (1958–2016) (Easterling et al. 2017).

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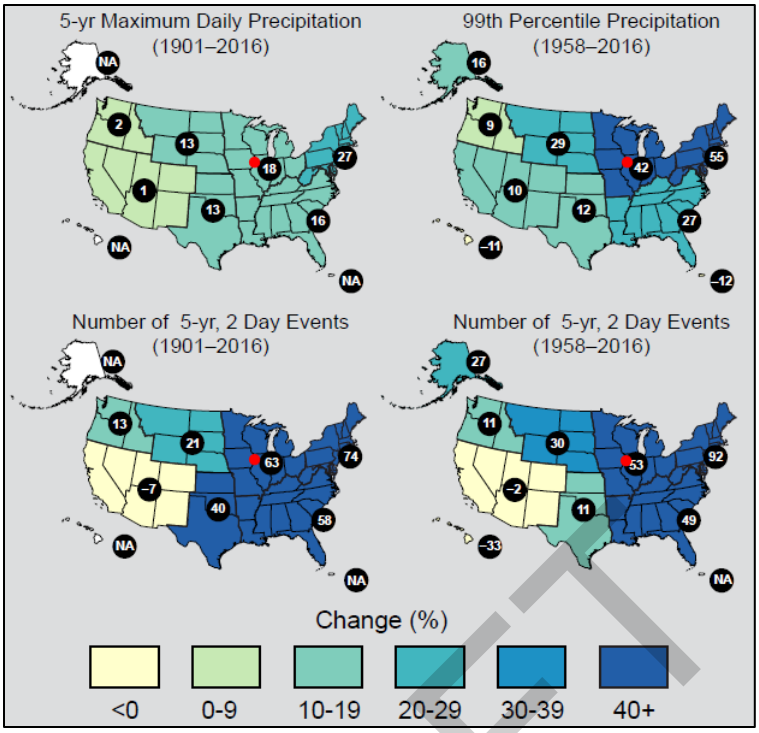

Figure A-43. Observed Changes in Heavy Precipitation (Easterling et al. 2017). Study Area indicated by red dot.

9.2.4 Precipitation Projections

Projections of future changes in precipitation in the Upper Mississippi Region generally concur that both annual precipitation and extreme precipitation totals will increase (USACE, 2015).

Using a planning horizon of 2055, Liu et al. (2013) projects an increase in spring, summer, and winter precipitation. Despite the projected increase in precipitation, the study also projects an increase in the severity of future droughts, as it is anticipated that projected temperature and evapotranspiration impacts will have more of an impact that increases in precipitation. Applying a planning horizon of 2058 to a GCM, Gao et al. (2012) generally projects increases in the magnitude of annual and daily extreme (defined as 95th percentile) storm events and in the frequency of precipitation events in the southern portion of the Upper Mississippi Region. A study of the Illinois watershed by Wilson and Weng (2011) used A1B and B1 emission scenarios and a 2020 planning horizon to project changes in monthly precipitation. Results indicate a general agreement of drier summer months and wetter winter months (-60% in June to +400% in January).

Multiple studies present future projections of extreme events, which include storm events and droughts. Tebaldi (2006) generally projects increases in the number of high (>10 mm) precipitation days, the number of storm events greater than the 95th percentile of the historical record, and the daily precipitation intensity index (annual total precipitation divided by number of wet days) for the general Upper Mississippi River region. Wang and Zhang (2008) project a significant increase (50 to 100%) in the recurrence of the current 20-year, 24-hour storm event for the general Upper Mississippi Region using downscaled GCMs and a high emissions scenario (A2) and a planning horizon of 2075.

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Results from Wang et al. (2011) show significant increases in the frequency and intensity of short duration (1 to 4 weeks) droughts in Illinois for the end of the 21st century. The study utilized multiple Regional Climate Models and two emissions scenarios and increases were due primarily to increased air temperatures. With a similar approach, Joetzjer et al. (2013) focused on the broader Mississippi River Region. This study concurred with Wang et al. (2011). For the majority of modeled scenarios and for the latter half of the 21st century, five member GCM ensembles projected significant increases in the frequency and areal extent of droughts of at least 12-month duration.

The NCA3 discusses precipitation projections in the Midwest. Results generally support the other studies' findings. Climate model projections presented in this study indicate a statistically significant increase in annual average precipitation (2.4 to 4.0 inches), wettest 5-day total (0.4 to 1.0 inches), and the number of heavy precipitation days (0.6 to 1.5 days) by the middle of this century. Additionally, the duration of consecutive dry days is expected to increase by 1 to 3 days. Particularly in the southern Midwest, projections indicate increased spring precipitation (9% in 2041-2062 relative to 1979-2000) and decreased summer precipitation (by an average of about 8% in 2041-2062 relative to 1979-2000) (Pryor et al. 2014).

Particularly in the southern Midwest, projections indicate increased spring precipitation (9% in 2041-2062 relative to 1979-2000) and decreased summer precipitation (by an average of about 8% in 2041-2062 relative to 1979-2000). Increases in the frequency and intensity of extreme precipitation, which are typically larger than the projected changes in average precipitation, are projected across the entire region (Pryor et al. 2014).

The NCA4 generally agrees with NCA3. The report also notes that while average precipitation projections are less certain than temperature projections, "…confidence is *high* that precipitation extremes will increase in frequency and intensity in the future throughout the CONUS". This is because seasonal average precipitation and extreme precipitation are controlled by different physical mechanisms. Extreme precipitation is particularly driven by atmospheric water levels, which increase with increasing temperatures (Easterling et al. 2017).

The NOAA National Centers for Environmental Information State Climate Summaries for Iowa and Illinois generally agree with the studies discussed above. In the study area, statistically significant increases greater than 15% are projected in the Spring (March–May) under a higher emissions pathway (mid-21st century compared to late 20th century) (Figure A-44). Again, rising temperatures are anticipated to increase evaporation rates and rates of soil moisture loss. Therefore, periodic summer droughts are expected to become more intense (Frankson et al. 2022a & 2022b).

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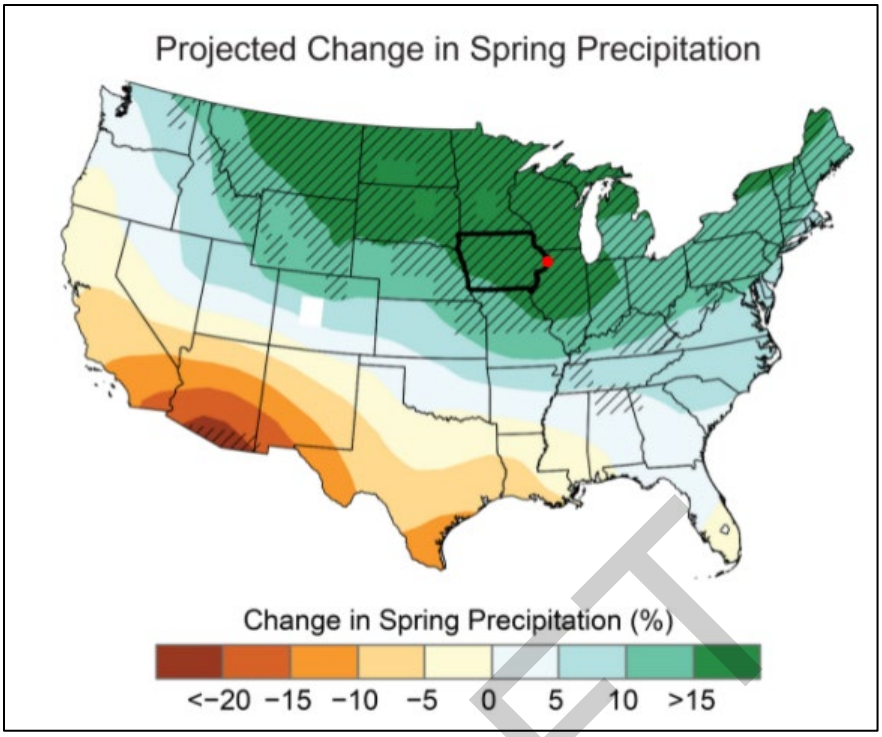

Figure A-44. Projected change in Spring Precipitation under a higher emissions pathway (mid-21st century compared to late 20th century).

Hashed area indicates statistical significance (https://statesummaries.ncics.org/, Franskson et al. 2022a and Frankson et al. 2022b). Red dot added to indicate Study Area location.

9.2.5 Hydrologic Observations

Regarding observed streamflow, the regional summary report concluded, “A strong consensus was found showing an upward trend in mean, low, and peak streamflow in the [Upper Mississippi Basin] study region.” (USACE, 2015).

From 1939 to 1998, the Upper Mississippi River and its tributaries saw an increase in river flow (Mauget 2004). An increase in “surplus” flow days increased and the number of drought incidence decreased for the Upper Mississippi Region during the same study period. From 1950 to 2000, Xu et al. (2006) found that the majority of gage stations in the Upper Mississippi Region showed statistically positive trends in both annual streamflow and baseflow.

From 1948 to 1997 USGS stream gage data, Small et al. (2006) found statistically significant increasing trends in both 7-day low flow and annual mean flow at multiple Upper Mississippi River Basin sites. For 1948 to 2004, (Qian et al. 2007) used hydrometerological observations and hydrological model simulations to determine statistically significant increasing trends in runoff within the Upper Mississippi Basin.

From 1930 to 2010 Xu et al. (2013) considered climate and streamflow data for 55 unregulated watersheds in Iowa, Illinois, Indiana, and Ohio. Increasing trends in total streamflow were observed in 35% of watersheds and increasing trends in baseflow were observed in 58% of watersheds. Most of this change was attributed to climate, supported by a statistically significant rate of precipitation increase in 22% of watersheds.

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Regarding drought, the NCA4 cites Andreadis and Lettenmaier (2006). Over the 20th century, this study found an increasing trend in both simulated soil moisture and runoff over much of the Continental U.S. (including the study area), with decreasing trends found primarily in the Southwest. They conclude that overall, droughts have become, “shorter, less frequent, and cover a smaller portion of the country”.

9.2.6 Hydrologic Projections

Regarding projected streamflow, the regional summary report concluded,

“Clear consensus in the literature is lacking, with some studies projecting an increase in future streamflow (as a result of increased precipitation) in the study region, while others project a decrease in flows (a result of increased ET). Seasonally, multiple studies suggest increased flows in the winter and spring and decreased flows in the summer” (USACE, 2015).

USACE 2015 cites studies that attempt to apply a combination of GCMs to macro-scale hydrologic models. Thomson et al (2005) tested various climate change scenarios based on 2 GCM projections. The two GCMs produced contradictory results for the Upper Mississippi Region. Hagemann et al. (2013) projected an overall increase in runoff of up to 100 mm per year in the Upper Mississippi Region over the period 2071–2100. However, both Hagemann et al. (2013) and CDMSmith (2013) determined that uncertainty associated with macro-scale hydrologic modeling was equal to or greater than the uncertainty associated with GCM selection. Döll and Zhang (2010) projected mild reductions in both low flow and average annual flow using two different GCMs simulating emission scenarios A2 and B2 and the macro scale hydrologic model WaterGap. Watershed impacted varied by GCM and emissions scenario.

Within the Upper Mississippi Region, Jha et al. (2006) and Wu et al. (2012) applied climate change scenarios to SWAT hydrologic models. These studies highlight significant uncertainty associated with future hydrologic projections. However, these studies can be used to show the potential for large-scale changes in either direction.

Projected changes to streamflow are not covered in great detail for the study area within the NCA3 or NCA4 report; however, the NCA3 report does highlight projected changes in spring peak river flows because of shifts of the amount and timing of snowpack and snow melt in much of the U.S. This shift is in response to warming trends. The NCA3 notes that projecting future flooding is difficult due to variables such as river level and soil moisture prior to a rain event, yet data suggests an increase in flooding frequency (Georgakakos et al. 2014).

Regarding drought, the NCA4 concludes with “medium” confidence that future soils will be drier at the surface. A greater frequency of agricultural (soil moisture) droughts is likely throughout the continental United States, even in areas where precipitation is projected to increase. This is because projected increases in temperature and resulting evapotranspiration are anticipated to be a more substantial driver than precipitation. Figure A-45 shows weighted multi-model projected change in near surface (top 10 cm) seasonal soil moisture under a higher emissions scenario (RCP8.5) for the end of the 21st century. Reduction in soil moisture is projected over all four seasons throughout the Continental United States. At the study area location, changes are smallest in the Spring and largest in the summer (Wehner et al. 2017). Cook et al. (2015) found that reduction in soil moister at 30 cm depth would be less than at 2 cm, but still significant.

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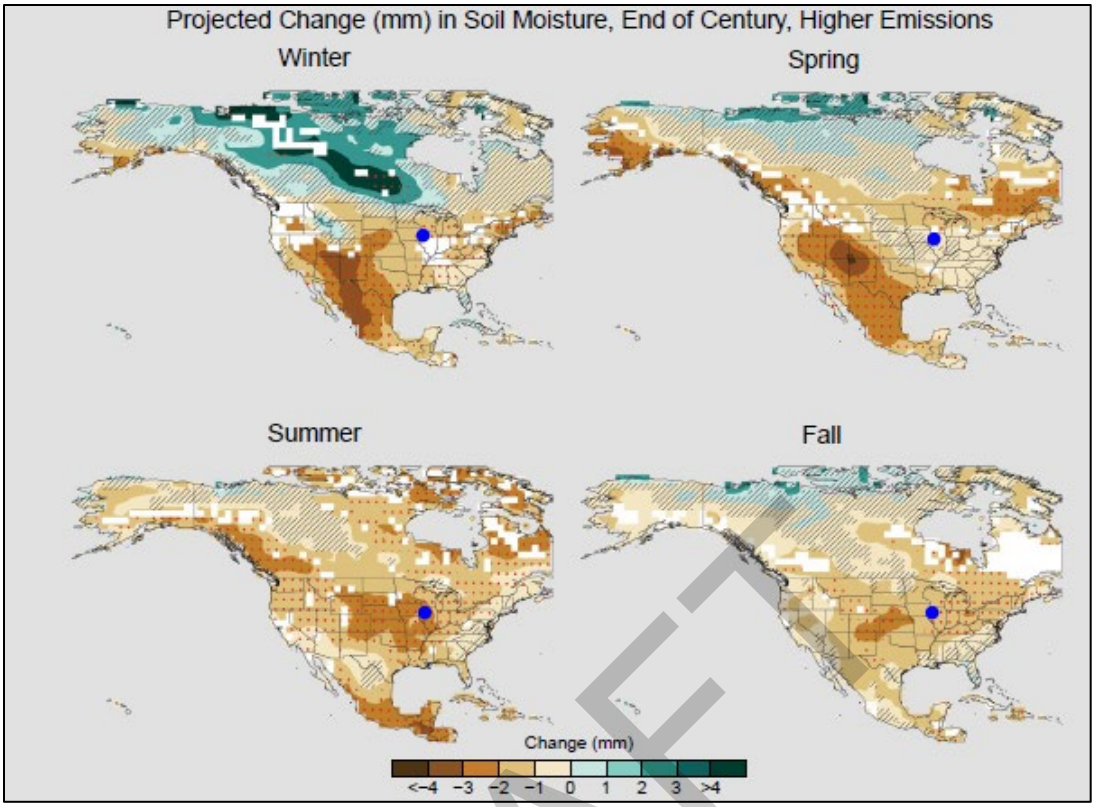

Figure A-45. Weighted Multi-Model Projected Change in Near Surface Seasonal Soil Moisture Under a Higher Emissions Scenario (RCP8.5) for End of the 21st Century

Red stippled areas are assessed to be large compared to natural variations. Hashed areas are assessed to be small compared to natural variations (Wehner et al. 2017). Blue dot added to indicate Study Area.

9.2.7 Green House Gases

Climate change is a fundamental environmental issue and is a particularly complex challenge given its global nature and inherent interrelationships among its sources, causation, mechanisms of action, and impacts. Analyzing a proposed management measure's greenhouse gas (GHG) emissions and how climate change may change a management measure's environmental effects can provide useful information to decision makers and the public. Climate change science is evolving and is only briefly summarized here. In 1970 the Council of Environmental Quality estimated the level of atmospheric carbon dioxide to be 325 parts per million (ppm) (Council of Environmental Quality, 1970). Since 1970, the concentration of atmospheric carbon dioxide has increased at a rate of about 1.6 ppm per year (1970-2012) to approximately 400 ppm as of September 2016 (current globally averaged value) (U.S. Department of Commerce). Based on the United States Global Change Research Program as well as other scientific records, it is now well established that rising global atmospheric greenhouse gas emission concentrations are significantly affecting the Earth's climate (Blanco et al., 2014). A large body of scientific evidence indicates that increases in GHGs in the Earth's atmosphere are contributing to changes in national and global and climatic conditions (Melillo, et al., 2014). These changes include such things as average temperature, changes in precipitation patterns, and increases in the frequency and intensity of severe weather events. These changes have the potential to impact a wide sector of the human environment including water resources, agriculture, transportation, human health, energy, and aquatic and terrestrial ecosystems.

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Therefore, it is important to understand the potential impacts of federal actions on GHG emissions and climate change as well as the potential changes that may occur to the human environment that could affect the assumptions made with respect to determining the impacts and efficacy of the federal action in question.

9.3 Phase II, Vulnerability Assessment: Analysis of trends in observed and projected data

9.3.1 Climate Hydrology Assessment Tool (CHAT)

The USACE Climate Hydrology Assessment Tool (CHAT) provides qualitative information at the HUC 8 watershed level about future climate conditions and allows the Corps to produce repeatable analytical results using consistent information (USACE 2001). To evaluate projected trends in hydrology for the study area, CHAT was used to analyze streamflow for the Apple-Plum watershed (HUC 07060005), located within the Upper Mississippi-Maquoketa-Plum watershed (HUC 0706). As shown in Figure A-46, the study area is immediately upstream of the Apple-Plum watershed outlet.

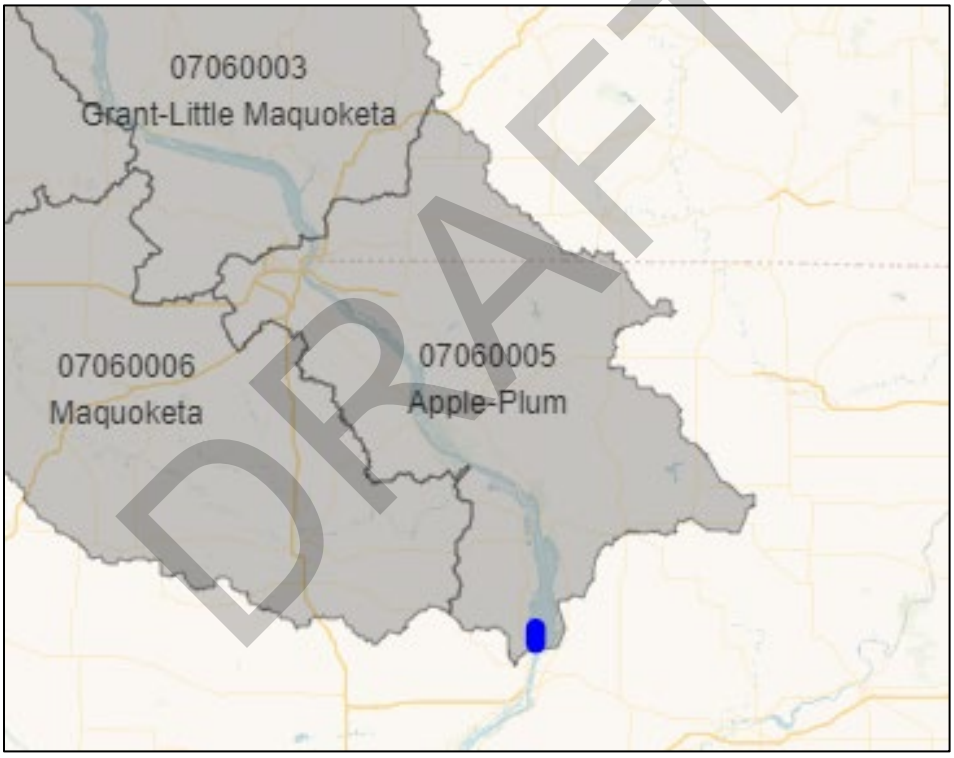

Figure A-46. Location of Apple-Plum Watershed (HUC 07060005) (https://climate.sec.usace.army.mil/chat/). Study Area Marked in Blue.

Projected hydrology under future climate conditions is generated using a hydrologic model with precipitation and temperature input parameters derived from GCM output. The range in projected annual maximum monthly streamflow is computed based on 64 different climate changed hydrologic model simulations for the 1950-2099 period. Results for the Apple-Plum watershed shown in Figure A-47 indicate there is a lot of uncertainty in projected climate changed hydrology. Figure A-48 shows trend lines computed for the “historical” period (water years 1951–2005) and “future” period (water years 2006–2099). A statistically significant trend was determined for the “future” period, but not for the “historical” period (Figure A-49).

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Based on the “future” trendline, over a 50-year project life annual maximum monthly flows could increase by nearly 1,650 cfs. Since normal stream flows here are on the order of 60,000 cfs and flood flows are on the order of 200,000 cfs and upwards, the increase of 1,650 cfs is negligible. Therefore, the projected increase in mean annual maximum monthly streamflow is not considered to have any operationally significant impacts. Even if mean annual maximum monthly streamflow increases by a few more thousand cfs than projected, it will remain a negligible amount compared to already experienced flows. These results are qualitative only.

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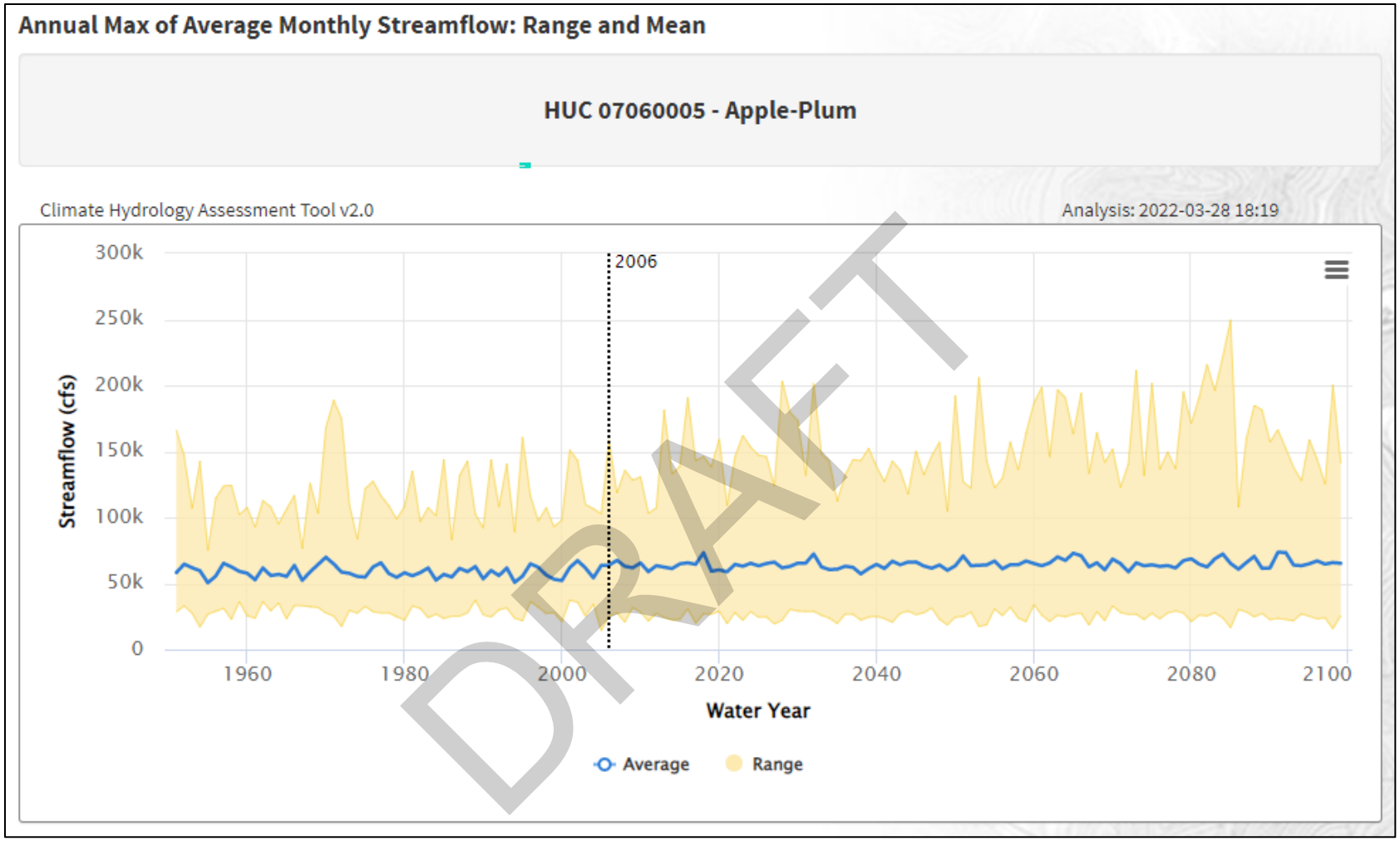

Figure A-47. Range In Projected Annual Maximum Monthly Streamflow for the Apple-Plum watershed (HUC 07060005) (https://climate.sec.usace.army.mil/chat/).

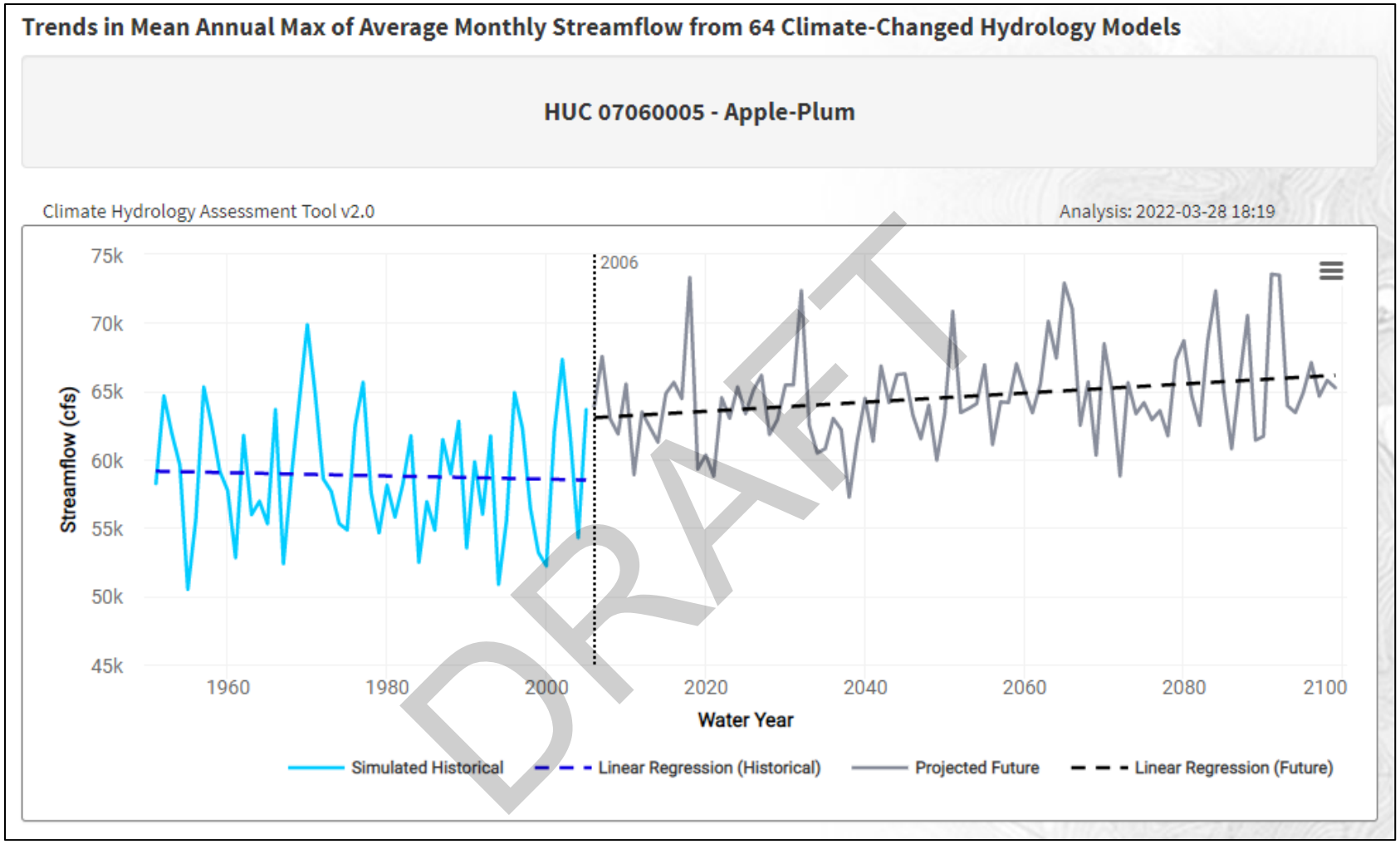

Figure A-48. Mean Projected Annual Maximum Monthly Streamflow for the Apple-Plum watershed (HUC 07060005). Trend lines computed for "historical" time period (water years 1951–2005) and "future" time period (water years 2006–2099) (https://climate.sec.usace.army.mil/chat/).

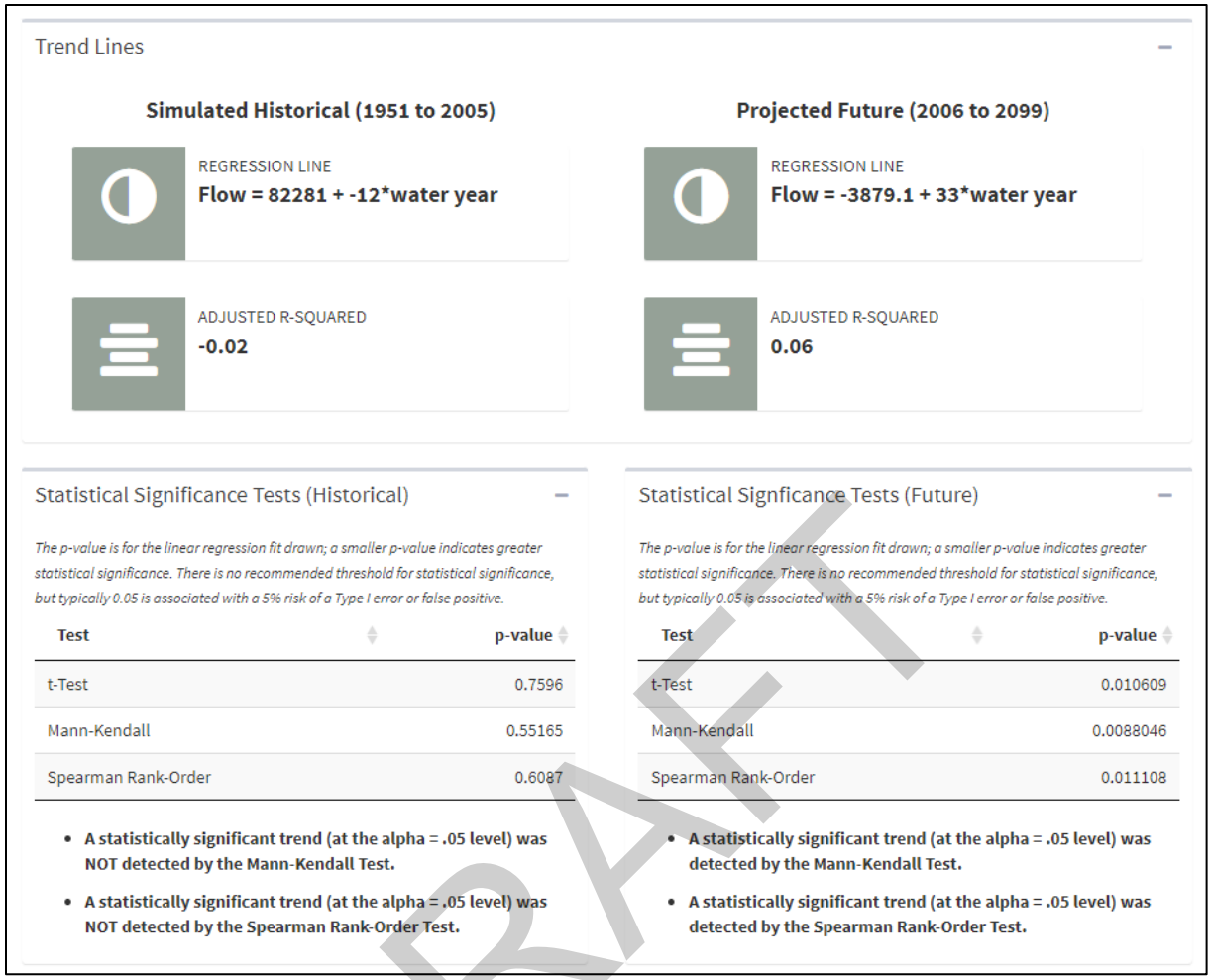

Figure A-49. Trend Line Regression Equations and Statistical Significance Tests for Apple-Plum Watershed (HUC 07060005) Mean Projected Annual Maximum Monthly Streamflow.

Regression and significance computed separately for "historical" time period (water years 1951–2005) and "future" time period (water years 2006–2099) (https://climate.sec.usace.army.mil/chat/).

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9.3.2 Vulnerability Assessment (VA) Tool

The USACE Climate Change Vulnerability Assessment (VA) Tool compared the relative vulnerability of the study area's HUC 04 watershed to climate change with that of the other 202 HUC 04 watersheds throughout the continental United States (CONUS) (https://maps.crrel.usace.army.mil). A screening level comparative assessment was conducted for Upper Mississippi-Maquoketa-Plum watershed (HUC 0706) for the Ecosystem Restoration business line.

Individual indicators including change in sediment load, short-term variability in hydrology, runoff elasticity (ratio of streamflow runoff to precipitation), macroinvertebrate index (sum score of six metrics indicating biotic condition), two indicators of flood magnification (indicator of how much high flows are projected to change overtime), mean annual runoff, change in low runoff, and percent of at risk freshwater plant communities were used to calculate weighted ordered weighted average (WOWA) composite vulnerability scores The default "National Standards" setting was used when conducting this vulnerability assessment.

Results of the Vulnerability Assessment Tool suggest that ecosystem restoration efforts in HUC 0706 watershed, are relatively less vulnerable to climate change compared to the other 202 HUC 04 watersheds in the CONUS (Figure A-50). The assessed watershed is not within the top 20% of WOWA scores flagged as being vulnerable. Vulnerability scores indicate little change between the two 30-year epochs (2050 and 2085) and little change between the wet and dry traces (Table A-20). Contributions to the overall vulnerability score from each of the different indicators are shown in Table A-21. The dominant indicators contributing to the HUC 0706 vulnerability scores are “At-Risk Freshwater Plants”, “Runoff Elasticity”, and “Macroinvertebrate Index”.

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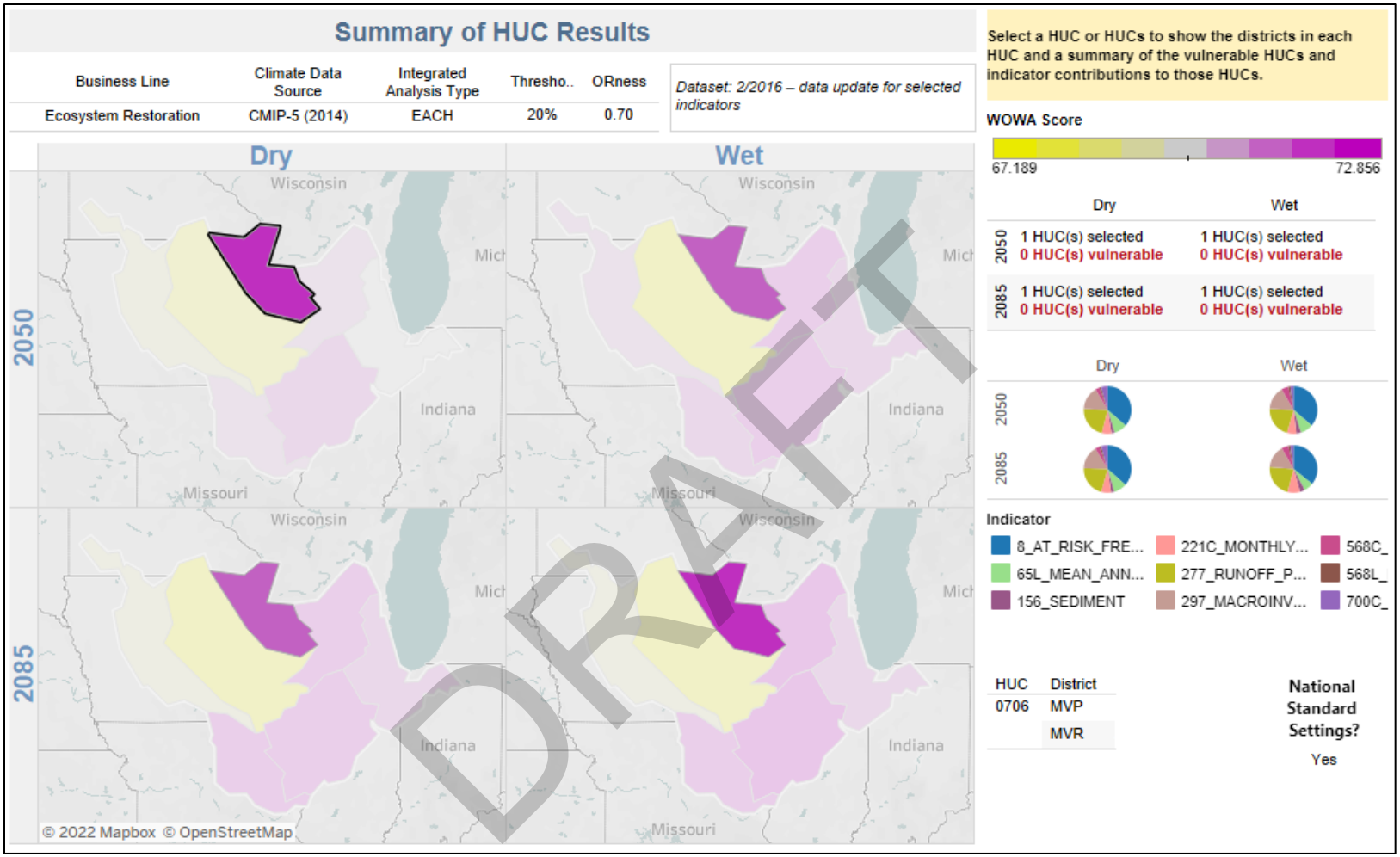

Figure A-50. Projected Vulnerability for Ecosystem Restoration Business Line Within the Upper Mississippi-Maquoketa-Plum Watershed (HUC 0706) (https://maps.crrel.usace.army.mil).

Table A-20. Projected Vulnerability Scores for Ecosystem Restoration Business Line Within the Upper Mississippi-Maquoketa-Plum Watershed (HUC 0706) (https://maps.crrel.usace.army.mil).

Vulnerability Scores			
2050 Dry	**2050 Wet**	**2085 Dry**	**2085 Wet**
67.97	67.19	67.54	67.78

Table A-21. Projected Individual Indicators of Vulnerability for Ecosystem Restoration Business Line Within the Upper Mississippi-Maquoketa-Plum Watershed (HUC 0706) (https://maps.crrel.usace.army.mil).

Individual Indicators	2050 Dry	2050 Wet	2085 Dry	2085 Wet
Sediment	1.49	2.23	1.46	2.34
Monthly covariance	4.78	4.57	4.85	6.16
Runoff elasticity	15.70	15.24	15.13	15.87
Macroinvertebrate	11.33	11.24	11.33	11.16
Flood magnification-	2.03	3.36	1.05	3.28
Flood magnification–local	0.81	1.00	0.83	1.01
Mean annual runoff-local	6.39	6.18	6.40	4.70
Change in low runoff	3.16	1.57	3.16	1.60
At risk freshwater plants	26.11	25.89	26.11	25.71

9.3.3 Non-Stationarity Detection Tool

The Non-Stationarity Detection Tool was used to analyze discharge at the USGS Gage 05420500, Mississippi River at Clinton, Iowa, using 12 different statistical tests to detect nonstationarities in peak annual streamflow record (https://climate.sec.usace.army.mil/nsd/). Located at Mississippi River Mile 516.6 and 5.8 miles downstream of the downstream study area boundary, the Clinton, IA gage is in the middle of Pool 14; therefore, the analysis period for the Non-Stationarity Detection Tool was restricted to 1940-2019 WY following initial operation of L&D 13 in May 1939 and L&D 14 in June of 1939 (Figures A-51 to A-53). The Energy Divisive Method detected a statistically significant change in the data's distribution in 1990 and the Lombard Wilcoxon Test detected a statistically significant change in mean in 1963. However, a lack of consensus between the statistical tests indicates that no significant operational nonstationarities or change points in the flow record can be detected.

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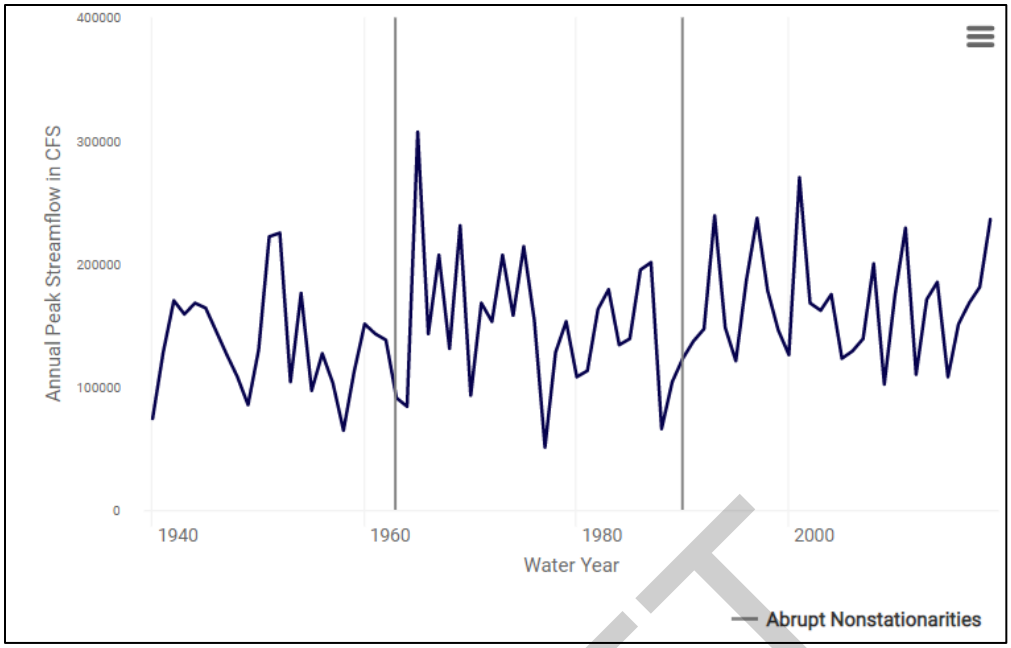

Figure A-51. Plot-Non-stationarity Analysis of Peak Annual Discharge for the Mississippi River at Clinton, Iowa (USGS gage 05420500) for the 1940 to 2019 WY Period (https://climate.sec.usace.army.mil/nsd/).

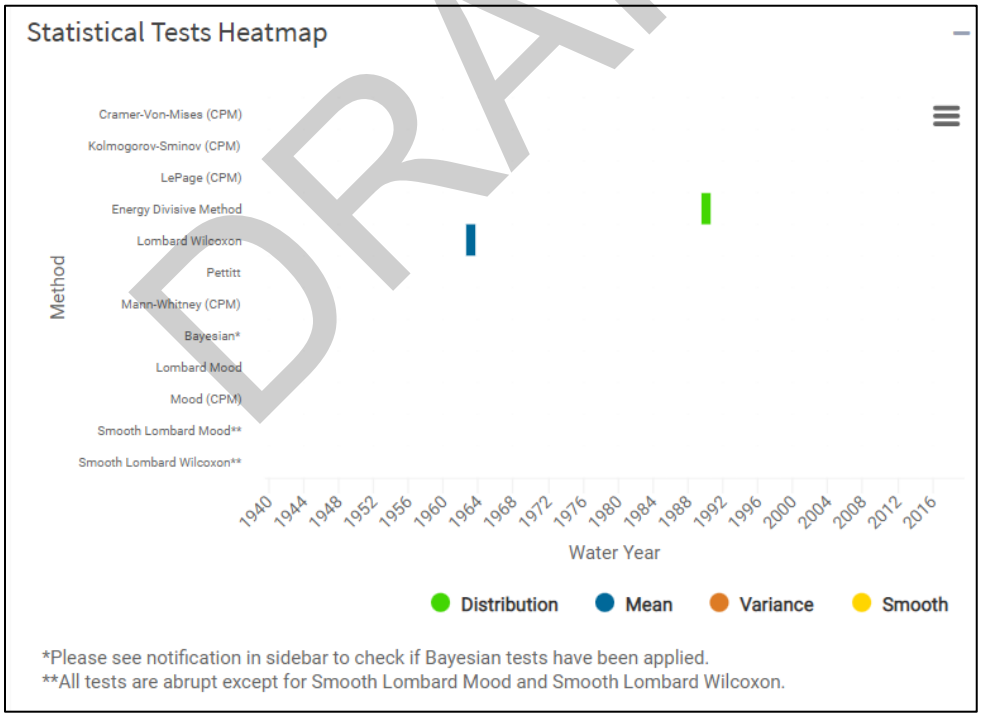

Figure A-52. Statistical Test Heat Map-Non-stationarity Analysis of Peak Annual Discharge for the Mississippi River at Clinton, Iowa (USGS gage 05420500) for the 1940 to 2019 WY Period (https://climate.sec.usace.army.mil/nsd/).

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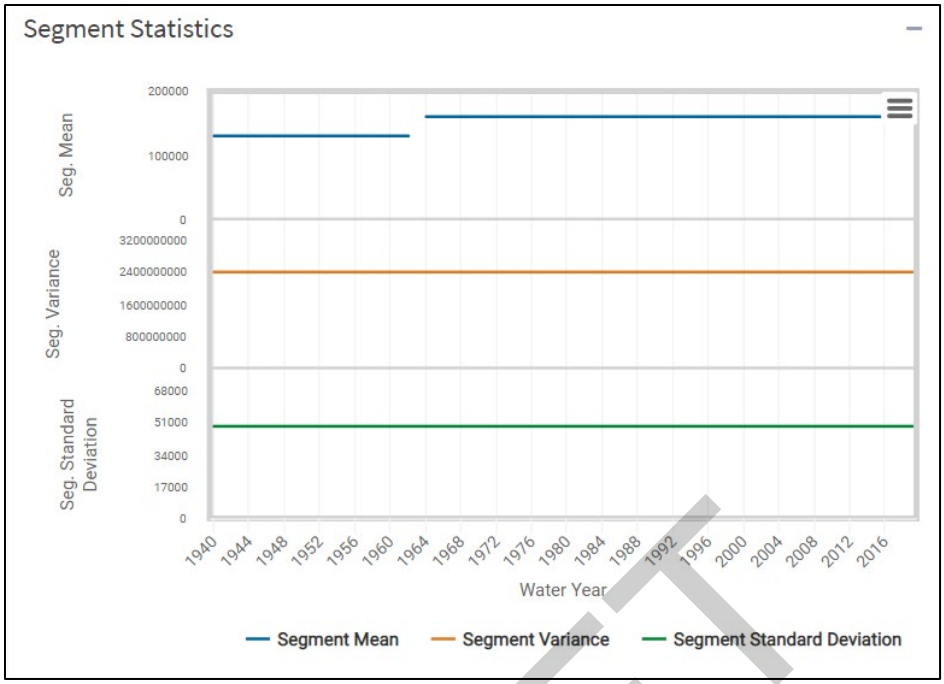

Figure A-53. Segment statistics-Non-stationarity Analysis of Peak Annual Discharge for the Mississippi River at Clinton, Iowa (USGS gage 05420500) for the 1940 to 2019 WY Period (https://climate.sec.usace.army.mil/nsd/).

Figure A-54 shows Monotonic Trend Analysis results for peak annual discharge at the Clinton gage (WY 1940–2019). A statistically significant trend was detected by both the Mann-Kendall test and the Spearman Rank-Order Test. A statistically significant trend was not detected by the t-Test. Because the t-Test is considered the least robust of the three tests utilized, it is concluded that a statistically significant trend is present in this dataset. The traditional slope of the trendline is 444 cfs/year suggesting an increase in peak annual discharge of 22,200 cfs over a 50-year period. While this increase is substantial, it should be noted that (1) the results from this analysis are qualitative and (2) the Study objectives are more sensitive to duration of flooding than they are to flood peaks.

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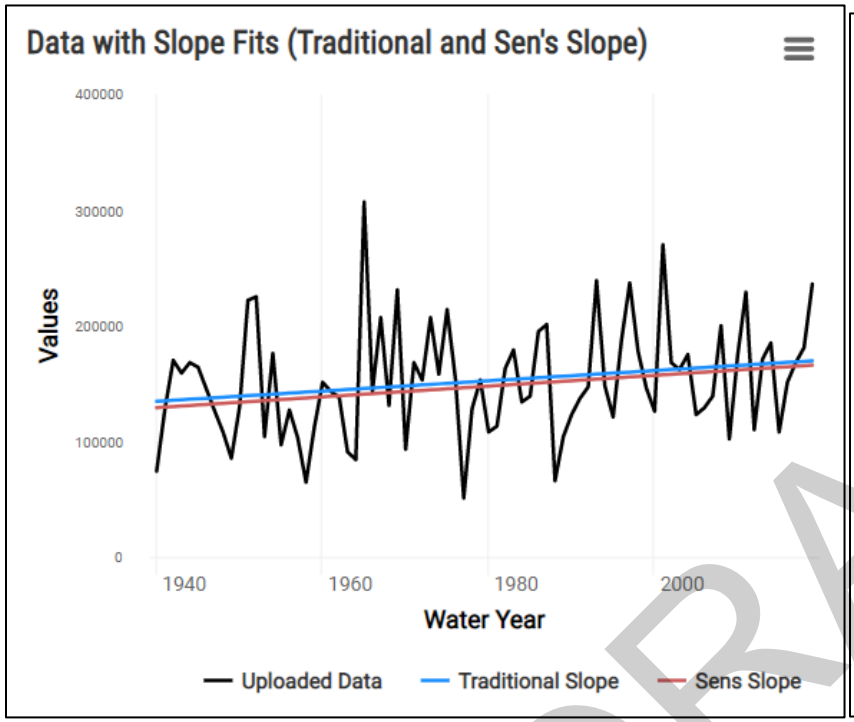

Trend Hypothesis Test

Test	P-Value
t-Test	0.058876
Mann-Kendall	0.043002
Spearman Rank-Order	0.03284

- **A statistically significant trend (at the alpha = .05 level) was NOT detected by the t-Test.**
- **A statistically significant trend (at the alpha = .05 level) was detected by the Mann-Kendall Test.**
- **A statistically significant trend (at the alpha = .05 level) was detected by the Spearman Rank-Order Test.**

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Figure A-54. Monotonic Trend Analysis of Peak Annual Discharge for the Mississippi River at Clinton, Iowa (USGS gage 05420500) for the 1940 to 2019 WY period (https://climate.sec.usace.army.mil/nsd/).

9.3.4 Time Series Toolbox

The Time Series Toolbox (TST) was used to evaluate the maximum number of consecutive days that the 0.2 annual exceedance probability (AEP) event water surface elevation was exceeded each year at the Lock and Dam 13 at Fulton, IL pool gage (https://climate.sec.usace.army.mil/tst_app/). Data was assessed for water years 1941 to 2021 and the 0.2 AEP event was considered "exceeded" whenever the water surface elevation at LD 13 gage was greater than 585.1 feet NAVD88 (USACE, 2004). Understanding the behavior of the 0.2 AEP event is helpful to the Study because (1) this is roughly the magnitude at which the Timber Stand Improvement (TSI) features begin to see inundation and (2) this is a moderate flood event and would be expected to create non-optimal velocities for Valisneria growth.

Figure A-55 to A-58 show non-stationarity analysis results for the number of days the 0.2 AEP water surface elevation was exceeded per year for the Mississippi River at L&D 13, Fulton, IL gage (water years 1941-2021). Abrupt changes in distribution were detected in 1954 (Cramer-Von-Mises method, Kolmogorov-Sminov method), 1959 (LePage method), 1975 (Cramer-Von-Mises method, Kolmogorov-Sminov method), 1977 (LePage method), 1987 (Kolmogorov-Sminov), 1995 (LePage method), 1997 (Cramer-Von-Mises method), 2001 (Kolmogorov-Sminov method), and 2013 (LePage method). Abrupt changes in variance were detected in 1959, 1977, 1995, and 2013 by the Mood method. The Bayesian method was not applied because normality assumptions were not met for this dataset. The results indicate there is consensus and robustness between the statistical tests to detect the presence of nonstationarities around the years 1959, 1977, and 1995, but the change in magnitude is not operationally significant due to design elevation constraints. No breakpoints were identified by the Time Series Toolbox.

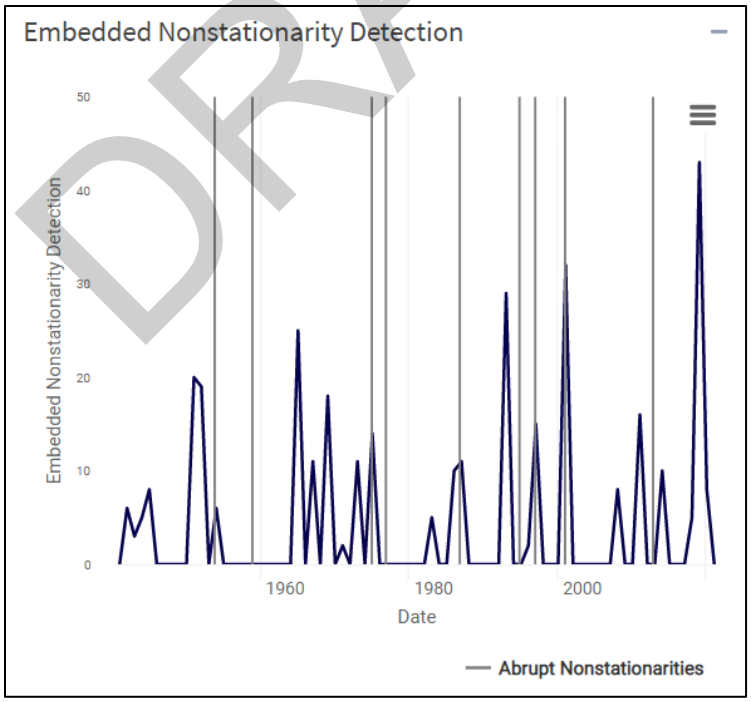

Figure A-55. Plot-Non-stationarity Analysis of "maximum number of consecutive days 0.2 AEP water surface elevation was exceeded each year", Mississippi River at L&D 13 gage, WY 1941-2021 (https://climate.sec.usace.army.mil/tst_app/).

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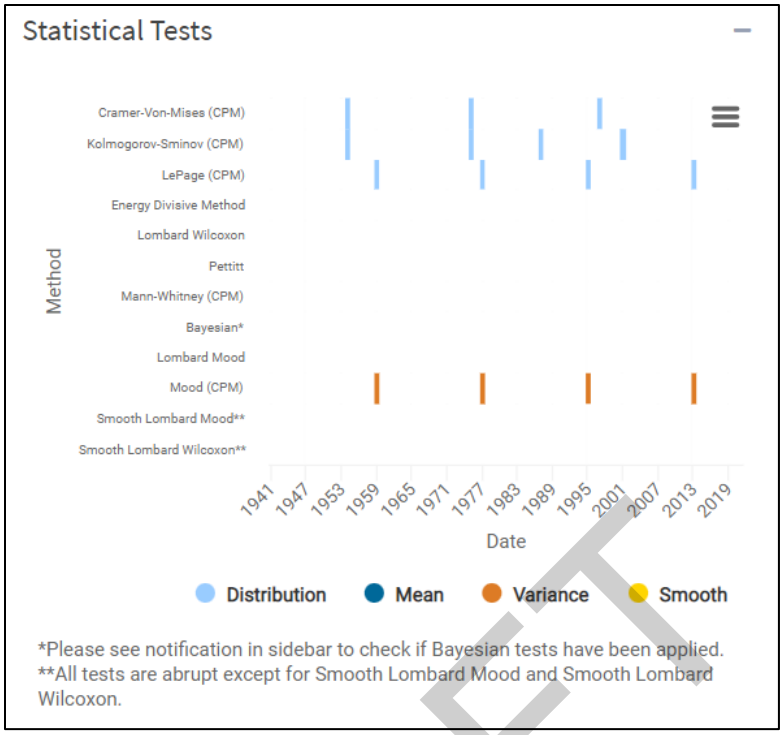

Figure A-56. Statistical Tests Heat Map-Non-Stationarity Analysis of "maximum number of consecutive days 0.2 AEP water surface elevation was exceeded each year", Mississippi River at L&D 13 gage, WY 1941-2021 (https://climate.sec.usace.army.mil/tst_app/).

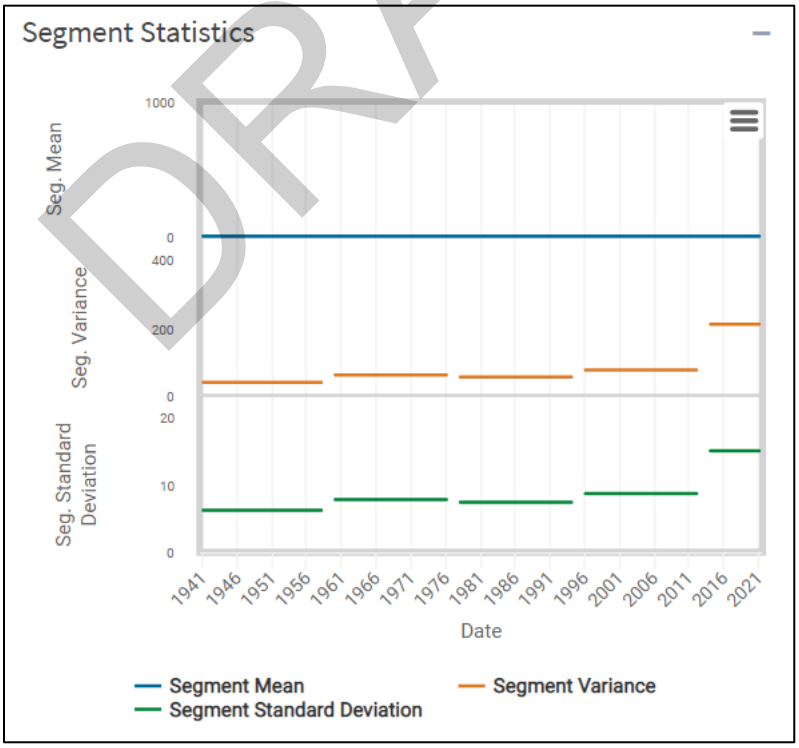

Figure A-57. Segment statistics-Non-stationarity Analysis of "maximum number of consecutive days 0.2 AEP water surface elevation was exceeded each year", Mississippi River at L&D 13 gage, WY 1941-2021 (https://climate.sec.usace.army.mil/tst_app/).

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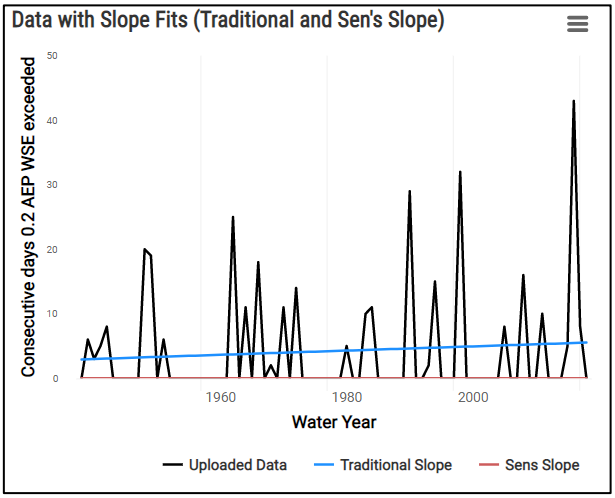
Figure A-61 shows Monotonic Trend Analysis results for the maximum number of consecutive days the 0.2 AEP water surface elevation was exceeded each year for the Mississippi River at L&D 13, Fulton, IL gage (water years 1941-2021). A statistically significant trend was not detected by the Mann-Kendall or Spearman Rank-Order tests; therefore, it is concluded that a statistically significant trend is not present in this observed dataset.



Test	P.Value
t-Test	0.41421
Mann-Kendall	0.99213
Spearman Rank-Order	0.99913

- **A statistically significant trend (at the alpha = .05 level) was NOT detected by the Mann-Kendall Test.**
- **A statistically significant trend (at the alpha = .05 level) was NOT detected by the Spearman Rank-Order Test.**

Figure A-58. Monotonic Trend Analysis of "maximum number of consecutive days 0.2 AEP water surface elevation was exceeded each year" for the Mississippi River at L&D 13 gage, WY 1941-2021 (https://climate.sec.usace.army.mil/tst_app/).

9.4 Phase II, Vulnerability Assessment: Quantitative hydrology

Quantitative assessment of climate factors was not conducted for this Study. No opportunities were identified to apply quantitative data to improve project design. Proposed features are designed to improve overall resiliency of target habitats and expected to somewhat reduce negative impacts of Climate Change within the study area.

9.5 Phase III, Risk Assessment

In the future, available literature suggests the following for the study area:

- Warmer temperatures and heat waves of longer duration
- Increases in total precipitation and magnitude of extreme precipitation events
- Increases in severity, length, and frequency of droughts
- Potential increases in spring and winter streamflow and decreases in summer streamflow

The USACE CHAT tool determined no statistically significant trend in "historic" annual maximum monthly streamflow and a statistically significant but negligible increase in "future" annual maximum monthly streamflow. The USACE Vulnerability Assessment Tool suggests that ecosystem restoration efforts in the vicinity of the study area (HUC 0607) are relatively less vulnerable to climate change compared to the other 202 HUC 04 watersheds in the CONUS.

The USACE Non-stationarity Detection Tool found a statistically significant observed peak

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annual discharge at nearby Mississippi River at Clinton, IA gage and no statistically significant non-stationarities in that data set. The USACE Time Series Toolbox found no statistically significant trend in the maximum number of consecutive days the 0.2 AEP water surface elevation was exceeded each year for the Mississippi River at L&D 13, Fulton, IL gage and no statistically significant non-stationarities or breakpoints in that data set.

Table A-22 summarizes the climate risks to the Lower Pool 13 HREP. In relation to timber stand improvement (TSI) locations, floodplain forests are vulnerable to both floods and droughts of longer duration. When these stresses exceed 40 days, they are particularly likely to threaten quality and quantity of forest. Long floods are triggered by increased precipitation from larger, slower moving storms and long droughts are triggered by rising temperatures, which increase evapotranspiration and rates of soil moisture loss. This harm has a qualitative likelihood of "possible" while the drought hazard has a qualitative likelihood of "likely". However, the TSI features mitigate this risk by improving individual tree vigor and resistance to disturbance events.

In relation to island, chevron, and rock mound features, longer duration floods (triggered by increased precipitation from larger, slower moving storms) are again a concern. Flood flows create high velocities and high turbidity conditions that are not ideal for wild celery growth. Floods of long duration are anticipated to have a more substantial impact on the vegetation; however, the island, chevron, and rock mound features are designed to reduce the impact of these hazards by improving resilience of wild celery. Additionally, flood flows create high velocities with the potential to increase scour at built features, within existing wild celery beds, and within a sensitive no-work area. To mitigate this risk, post-TSP feasibility level of design analysis and PED analysis will adjust proposed features to ensure that they do not substantially increase scour risk and compound climate impacts.

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Table A-22. Potential Climate Risks to the Project

Feature	Timber Stand Improvement Sites		Island, Chevrons, and Rock Mounds	
Trigger	Increased precipitation from larger, slower moving storms	Rising temperatures are anticipated to increase evapotranspiration rates and rates of soil moisture loss	Increased precipitation from larger, slower moving storms	
Hazard	Future flood volumes may be larger than present; large flood volumes may occur more frequently and with longer durations	Future droughts may be more frequent, more intense, and of larger areal extent	Future flood volumes may be larger than present; large flood volumes may occur more frequently and with longer durations	
Harm	Floods that inundate tree roots, particularly floods of longer duration lasting more than 40 days threaten quality and quantity of forest.	Droughts that limit tree roots' access to moisture, particularly droughts of longer duration lasting more than 40 days threaten quality and quantity of forest.	Flood flows create high velocities and high turbidity conditions that are not ideal for wild celery growth. Floods of long duration are anticipated to have a more substantial impact.	Flood flows create high velocities with the potential to increase scour at built features, within existing wild celery beds, and within sensitive no-work area.
Likelihood	Possible	Likely	Possible	Possible
Mitigation	By improving individual tree vigor and resilience to disturbance events, TSI efforts are likely to lessen the impacts of this hazard.	By improving individual tree vigor and resilience to disturbance events, TSI efforts are likely to lessen the impacts of this hazard.	By improving velocities and turbidity during non-flood periods, chevron and rock mound features are likely to improve the resiliency of wild celery and lessen the impacts of this hazard.	Post-TSP feasibility level of design analysis and PED analysis will adjust proposed features to ensure that they do not increase scour risk and compound climate impacts.

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10. FURTHER ANALYSIS PLANNED

The following hydraulic analysis will be completed or considered during post-TSP feasibility level of design (FLD):

- Scour risk has not yet been evaluated. Higher flow conditions should be applied to the Lower Pool 13 HREP 2D HEC-RAS model to evaluate if proposed features increase velocities such that scour is likely. Areas of particular concern include: (1) the sensitive no-work area, (2) locations of existing wild celery beds, (3) the immediate vicinity of proposed features, (4) the immediate vicinity of dredge material placement sites, and (5) areas where mussels are found. Further grid cell refinement of the model may be required to confidently answer these questions.

- Initial 1D hydraulic rise modeling has been completed for the TSP. The PDT intends to complete further analysis during FLD prior to public review of the feasibility study.

The following hydraulic analysis will be completed or considered during PED phase:

- Water level management is being considered as part of a future HREP feasibility study in Lower Pool 13. As more details are available, the relationship between these new hydraulic conditions and the features proposed in the current feasibility study should be investigated utilizing the Lower Pool 13 HREP 2D HEC-RAS model.
- To further refine accuracy of velocity outputs of the 2D HEC-RAS model, the impact of changing manning's n at feature locations should be investigated.

11. REFERENCES CITED

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT B
CIVIL AND ENVIRONMENTAL ENGINEERING

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APPENDIX E
ENGINEERING APPENDIX

ATTACHMENT B
CIVIL AND ENVIRONMENTAL ENGINEERING

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1. CIVIL DESIGN CONSIDERATIONS

1.1. Submerged Aquatic Vegetation Design Criteria

A major objective of this project is the preservation and enhancement of *Vallisneria americana* Michx. *Vallisneria americana* (also referred to locally as wild celery, water celery or eelgrass) is a perennial submersed aquatic plant that represents an important component of aquatic plant communities in the Upper Mississippi River System. Wild celery possesses ribbon-like leaves that can extend up to 2 meters in length (McFarland, 2006). Sexual reproduction via pollination is possible, albeit rare. The female flower blooms slightly below the water surface, causing a dimple in the water intended to collect male flowers as they float downstream. Reproduction in the UMRS is most commonly accomplished asexually through the use of underground rhizomes, allowing Wild celery to spread rapidly and form dense “forests” of aquatic vegetation (McFarland, 2006). Wild celery survives winter conditions in the Upper Mississippi River through the use of tubers. At the end of the growing season, plants sequester sugars and nutrients into tubers in the substrate and use the energy stored there to germinate the following spring.



Photograph 1. Wild celery Bed Seen Under Water in Lower Pool 13 (August 2020)

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Photograph 2. Wild celery Bed Seen from Above Water in Lower Pool 13 (August 2020)

Wild celery is a very important food source for waterfowl, primarily those species known as "divers". Diving ducks, especially the canvasback (*Aythya valisineria*), target the energy-rich tubers produced by Wild celery during fall migration. *Vallisneria*'s common name of "wild celery" is a testament to the canvasback's reputation as high quality table fare. Canvasbacks feed on the plant so often during migration that it has been reported by hunters who harvest the ducks that the meat has a celery-like flavor to it. Canvasbacks were so highly coveted as table fare that commercial market hunting in the 19th century almost caused extinction of the species. The passing of the Lacey Act in 1900 and the Migratory Bird Treaty Act in 1918 put an end to the commercial harvesting of game birds in the United States. This legislation, coupled with Teddy Roosevelt's creation of the National Wildlife Refuge system, allowed the recovery of canvasbacks and many other species of waterfowl.

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Photograph 3. Wild celery Tuber in Substrate at Lower Pool 13 (August 2020)

Canvasbacks will dive down to the substrate and root out the tubers of Wild celery*, Sagittaria latifolia* (arrowhead), and other species of submerged aquatic vegetation. Canvasbacks in particular coordinate migratory patterns to follow the location of wild celery beds within the Upper Mississippi River System. While this is a primary food source for canvasbacks and other waterfowl during the non-breeding seasons, other animals such as muskrats, fish, and invertebrates use these vegetation beds as both a food source and habitat.



Photograph 4. Canvasback Flock from htpps://abcbirds.org/bir/canvasback/ obtained 6/4/2020

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Photograph 5. Fall Migration at Lower Pool 13 (October 2020)



Photograph 6. Resting Waterfowl at Lower Pool 13 (October 2020)

Research conducted on wild celery included conversations with subject matter experts, as well as peer-reviewed published articles (Kreiling, Yin, & Gerber, 2007, Kimber, Owens, & Crumpton, 1995, McFarland, 2006, Sparks *et al*., 1990, Lund, 2019, UMRCC, 2003, and Giblin, unpublished data). Based on this research, the following minimum criteria was established for optimum wild celery habitat:

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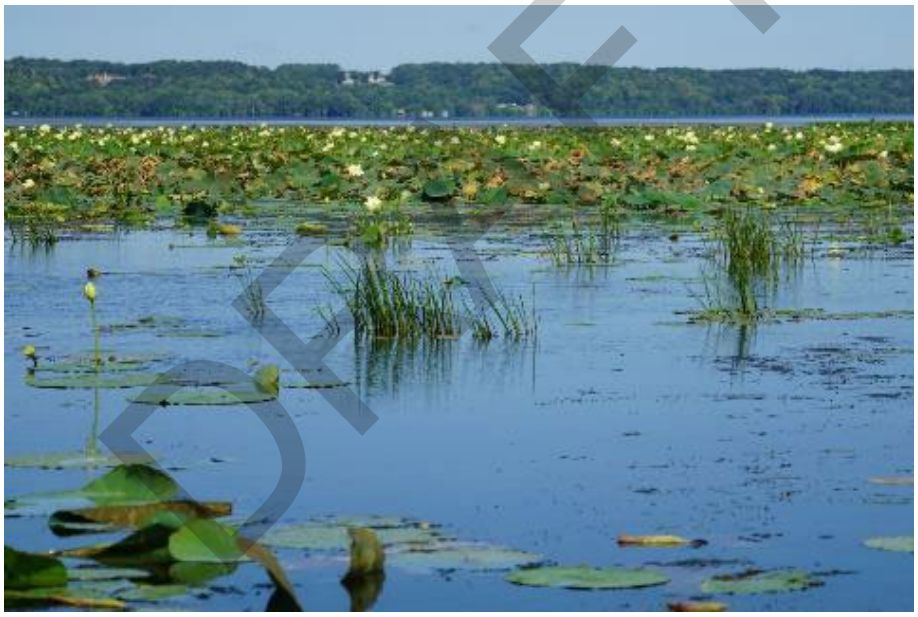
Table 1. Wild celery Design Criteria

Optimum Velocity During Growing Season	**10-20 cm/sec**
	Velocities below 10 cm/sec will allow wild celery to remain, but they could be outcompeted by other plants which prefer lower velocities if not already present.
Water Clarity	Turbidity <= 20 NTU
	Secchi disk depth >= 0.5 m
	TSS <= 25 mg/l
Depth	1.5-6 feet
	Less than 1 foot, emergent species tend to dominate
	Depth in and of itself does not have an impact on Wild celery, however less light is able to penetrate the water column in deeper areas. Resource managers with IA DNR have documented cases of V. americana in up to 6 feet of water in Pool 13. This is likely the upper limit when it comes to depth for V. americana considering the current water clarity in the pool. This range is in agreement with that listed in the Diving Duck Migration Model as well (1.5-6 feet) and was therefore used as part of the design criteria for project features.



Photograph 7. Diverse Aquatic Vegetation in Some Portions of Lower Pool 13 with Lower Velocities During the Growing Season (August 2020)

Further discussion of optimal wild celery habitat and data analysis is documented in the following memo: *USACE, Lower Pool 13 HREP Vallisneria americana Mapping Effort: Draft Memo.* Prepared by the Rock Island District, U.S. Army Corps of Engineers. June 2020

1.2. Wind Driven Wave Reduction

Wind fetch is defined as the unobstructed distance that wind can travel over water in a constant direction. Fetch is an important characteristic of open water because longer fetch can result in larger wind-generated waves.

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One goal of this project is to reduce wind fetch across the lower pool, therefore reducing the size of wind-generated waves. This, in turn, will reduce the total suspended solids/turbidity of the water. USACE has designed projects in the past aimed to achieve similar goals including Pool 8 Islands HREP and Pool 9 Harpers Slough HREP. This project is very similar, but with an added design constraint.

As part of the National Wildlife and Fish Refuge, a main objective of Lower Pool 13 is to support and protect the fish and wildlife that reside there. For this reason, the sponsors of this project have limited proposals that would include breaking the water's surface during spring and fall duck migration in the canvasback priority areas. Protruding land mass is a stressor on the canvasback duck and other diving ducks who use this area during migration periods. This constraint provides a challenge in attempting to reduce wind fetch across the lower pool.

In addition to velocity optimization, these in pool structures will also be of value to reduce or break down wind driven waves. As noted by the project sponsors, increased wind grows larger waves, which circulate and resuspend the sediment. This causes an increase in turbidity which is detrimental to future SAV growth. The SAV itself can serve to break up waves, and filter excess turbidity, and in general water is clearer within submerged vegetation beds. However, if the turbidity is too high, these beds will not be able to get established, and overall, the future of the beds continues to diminish over time.

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Photograph 8. Resuspended Sediment on High Wind Days Lower Pool 13.
This was at the north tip of the Thompson Causeway Campground. (IADNR Photo Credits).
25 mph out of the NW. (10/12/2020)



Photograph 9. Views from Bulgers Hollow October 2020



Photograph 10. Vantage 1, 10/5/20 – 17 mph S wind – Bad Day (IA DNR)

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Photograph 11. Vantage 1, 10/8/20– 6 mph E wind – Good Day (IA DNR)

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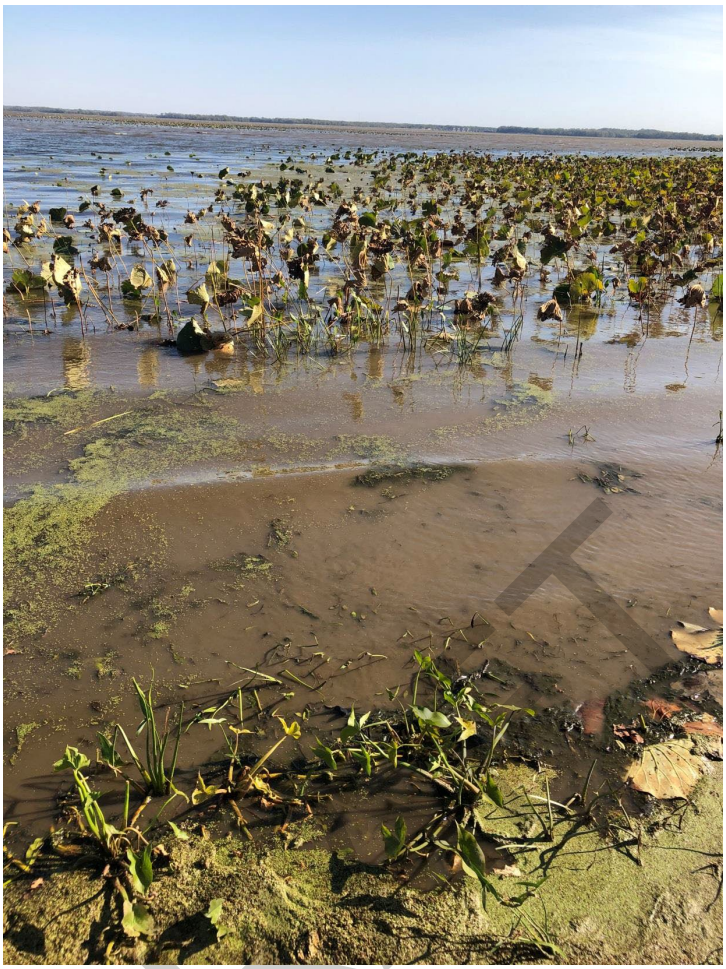

Photograph 12. Vantage 2, 10/5/20 – 17 mph S wind – Bad Day (IA DNR)

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Photograph 13. Vantage 2, 10/8/20– 6 mph E wind – Good Day (IA DNR)

1.3. Island Protection

Island erosion was identified by the sponsor as a concern, included losing the upstream protection for submerged aquatic vegetation beds, loss of flow diversity, loss of nesting habitat, and loss of floodplain forest habitat.

LTRM Status and Trends report (DRAFT), 2021 was reviewed along with the Utilized *Recent planform changes in the Upper Mississippi River* by Rogala *et al.*, 2020. which indicated that Pool 13 gained ~22 ha surface area between 2000 and 2010 and similar gains from 1989-2000, Mostly in the form of impounded delta (orange)

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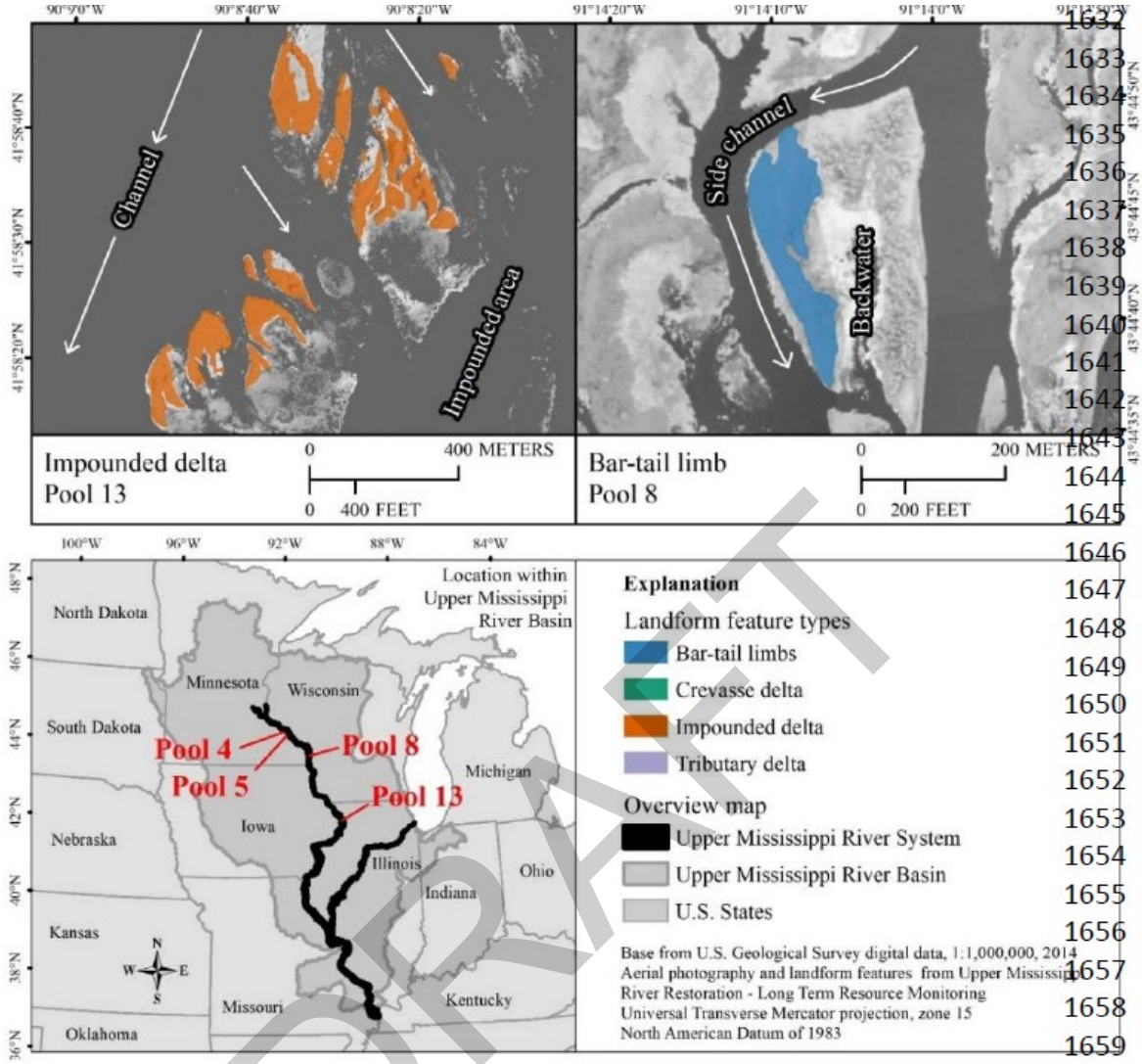

The NESP ENV Report 8 Bank Erosion Field Survey Report was also reviewed for RM 551.9.

To determine if the islands were eroding, the team performed site visits in 2020 to each proposed island. A photographic comparison of islands over time, at close river surface water levels was compared to determine the overall rate of erosion.

Table 2. Imagery Sources for Island Erosion Analysis

Imagery Source	
1998	NAPP 1998 IL Quadrangle
2002-2007	Iowa Historic Imagery (https://ortho.gis.iastate.edu/)
2010-2017	USDA NAIP aerial imagery (MVR/EGIS/Data/Layers/Imagery-Baselayers/NAIP_Aerial_Photos.lyr)

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Table 3. Imagery Dates and Pool Stage for Island Erosion Analysis

Year	Date	LD13 Pool Stage (ft.)	LD13 Flow (cfs)	WSE (ft '88) at RM 528.5
1998	4/5/1998	14.1	119,000	584.1
2002	5/3/2002	14.2	121,000	584.2
2004	8/7/2004	14.4	39,000	582.7
2005	4/30/2005	14.4	96,000	583.8
2006	7/9/2006	14.3	21,000	582.5
2007	4/25/2007	14.4	81,000	583.4
2010	7/23/2010	14.5	84,000	583.5
2011	7/25/2011	14.2	102,000	584.0
2012	6/27/2012	14.2	85,000	583.5
2013	7/11/2013	14.3	126,000	584.2
2014	7/23/2014	14.5	91,000	583.7
2015	9/6/2015	14.3	36,000	582.7
2017	9/18/2017	14.5	48,000	582.8

This analysis did not identify active erosion during the period of review, but it was noted that islands IP-H4, IP-H5 and IP-H6 were actively eroding over time (and nearly gone), and that any work to restore or protect these would be important for nesting habitat, flow diversity, and velocity reduction downstream.

1.4. Nesting Island Criteria.

Since the construction of Lock and Dam 13, the habitat in the lower end of the pool has become less diverse for a number of reasons one of these being that islands have eroded;

Dredged material placement from access dredging was identified to have a beneficial use at several islands. Priority placement was determined by the USFWS to proceed in the following order: Woodruff (IP-H6), Gomers (IP-H5), Cormorant (IP-H4).



Photograph 14. IP-H4 Cormorant Island (October 2020)

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Photograph 15. IP-H6 Woodruff Island (October 2020)



Photograph 16. IP-H5 Gomer's Island (October 2021)

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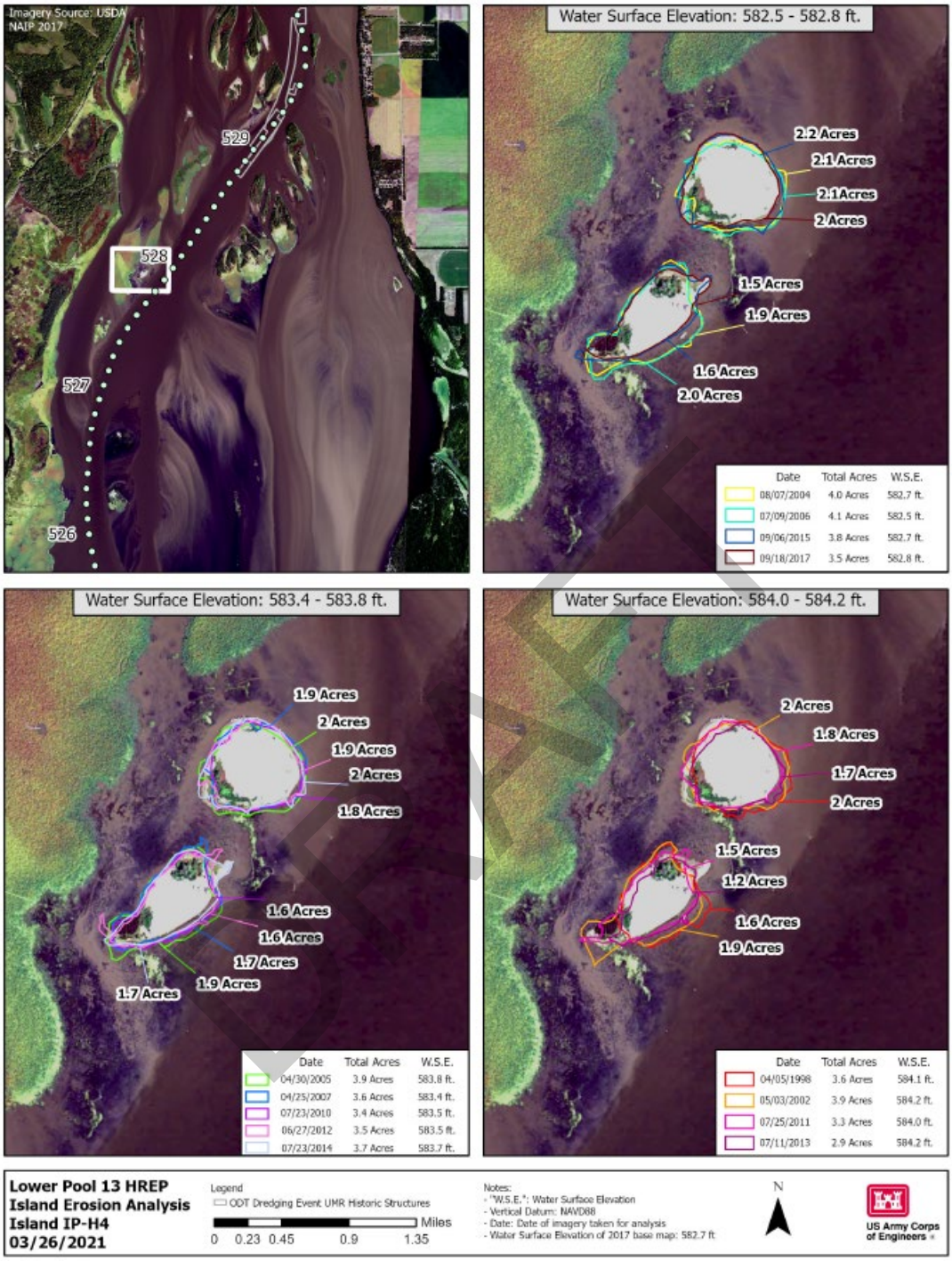

Figure 1. IP-H4 Cormorant Island

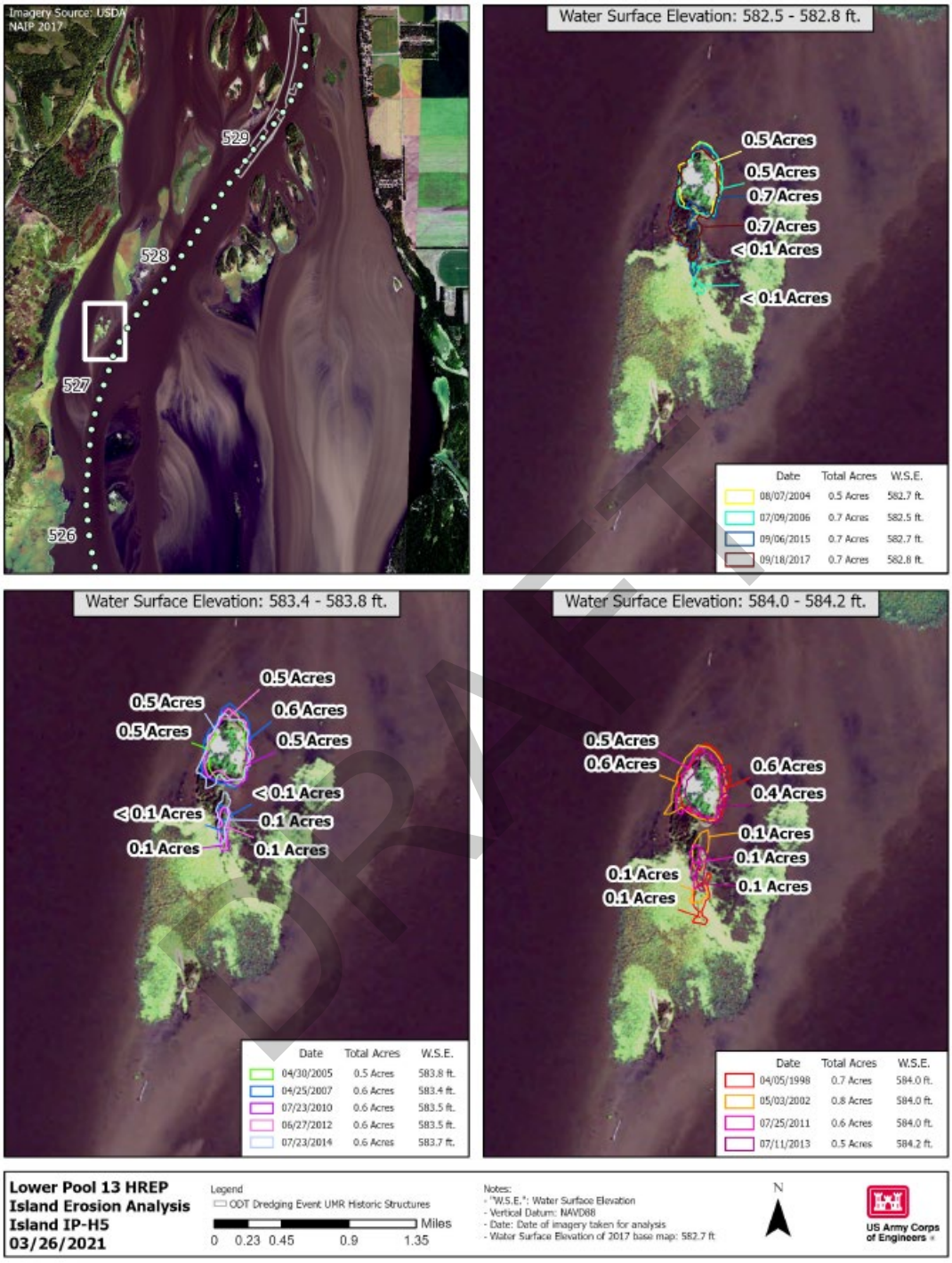

Figure 2. IP-H5 Gomers Island

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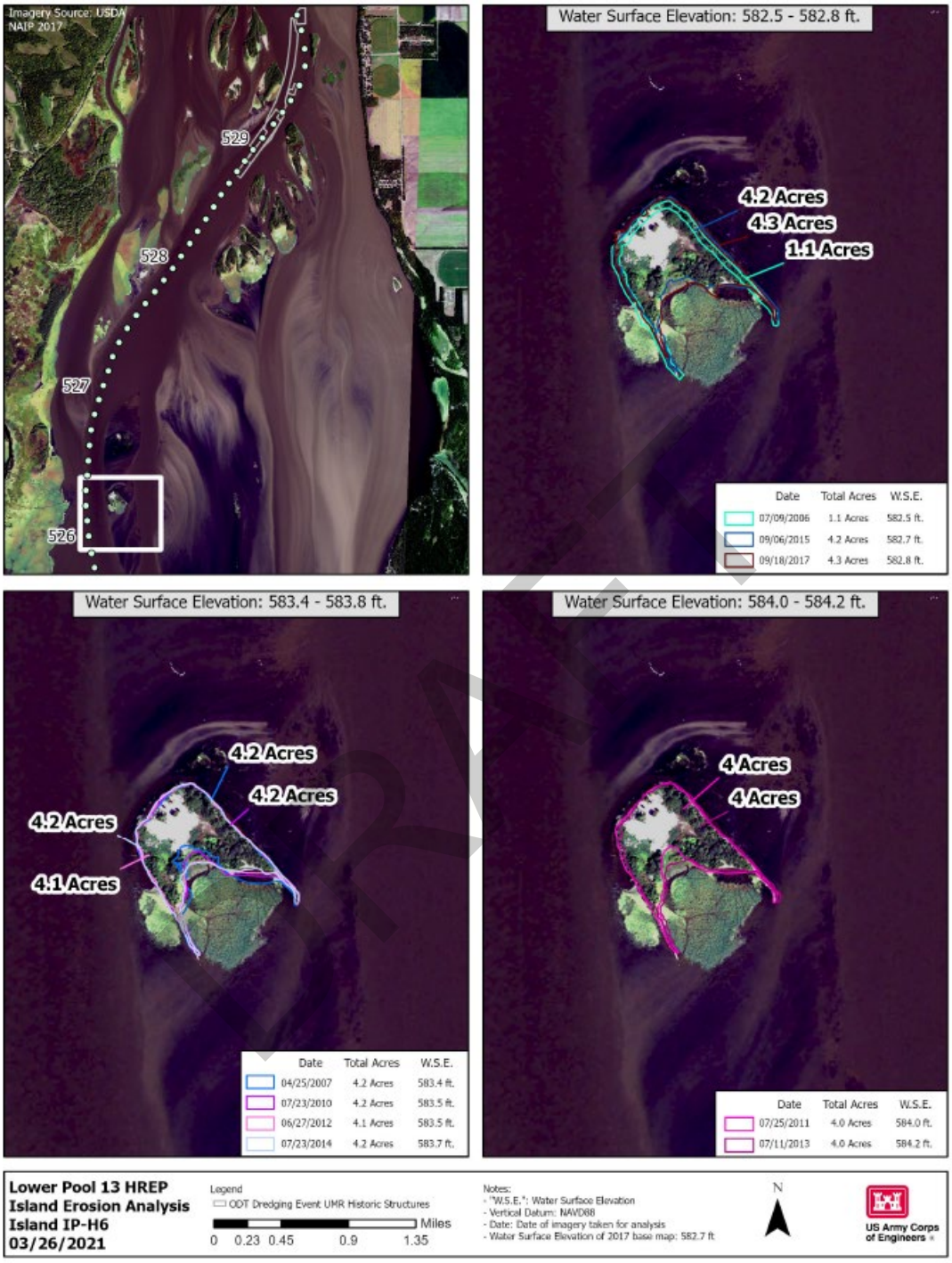

Figure 3. IP-H6 Woodruff Island

1.4.1. Existing Nesting Islands

Existing islands in Lower Pool 13 have been constructed or modified by adding dredged material. The success of these islands can be mimicked in future placement sites.

1.4.1.1. Pelican Island

The Dredged Material Management Plan, Upper Mississippi River Miles 525.1-538.7, Pool 13, Site Plan For Sabula Reach, Sabula Lower, Dark Slough, Elk River And Pomme De Terre Dredge Cuts, Final Report, December 2004 reviewed multiple sites for material placement near the Lower Pool 13 HREP project locations. Sites 5a and 5b were identified for island creation. These islands were located between Mississippi RM 526.2 to 526.9. In 2006, Pelican Island was constructed. The island was anticipated to provide habitat for terrestrial species and semi-aquatic species. Islands provide new nesting, feeding, and loafing areas for waterfowl, reptiles, amphibians, as well as furbearers. Islands in the lower third of a pool protect aquatic vegetation by deflecting the river's current and breaking up waves. The aquatic vegetation located in the protected areas behind islands is used for food by migrating waterfowl and as habitat for other aquatic life and life history stages.

New island creation can enhance terrestrial and aquatic habitat diversity and is an approach towards reducing the effects of wave action on sediment re-suspension. Changes in flow pattern around and through the proposed island complex would create new fish and invertebrate habitats primarily through the promotion of secondary and tertiary channel development and diversification of water velocities. Rock used to armour the islands against erosion would also provide spawning habitat for fish species, such as channel catfish. The rock would also provide a substrate for macroinvertebrate production as well as periphytic (e.g., algae) organisms. The wind buffering capacity of islands enhances growth of submergent and emergent aquatic plants on at least one side of an island. In addition, reduction in sediment re-suspension would also improve environmental conditions for the establishment and maintenance of aquatic vegetation. The vegetation provides fish habitat and food, as well as bank protection.

Pelican Island, a successful nesting island constructed of dredged material was studied. Pelican Island has a top elevation of approximately 586.1 MSL 1912 (585.46 NAVD88). The island was evaluated in the 2004 DMMP Report, and constructed in 2006.

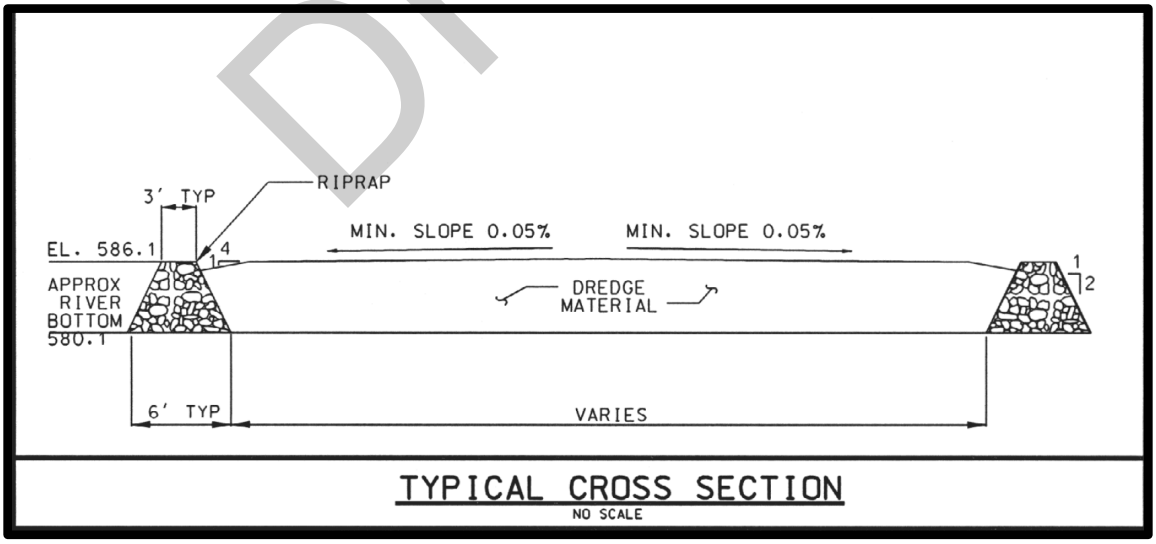

Figure 4. Pelican Island Typical Cross Section 2004
(Source: Dredged Material Management Plan, Upper Mississippi River Miles 525.1-538.7, Pool 13, Site Plan For Sabula Reach, Sabula Lower, Dark Slough, Elk River And Pomme De Terre Dredge Cuts, Final Report, December 2004)

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1.4.1.2. Cormorant Island

In 2020, an Environmental Assessment (Dredged Material Placement, Upper Mississippi River, Pool 13 River Miles 529.1-529.3, Elk River Dredge Cut, Final Environmental Assessment, May 2020) was completed in the project area which identified a placement site at Cormorant Island. The purpose of this dredging project and associated dredge placement site was to maintain a commercial navigation channel for the transport of commodities, etc., and thus avoid disruption to transport of those commodities, and to maintain the channel in such a manner to avoid potential loss of life, personal injury, or property damage that may result from inadequate maintenance of the channel and subsequent groundings and/or closures of the main channel.

The Environmental Assessment (EA) was an after-the-fact National Environmental Policy Act (NEPA) compliance document for the after-the-fact EA at Elk River Reach, Pool 13 of the Upper Mississippi River. Time constraints prevented the completion of NEPA documentation prior to the initiation of emergency work. NEPA documentation for the dredging event will be accomplished after-the-fact as per Engineering Regulation 200-2-2, Paragraph 8 Emergency Actions allows the District Commander to respond to situations to prevent or reduce imminent risk of life, health, property, or severe economic losses without first preparing specific documentation.



Figure 5. Map of Proposed Dredge Cut and Selected Placement Site (EA 2020)

The Rock Island District needed to perform dredging in order to maintain the nine-foot channel navigation at the Elk River Reach. Material dredged from the Elk River dredge cut consists predominantly of medium to fine brown sand. Approximately 9,478 CY of dredged material was removed from the channel by mechanical dredging and placed between Islands 303 and 304 (Cormorant Islands). The material was graded after placement to expand American white

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pelican nesting habitat by connecting Islands 303 and 304. Both islands are primarily comprised of sand.

These islands are located on the Iowa side of the channel near Elk River Slough, ~7 miles south of Sabula, Iowa, approximate RM 535. The site is in Section 28, Township 83 North, and Range 7 East, Clinton County, Iowa. Placement was to be between the two government-owned islands. Dredged material was to be placed up to but not exceeding the Ordinary High Water Mark (586.98 ft MSL 1912/ 586.34 NAVD88) The material would be graded after placement. Side slopes of the placed material would fall at approximately 3H:1V slope.

Cormorant Island has also been supplemented with dredged material on the upstream and downstream ends of the islands and has a top elevation of around 583.0 NAVD88 prior to dredge placement. This is also a successful nesting island.

Cormorant Islands (Islands 303 and 304, RM 527.7-528.0)

OSIT PREFERRED SITE

- Restoration of the Cormorant Islands is a Refuge priority.
- Pelican and cormorant nesting is now complete for the year, so dredged material placement during the fall of 2019 would be ideal timing.
- A mussel survey was conducted at this site in 2016, associated with the Deepwater Horizon Oil Spill NRDA restoration proposal. During this survey 152 mussels of 10 species were found. No state or federally listed species were identified.
- The OSIT would like to see dredged material placed between the upstream and downstream Cormorant Islands (Islands 303 and 304), as the upstream island will provide protection and prevent erosion of the placed material.
- Shallow access leading from the channel to the island may make both hydraulic and mechanical placement difficult; however, the Cormorant Islands appeared to be located the closest to the channel out of all of the sites assessed.
- The OSIT discussed the potential to begin placing material adjacent to the channel and extend the placement toward the upstream island to help alleviate access issues. The OSIT agreed with this approach as long as there is enough material to ensure connection of the placement with the existing upstream island, preventing flow between the placement area and the existing island which would likely result in accelerated erosion of the existing islands.



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Photograph 17. Cormorant Island Nesting
(After material placement from the DMMP, 2020)

1.4.1.3. Flood Frequency Events.

Table 4 shows the elevations anticipated to be exceeded with 2, 5, and 10-yr return periods for each placement location according to the 2004 Upper Mississippi River Flood Frequency Study.

Table 4. Water Surface Elevations at Locations of Interest,
2004 Upper Mississippi River Flood Frequency Study

Island	River Mile	Water Surface Elevation, ft NAVD88		
		50% AEP 2-yr return period	20% AEP 5-yr return period	10% AEP 10-yr return period
Woodruff	526.60	583.6	586.0	587.9
Gomers	527.25	583.9	586.1	588.0
Cormorant[1]	527.75	584.0	586.2	588.1

[1] OHWM 586.34 NAVD88 for Cormorant EA Emergency Placement

1.4.1.4. Design Criteria.

A design top elevation for these islands was set at 586.0 NAVD88, creating an estimated capacity for material disposal is approximately 858,600 CY of dredge material.

Maximum velocities anticipated at each placement location will be determined during the design phase using the 2D RAS model developed for the Lower Pool 13 HREP Southwest Corner Feasibility Study. This information will be used to inform side slopes and need for stone protection.

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Based on engineering considerations in the Environmental Design Handbook side slopes of 5:1 or flatter should be used to reduce rill erosion due to rainfall runoff. If it is determined that riprap is to be utilized (this is currently not the case) riprap side slopes of 4:1 or flatter may be necessary to combat ice force issues. For quantity purposes, the capacity at these sites was determined using a 4H:1V side slope (the more conservative quantity

Table 5. Nesting Habitat Design Criteria

Minimum Top Elevation	586.0 NAVD88
Side Slopes used for Capacity Volumes	4H:1V
Side Slopes for Design (if no stone required)	Varies. 3:1 for Cormorant Island DMMP site is successful to date with sand. Flatter slopes may be required. Geotechnical and Hydraulic analysis to be conducted during design to select appropriate slopes.
Stone Protection	None included in the feasibility study costs. This will be further evaluated during the design phase (2D RAS model)



Photograph 18. Nesting Habitat on Cormorant Island (October 2020)



Photograph 19. Nesting Habitat (October 2020)

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1.5. Overwintering Habitat.

During initial plan formulation, a major objective of this project was to provide overwintering habitat for the backwater fishery including the bluegill and other centrarchids. According to Palesh and Anderson, significant factors contributing to the value of winter bluegill habitat on the UMRS include water depth, dissolved oxygen (DO), water temperature, and current velocity.

Water depths provide cover in terms of space and darkness and are considered optimum when 50% or more of a backwater area is at least 4 feet deep at normal pool elevation.
Lack of adequate DO has resulted in winter fish kills. A DO concentration of at least 5 mg/L is considered optimum. Water temperature also affects habitat suitability, especially on the UMRS where super cooled water (< 0 °C) from the main channel may be introduced into the backwaters. A water temperature of 4 °C is considered optimum. The optimum current velocity is 0 cm/sec because even minor currents appear to impact winter bluegill use of UMRS backwater habitats (1990). Based on these guidelines from the bluegill winter habitat suitability index (HSI) model and additional information on conditions observed by UMRS fisheries biologists and water quality specialists, the following criteria were established for mapping overwintering habitat:

Table 6. Overwintering Habitat Design Criteria

Depth	4-10 ft below flat pool (elevation 582.066 ft NAVD88)
Dissolved Oxygen	DO >= 3 mg/L
Water Temperature	Water Temperature >= 1°C
Velocity	Velocity <= 1 cm/sec

A detailed discussion and data results on overwintering fish habitat is documented in the following memo:

USACE, ***Lower Pool 13 HREP Overwintering Mapping Effort:*** Draft Memo.
Prepared by the Rock Island District, U.S. Army Corps of Engineers. June 2020

Data maps dated 1994-2018 are included in the following document:

USACE, ***20200609_Overwintering1994-2018:*** Maps.
Prepared by the Rock Island District, U.S. Army Corps of Engineers. May 2020

Overwintering habitat was removed as a project objective.

2. Site Selection.

Structure locations were selected using a variety of water quality data, bathymetry, historic aerial photos, existing feature locations (such as wingdams and the main channel), existing aquatic vegetation beds, and avoidance of areas that experienced historic activities, and areas where resuspension of sediments from wind driven waves was most likely to occur. Final locations were selected in the upper, middle, and lower end of the southwest quadrant

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Location of features was developed over the project life and included information such as sponsor input and recommendations, water depths, water quality data, vegetation monitoring information, habitat suitability index, velocity, wind wave modeling, sediment evaluation, canvas back use area, mussel survey, historic aerial photography, navigation impacts, access dredging, recreational boating impacts, floodplain impacts, hazardous toxic and radioactive waste assessments, cultural and historic sites, and real estate boundaries.

2.1. Sponsor Recommendations.

Project priority areas were identified by the project sponsors at a workshop in March 2021. In April 2021, the team discussed various feature locations identified by al agencies. In May 2021, the PDT selected the optimum locations for all features. A site visit in October 2021 confirmed the general locations of the features.

2.1.1. USFWS.

At the March 2021 workshop, the USFWS identified the southwest pool as a priority area. In April 2021, the team discussed various feature locations identified by their agencies. In May 2021, the PDT selected the optimum locations for all features. A site visit in October 2021 confirmed the general locations of the features.

2.1.2. Iowa DNR.

At the March 2021 workshop, the Iowa DNR recommended that there be island constructed to diversify flows at the upstream end of the southwest pool, and features to reduce wind fetch and diversity flows lower in the pool. These efforts should protect and expand existing Wild celery beds in this location.

2.1.3. Illinois DNR.

At the March 2021 workshop, the Illinois DNR recommended that the areas in the southwest pool be expanded.

2.1.4. USGS.

At the March 2021 workshop, the USFS provided information regarding the UMRS Submersed Aquatic Vegetation Suitability Model. This model showed that many areas in the SW corner of the pool were suitable for SAV.

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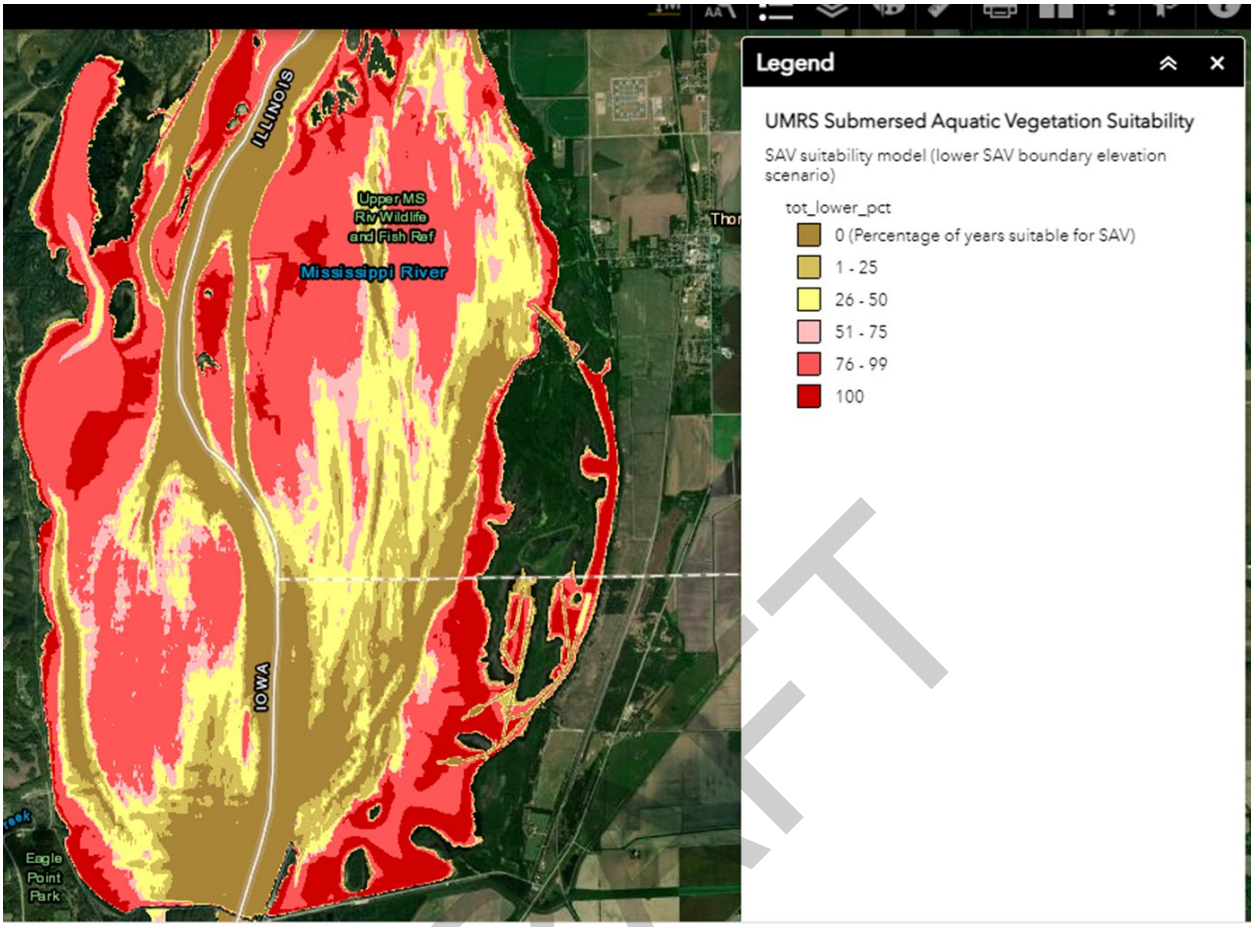

Figure 6. UMRS Submerged Aquatic Vegetation Sampling (USGS March 2021)

2.1.5. Site Visit Recommendations (October 2021).

A site visit occurred on October 2021.At this call the following decisions were made.

- Remove island restoration as an objective, these will be dredge material placement sites for this project. IPH-4, IPH5, IPH6
- Objectives will be forested areas and SAV sites
  - Study area concurrence with revisions captured in due-outs
- Team concurrence on the measures and alternatives
  - Maximum plan move RM-H6, add rock mounds (RMH-12), add additional chevron (CV-10), increase RM-H9A above water. Need tree planting locations (RE-H1 and RE-H2) and any additional measures with costs
  - Efficient plan move RM-H6, remove RM-H7, and modify RM-H9AE for safety to include gaps. need TSI locations (TSI-H1 and TSI-H2) and any additional measures with costs
  - High Priority Alternative – no revisions needed

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Photograph 20. PDT Site Visit (October 2021)

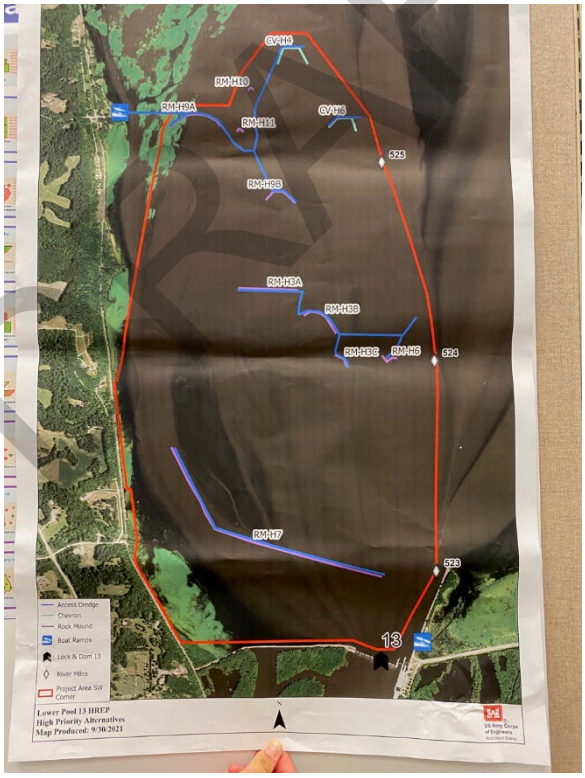

Figure 7. High Priority Alternative

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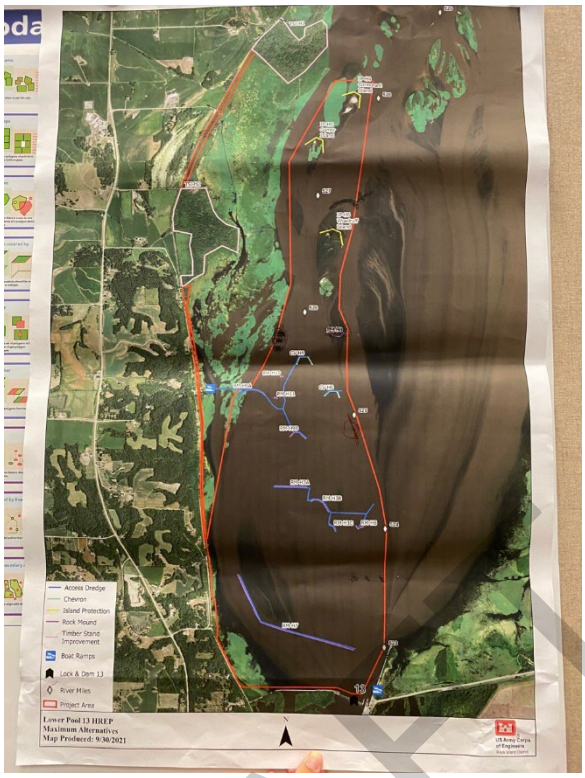

Figure 8. Maximum Alternative



Figure 9. Efficient Plan

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2.2. Water depths.

Based on the design criteria developed, water depths are an important parameter to consider ensuring that SAV has sufficient light breaking through the water surface. Depths that are too great may not be able to create the light penetration required for annual growth of SAV to include Wild celery.

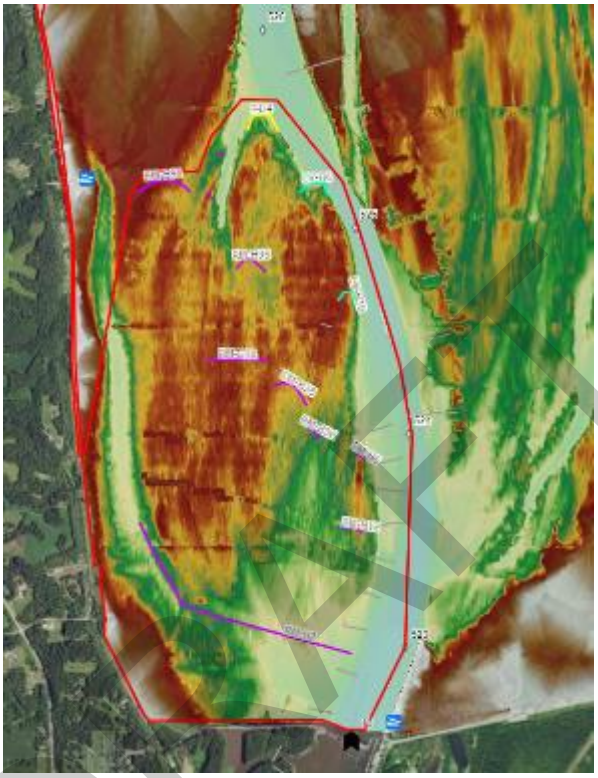

Figure 10. Southwest Pool Features over Bathymetry

2.3. Water Quality Monitoring.

2.3.1. Water Quality Monitoring (LTRM).

Water quality monitoring in the pool is accomplished with a combination of Fixed Site Sampling (FSS) and Stratified Random Sampling (SRS). For FSS, a relatively small number of nonrandomly-selected fixed sites are monitored repeatedly at intervals ranging from once every two weeks to once every two months. Water quality SRS occurs at a larger number of randomly selected locations at seasonal (quarterly) intervals. Some of the data available for review include *in situ* measurements, water clarity, water chemistry including nutrient parameters, and chlorophyll.

2.3.2. Water Quality Monitoring (USACE).

included in the Attachment F: Water Quality

2.3.3. Water Quality Monitoring (Sediment Sources).

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Turbidity evaluation and sources is also summarized in Attachment F: Water Quality

2.4. Vegetation Monitoring.

Vegetation monitoring was conducted using transects prior to 1998, when the current SRS protocol was implemented. Data are collected on the distribution, frequency of occurrence, and relative abundance of aquatic vegetation within the pool, including the following aquatic vegetation types: submersed, rooted, floating-leaf, emergent, algae, and duckweeds. Vegetation maps utilize SRS summer vegetation sampling data. Each sampling site assigned value between 0-6 (rake values).



Photograph 21. Vegetation Sampling Using a Rake

Water quality and vegetation data are available for download at https://umesc.usgs.gov/ltrm-home.html.

2.5. Initial Habitat Suitability Index (water depth, vegetation presence, turbidity levels of LTRM data 1998-2018).

LTRM is the monitoring and research component of the Upper Mississippi River Restoration Program. The goals of the LTRM are to develop a better understanding of the ecology of the Upper Mississippi River System and its resource problems, monitor resource change, develop alternatives to better manage the Upper Mississippi River System, and provide for the proper management of monitoring information.

UMRR established ‘Trend Pools’ in the Mississippi and Illinois Rivers to detect long-term trends across the Upper Mississippi River System (UMRS) in Pools 4,8,13,26 and Open River on the Mississippi. These trend pools have monitoring efforts for vegetation, fish, water quality.

LTRM data was available was analyzed to determine the extent and any potential trends in the pool. Mapping and data were reviewed between April 1 and October 31 each year (growing season), reviewing the presence of Wild celery (species code SSSPCV VAAM3), velocity between 10 to 20 cm/sec and water clarity (Turbidity $\leq$20 NTU, Secchi $\geq$0.5m, TSS $\leq$25 mg/L). These HIS ratings. These trend maps allowed the team to narrow down priority areas for features within Lower Pool 13, determining the need to focus primarily within the southwest pool, in an area where vegetation appeared to be declining, and that should be addressed in a timely manner. Used the LTRM data to determine sample locations that meet 0,1 or 2 of the desired design criteria parameters (HSI Rating). Red dots mean neither criterion met, yellow one criterion, green both.

Typical HSI maps generated are shown below, both in areas with vegetation plotting and without.

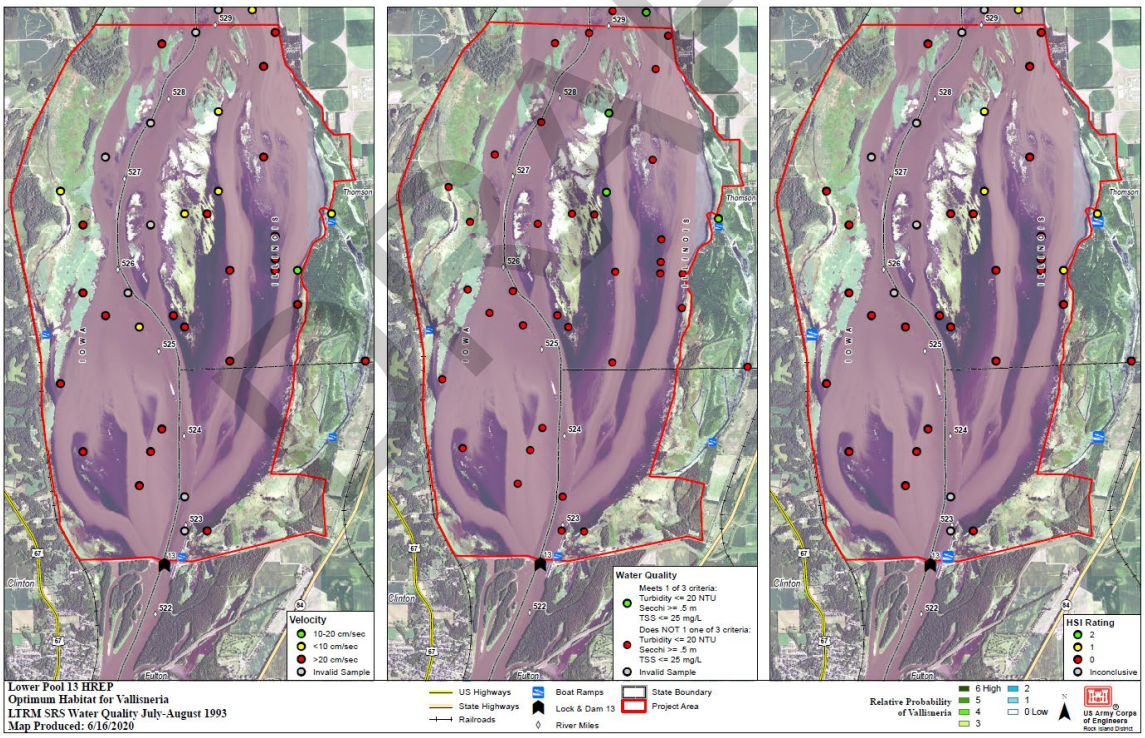

Figure 11. Typical HSI for SAV (no Vegetation Monitoring Results)

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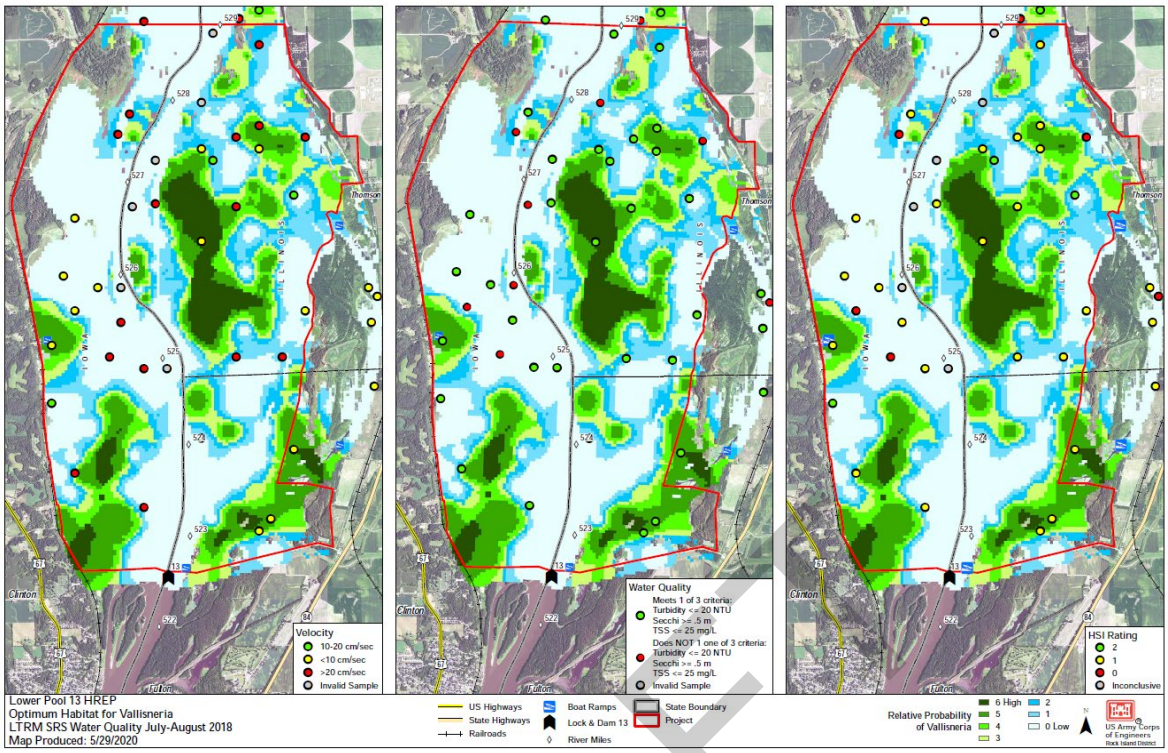

Figure 12. Typical HSI for SAV (with Vegetation Monitoring Results)

The HSI maps for Lower Pool 13 from 1998 to 2018 are included in Attachment B-A, *Initial Habitat Suitability Index-LTRM data 1998-2018*.

2.6. Velocity.

To address the matter of optimum velocity, it was determined that structures would need to be constructed to reduce velocity in areas with the appropriate depths for typical turbidity in the pool. These structures could be constructed of multiple materials, although for the purpose of this report, riprap structures were generally selected. More information on hydraulic modeling to support the site selection is included in Attachment H Hydraulics and Hydrology.

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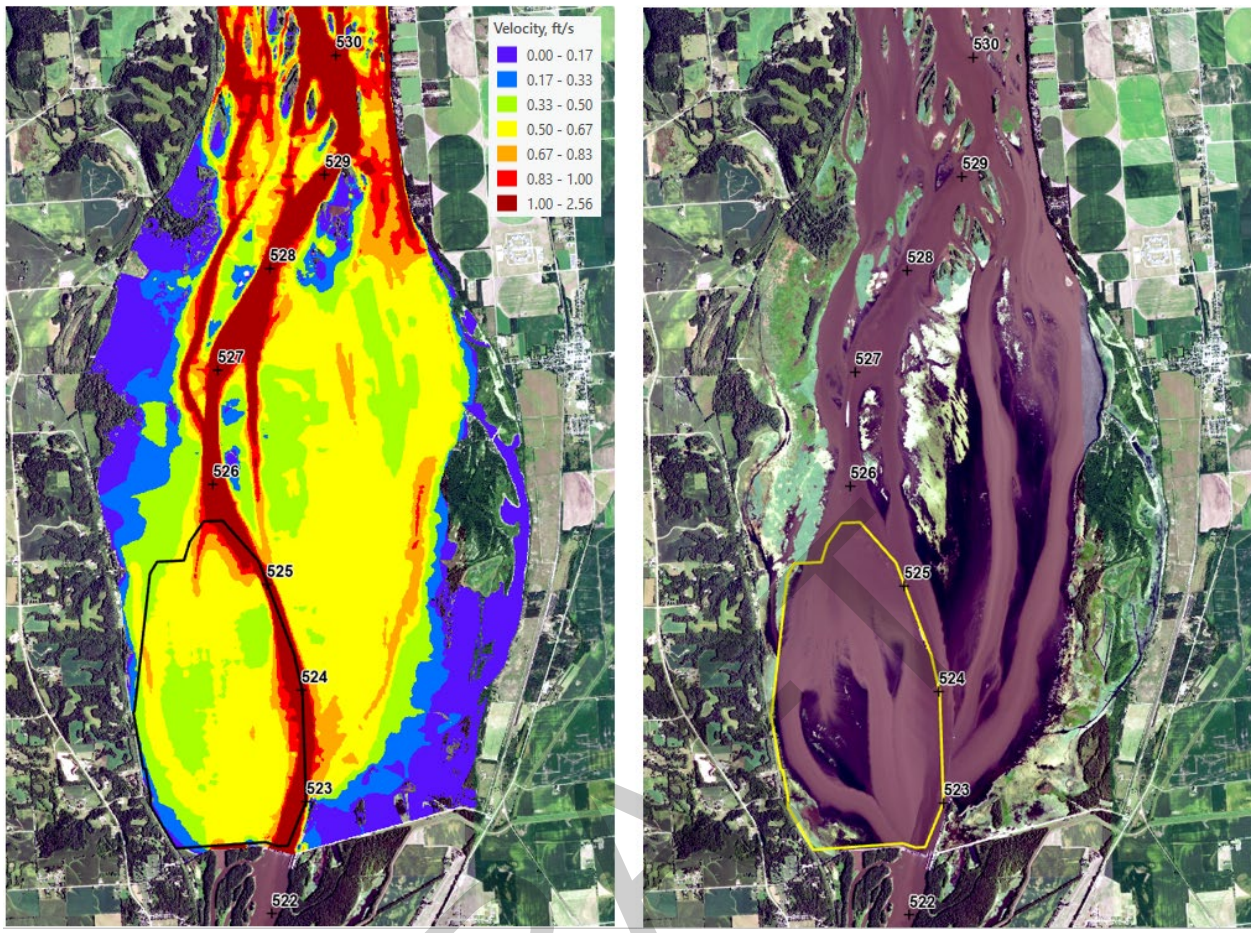

Figure 13. Existing Conditions Velocity Results

Left: Existing Condition Velocities Simulated in 2D HEC-RAS for the 55% Duration Flow Condition (60,000 cfs). Colors represent velocities in feet/second. Target wild celery velocity is less than 15 cm/sec or 0.5 ft/sec. Study Area outlined in black.

Right: 2015 NAIP imagery demonstrating typical location of vegetation in the Study Area. Study Area outlined in yellow.

2.7. Wind Wave Modeling.

Wind fetch and wave modeling was completed on existing conditions to help identify optimum areas for features to reduce waves and thereby the resuspension of sediment. A few of the parameters reviewed in site selection included orbital velocity, wave height, wavelength, wind fetch, and likelihood for sediment resuspension. More information on these modeling efforts is included in Attachment A, Hydraulics and Hydrology.

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Figure 14. Season Wave Average Maximum Orbital Velocity

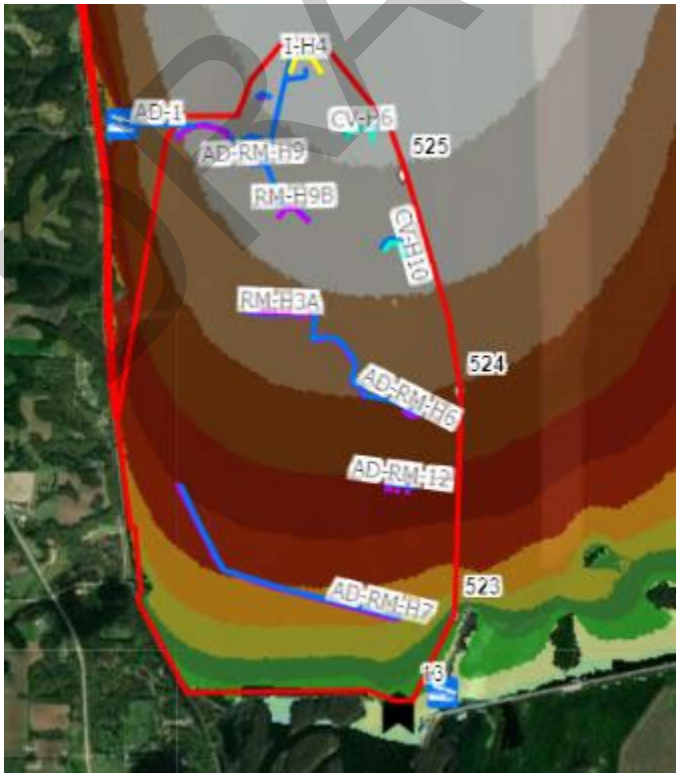

Figure 15. Season Wavelength

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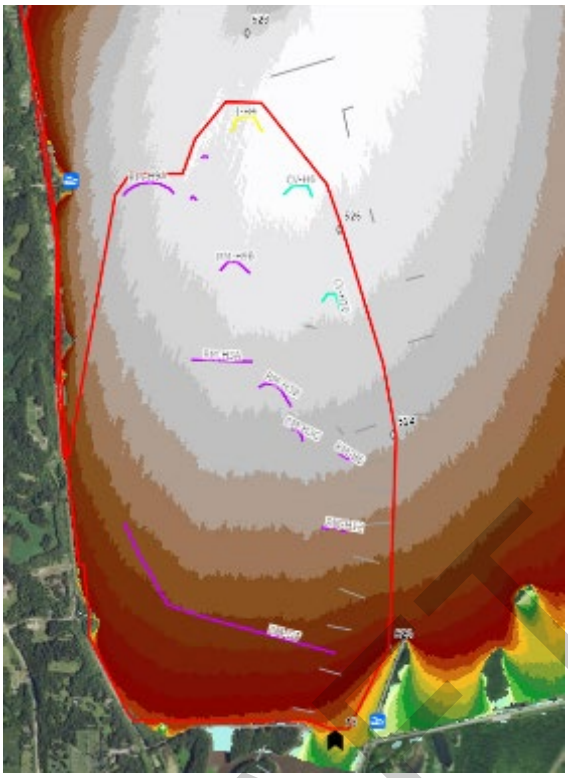

Figure 16. Wind Fetch Results

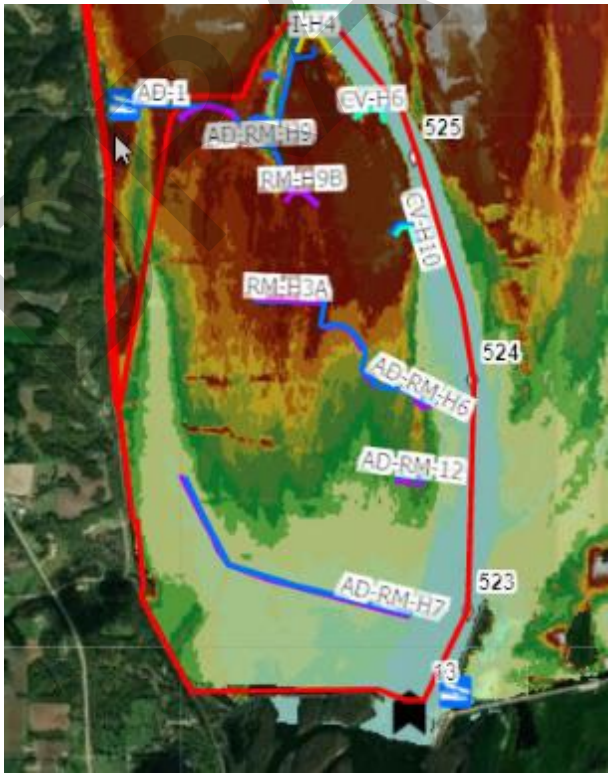

Figure 17. Percentage Resuspension of Sediment

2.8. Sediment Evaluation.

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Substrate is another important parameter to consider in the placement or construction of features that will encourage SAV. Geotechnical borings were not obtained during the feasibility level of design but will be required during the design phase of this project. However, grab samples and visual assessments were conducted during multiple site visits were conducted to determine what materials may be better suited for SAV in lower Pool 13.

2.8.1. September 2020 Sediment Evaluation.

In September 2020, a site visits to assess typical sediment near the river bottom surface occurred in areas where Wild celery was present.



Figure 18. Sediment Sample Sites (August 2020)

2.8.1.1. Gomer's Lake (Pool 13 Sed Site B on Sediment Sample Location Map).

Discovered wild celery when pulled in anchor. We were not expecting to find it here. Tubers larger than other sample locations. Location: Water Quality Sample Point WM526.6D. Substrate: Brown/dark brown silty clay, approximately 5 % fine to medium grain sand. Secchi Depth unknown. Approximate Water Depth: 3 feet

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Photograph 22. Sediment at Gomer's Lake (September 2020)



Photograph 23. SAV at Gomer's Lake (September 2020)



Photograph 24. SAV at Gomer's Lake (September 2020)

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2.8.1.2. Middle of River (Pool 13 Sed Site C)

When approached the first bed, intermixed with a filamentous green alga. Moved further into the river and noted more uniform berm of wild celery. Noted that wild celery had created the flower and saw the “green bean” seeds following a spiral lead and floating at the surface. Numerous snails were attached to the celery.
Location: 41° 56’ 28.18’’, 90° 9’ 8.64”
Substrate: Brown/black silty fine to medium sand. Approx. 1% small white grains (shell fragments?)
Secchi: unknown
Approx. Water Depth: around 4 feet



Photograph 25. Sediment Site C Above Water View of SAV Bed (September 2020)



Photograph 26. Sediment Site C SAV near wild celery bed (September 2020)

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Photograph 27. Sediment Site C Underwater view of SAV (September 2020)



Photograph 28. Sediment Site C Underwater View of SAV (September 2020)



Photograph 29. Sediment Site C Underwater View of SAV (September 2020)

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Photograph 30. Sediment Site C Sediment Sample (September 2020)



Photograph 31. Sediment Site C Sediment Sample with Tuber



Photograph 32. Sediment Site C Above Water View of SAV Bed (September 2020)

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2.8.1.3. Penguins Nose (Pool 13 Sed Site D)

Shallow, Wild celery just big enough to reach surface. Bed least dense of sample sites.
Location: 41° 57’ 45.79”, 90° 7’ 13.29”
Substrate: 3 to 5 inches of light brown, sand, and silty sand, underlain by indurated burnt orange clay with sand (probably original surface prior to pool inundation).
Secchi: Clear to bed.
Approx. Water Depth: 1 to 2 feet.



Photograph 33. Sediment Site D Sediment Sample (September 2020)



Photograph 34. Sediment Site D Shallow Water Sampling (September 2020)

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Photograph 35. Sediment Site D Underwater View of SAV (September 2020)



Photograph 36. Sediment Site D Underwater View of SAV (September 2020)



Photograph 37. Sediment Site D Underwater View of SAV (September 2020)

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Photograph 38. Sediment Site D Above Water View of SAV Bed (September 2020)



Photograph 39. Sediment Site D Above Water View of SAV Bed (September 2020)

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2.8.1.4. Just downstream of islands (Pool 13 Sed Site E)

Deep, high turbidity, long Wild celery, fewer seeds. Smaller diameter tubers. Largest bed in the lower pool.
Location: 41 58’ 2.77”, 90 8’ 35.86”
Substrate: Grayish brown organic rich clay.
Secchi: 27.0 cm
Approx. Water Depth: 3.5 to 5 feet.



Photograph 40. Sediment Site E Sampling (September 2020)



Photograph 41. Sediment Site E Sediment Sample (September 2020)



Photograph 42. Sediment Site E Above Water View of SAV Bed (September 2020)

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Photograph 43. Sediment Site E Underwater View of SAV (September 2020)



Photograph 44. Sediment Site E Underwater View of SAV (September 2020)



Photograph 45. Sediment Site E Underwater View of SAV (September 2020)

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Photograph 46. Sediment Site E Underwater View of SAV (September 2020)

2.8.1.5. Further downstream of islands within main central bed: (Pool 13 Sed Site F)

Clearer water, long Wild celery, fewer seeds. Location: just a little further downstream. Substrate: Gray brown silty/clayey sand. Approx. Water Depth: 4 to 5 feet



Photograph 47. Sediment Site F Sediment Sample (September 2020)

2.8.1.6. Closer to Lock: (Pool 13 Sed Site G)

VERY clear, deep. Location: 41°54’ 47.4”, 90°8’ 11.7”. Substrate: Brownish gray sandy clay, fine sand size, shell fragments (10%). Secchi: 91 cm. Approx. Water Depth: 5 to 6 feet (Shovel depth)

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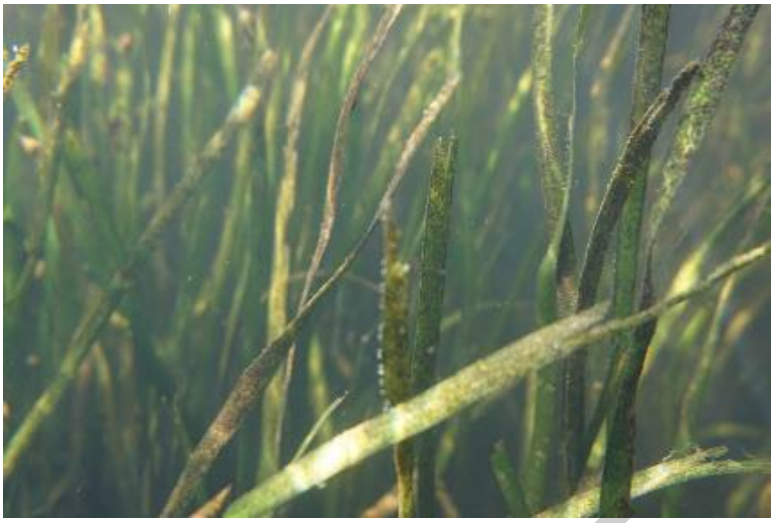
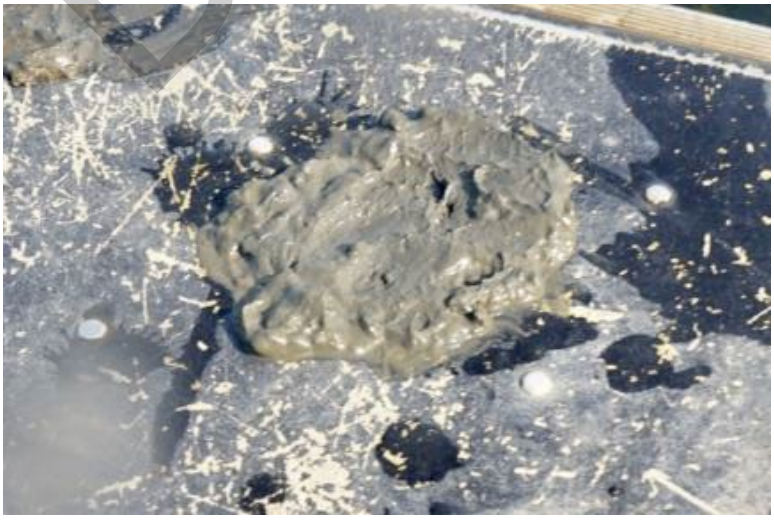


Photograph 48. Sediment Site G Underwater View of SAV (September 2020)



Photograph 49. Sediment Site G Underwater View of SAV (September 2020)



Photograph 50. Sediment Site G Sediment Sample (September 2020)

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Photograph 51. Sediment Site G Above Water View of SAV (September 2020)

2.8.2. June 2021 Sediment Evaluation.

In June 2021, additional sediment analysis was conducted in the southwest pool.

2.8.2.1. Site W-M525.1G (Sonde Location), Observation Point CV-H5/IS-H4 DS, located downstream of potential feature CV-H5/IS-H4.

Coordinates: 41.933399°N, 90.164759° W, Vegetation: None present
Depth: 1.19 m, Water Clarity: Turbidity: 7.03 FNU, Secchi Disk Depth: 59.0 cm
Sediment: Field: Shells, a little grit, very gray, lots of clay. Visual: gray/brown, moist silty clay, somewhat firm, some shell fragments, organics present



Photograph 52. Site W-M525.1G Underwater View of Sonde (June 2021)

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Photograph 53. Site W-M525.1G Sediment Sample Near Sonde (June 2021)

2.8.2.2. Mid SW Pool, Observation Point RM-H3A U/S, located just upstream of potential feature RM-H3A

Coordinates: 41.924634°N, 90.166567°W. Vegetation: a little bit of Wild celery upstream of here but not at this location. Depth: no observation recorded. Water Clarity: no observations recorded. Sediment: Field: Smooth silty clay, no feeling of sand in these at all. Visual: brown moist clay, firm, some organics present.



Photograph 54. RM-H3A U/S, No vegetation mid-pool (June 2021)

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Photograph 55. RM-H3A U/S, Sediment grab sample mid pool (June 2021)

2.8.2.3. Lower SW Pool, Observation Point RM-H7 U/S, located upstream of potential feature RM-H7.

Coordinates: 41.913953°N, 90.170856°W. Vegetation: SAV (Wild celery) noted. Depth: 1.10 m. Water Clarity: Turbidity: 14.79 FNU, Secchi Disk Depth: 32.0 . Sediment: Field: No grit or sand felt, softer (not as stiff), small shells in sample. Visual: brown saturated clay, plastic, shells, and shell fragments present.



Photograph 56. RM-H7 U/S Wild celery noted at lower SW Pool (June 2021)

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Photograph 57. RM-H7 U/S Sediment sample in lower SW Pool (June 2021)

2.8.2.4. Upper SW Pool, Observation Point RM-H9A D/S, located just downstream of potential feature RM-H9A.

Coordinates: 41.934861°N, 90.174986°W. Vegetation: Rooted Floating aquatic vegetation (Lotus) noted. Depth: 0.83 m. Water Clarity: Turbidity: 5.62 FNU, Secchi Disk Depth: 48.0 cm. Sediment: Field: Slightly firm clay, with a little bit of sand in it. Visual: brown saturated clay, plastic, shells, and shell fragments present.



Photograph 58. RM-H9A D/S Break in vegetation is where historic island used to be (June 2021)

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Photograph 59. RM-H9A D/S Grab sample closer to Gomer's Lake (June 2021)

2.8.2.5. Near Channel, Upper SW Pool, Observation Point CV-H6 D/S, located downstream of potential feature CV-H6.

Coordinates: 41.932621°N, 90.160441°W. Vegetation: None present. Depth: 1.06 m. Water Clarity: Turbidity: 8.08 FNU, Secchi Disk Depth: 47.0 cm. Sediment: Field: Very sandy, shells, not stability. Visual: brown silty sand, fine to very fine grained, shells/shell fragments present, organics present, somewhat firm.



Photograph 60. No vegetation noted near CV-H6 (June 2021)

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Photograph 61. Material near CV-H6 (June 2021)

2.8.3. Summary: Sediment Evaluation.

The grab samples indicate that the bed surface of the Lower Pool is quite variable. Within and near the large central wild celery bed silty fine to medium sand appears to be the predominant sediment type. In some of these areas abundant shell fragments ae present. In the extreme north portion of the wild celery bed, organic rich clay is present, which may be indicative of low velocity environments just south of a series of islands. In the extreme northeast portion of the Lower Pool sand over what appears to be a former soil surface is present, indicative of the furthest extent of inundated area. The western portion of the Lower Pool had more grab samples collected and can be quantified better. Moving westward away from the navigation channel, finer grain sediments are more dominant, which correlates to the lower velocity flow regimes found in those areas. Wild celery appears present in many sediment types, from fine to medium sand, silty sands, sandy clay and clay.

2.9. Canvasback Priority Area.

Canvasback waterfowl have been observed and studied to avoid above ground islands or island features. The USFWS identified a general canvasback priority area and required that any features constructed in this zone remain near normal pool, and that these areas discourage future tree or large shrub growth. There were two features on the upstream end of the pool which could be slightly higher than flat pool elevations. The areas to promote SAV growth are generally located within this canvasback priority area.

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Figure 19. Canvas Back Priority Area is screened.
Canvasback survey locations are shown as dots. (2021: USFWS)

2.10. Mussel Surveys.

2.10.1. 2019 Mussel Survey.

A pool wide mussel survey was conducted in 2019. One Higgins Eye was located. This area was avoided for potential feature construction.

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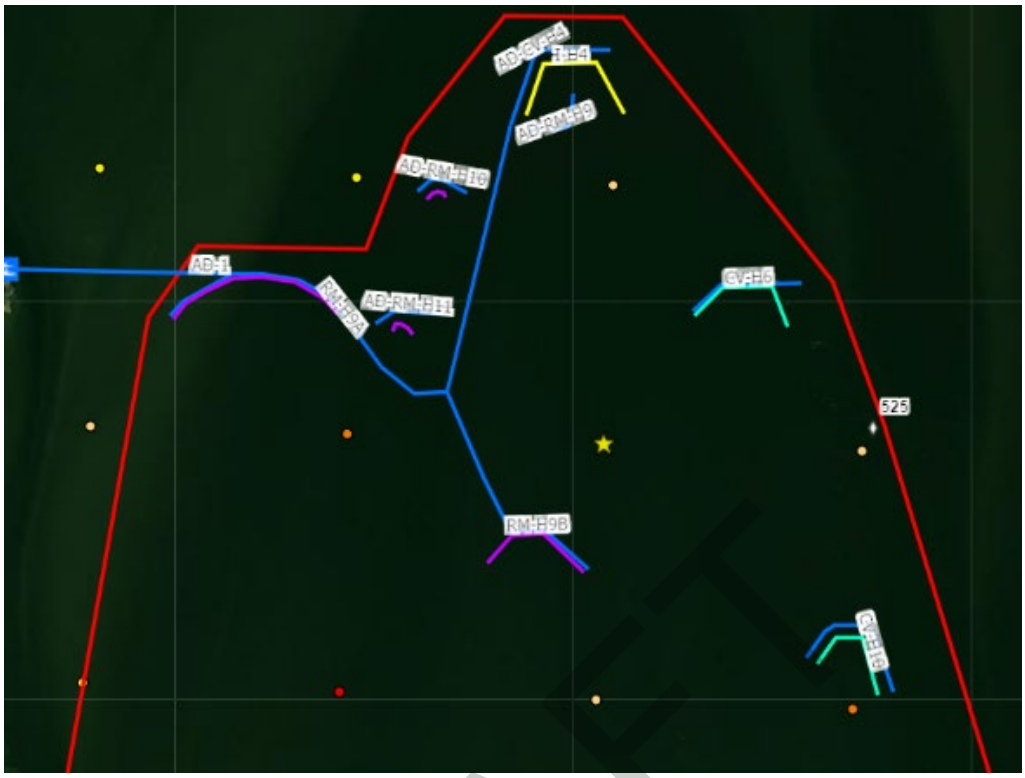

Figure 20. 2019 Mussel Survey (Star indicates location of Higgins Eye)

2.10.2. July 2021 Mussel Survey.

On July 1, 2021 the Corps, FWS (Refuge and the Illinois-Iowa Ecological Services Office) and the IL DNR performed dives, sorted, and collected data on freshwater mussels at the Project site. A mussel assessment was conducted to determine abundance and types of species along some of the proposed project features. Approximately 18 species were preliminarily identified. One Higgins Eye was preliminarily identified during this site visit near Feature I-H4

Table 7. 2021 Preliminary Mussel Survey Results

Site	UTM X	UTM Y	Depth (ft)	Sediment**	Search Time (min)*	Divers	Bank	HREP Feature ID	Notes
1	734940.0736	4643025.070	0-1	Si	20	Rich Lewis, Bob Schanel	Open Water	IS-H1, I-C	Pagoda (previously) mussel collected (n=1)
2	735262.7457	4643726.815	10	Si	20	Ray Garrett, Sheldon Fairfield	Open Water	I-C	Current training
3	735539.4134	4643488.399	Not sampled	Not sampled	Not Sampled	Not Sampled	Open Water	CV-H5, I-C	Not sampled - unsafe conditions
4	735366.9928	4643348.361	0-1	Si, Sr	20	Rich Lewis, Bob Schanel	Open Water	I-C	Lots of zebra mussels, some gravel, Butterfly collected (n=1)
5	734440.9453	4643241.67	0	Sr	20	Ray Garrett, Sheldon Fairfield	Open Water	I-C	None
6	734820.1263	4643601.42	0-1	Si, Cl	20	Rich Lewis, Bob Schanel	Open Water	I-C	Few inches of silt over clay
7	734426.6623	4643728.436	Not sampled	Not sampled	Not Sampled	Not Sampled	Open Water	I-C	Not Sampled - Location will be val bank a bar
8	734830.4223	4643513.986	Not sampled	Not sampled	Not Sampled	Not Sampled	Open Water	I-C	Not Sampled - Location will be val bank a bar
9	734806.1842	4643330.089	Not sampled	Not sampled	Not Sampled	Not Sampled	Open Water	I-C	Not Sampled - Location will be val bank a bar
10	734747.7229	4643414.096	0-2.5	Sr	20	Ray Garrett, Sheldon Fairfield	Open Water	RM-H4	Plenty of zebra mussels
11	734769.7134	4643350.294	4	Sr	20	Rich Lewis, Bob Schanel	Open Water	RM-H7	None
12	734519.3533	4643434.1	Not sampled	Not sampled	Not Sampled	Not Sampled	Open Water	RM-H7	Not Sampled - Located val bank a bar
13	734784.709	4643284.122	0-1	Si	20	Rich Lewis, Bob Schanel	Open Water	RM-H7	None
14	735063.5858	4643220.691	0-1	Si	20	Ray Garrett, Sheldon Fairfield	Open Water	RM-H7	None
15	735344.1107	4643153.971	0-1	Si	20	Ray Garrett, Sheldon Fairfield	Open Water	RM-H7	Butterfly collected (n=1)
16	735314.691	4643180.903	Not sampled	Not sampled	Not Sampled	Not Sampled	Open Water	RM-H7	Not Sampled - Located too close to main channel - unsafe conditions
17	735209.3529	4643210.719	0-1	Si, Cl	20	Rich Lewis, Bob Schanel	Open Water	RM-H8A	Few inches (1inch) silt over clay.
18	735228	4644021	0	Si	20	Ray Garrett, Sheldon Fairfield	Open Water	RM-H2B, I-C	Few point added during survey, many dead shells, Butterfly collected (n=2)

*Search time: 20 min search per diver for 40 min total search time per survey site.
**Sand (Sd), Silt (Si), Clay (C)

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Figure 21. Approximate location of Higgins Eye



Photograph 62. Higgins Eye

2.10.3. Future Mussel Surveys.

Based on the preliminary mussel assessment results which included identification of a Higgins Eye mussel, further coordination was initiated with the FWS to determine the appropriate next steps.

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2.11. Historic Maps and Photographs.

2.11.1. Pre-inundation Maps.

These maps show land use pre-inundation. The red boundary, when shown, is a larger extent that the final boundary for this HREP which focuses generally on the west side of the navigation channel. These maps were used to understand pre-inundation conditions, and to help identify any construction constraints for the placement of features such as stump fields, roads, or building foundations.



Figure 22. 1878 Farquhar Map

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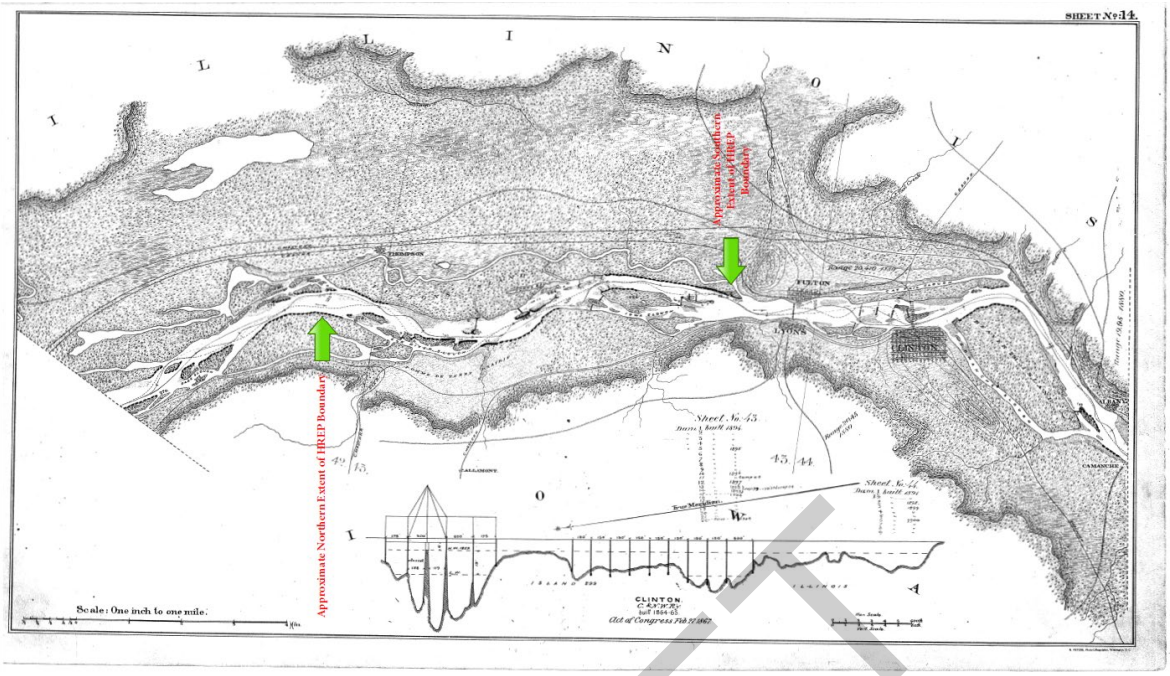

Figure 23. 1887-88 Mackenzie Map

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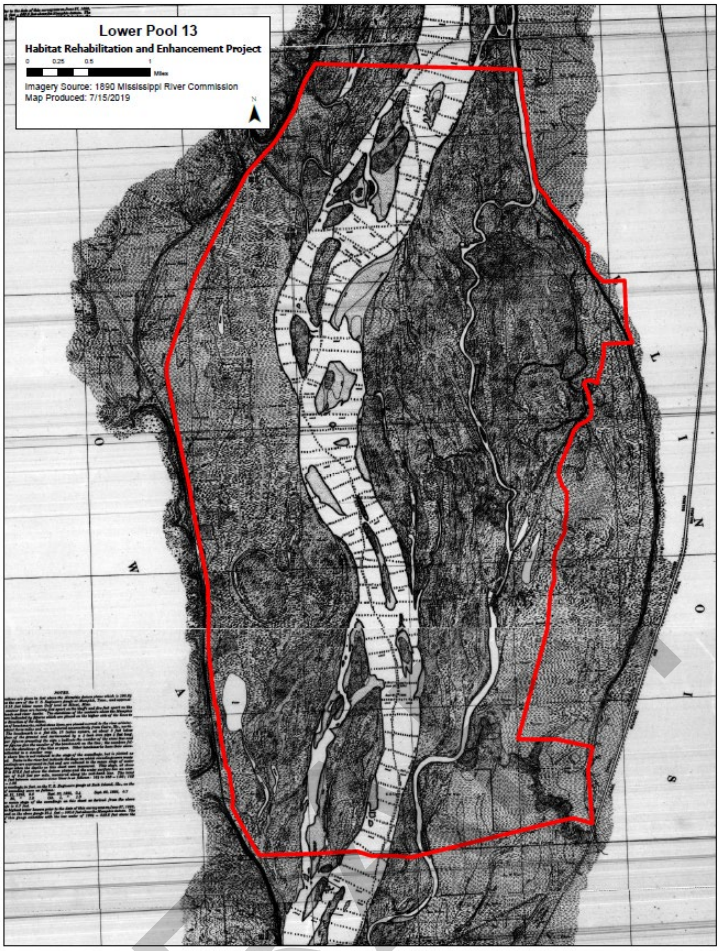

Figure 24. 1890 Mississippi River Commission Map

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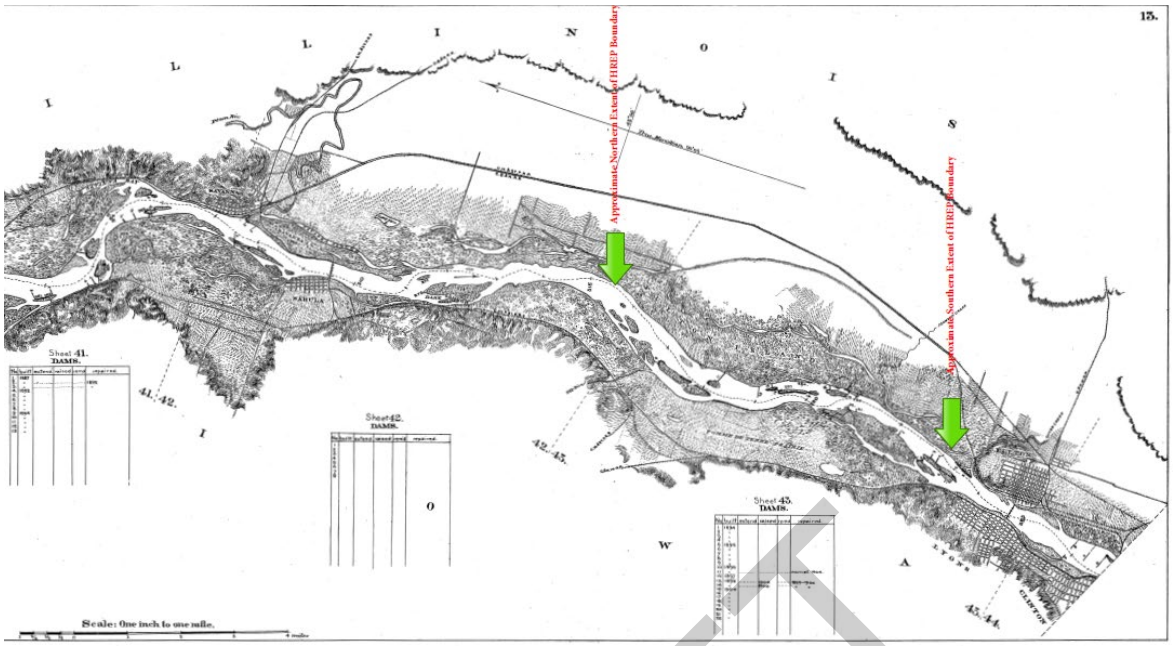

Figure 25. 1903-5 Townsend Chart

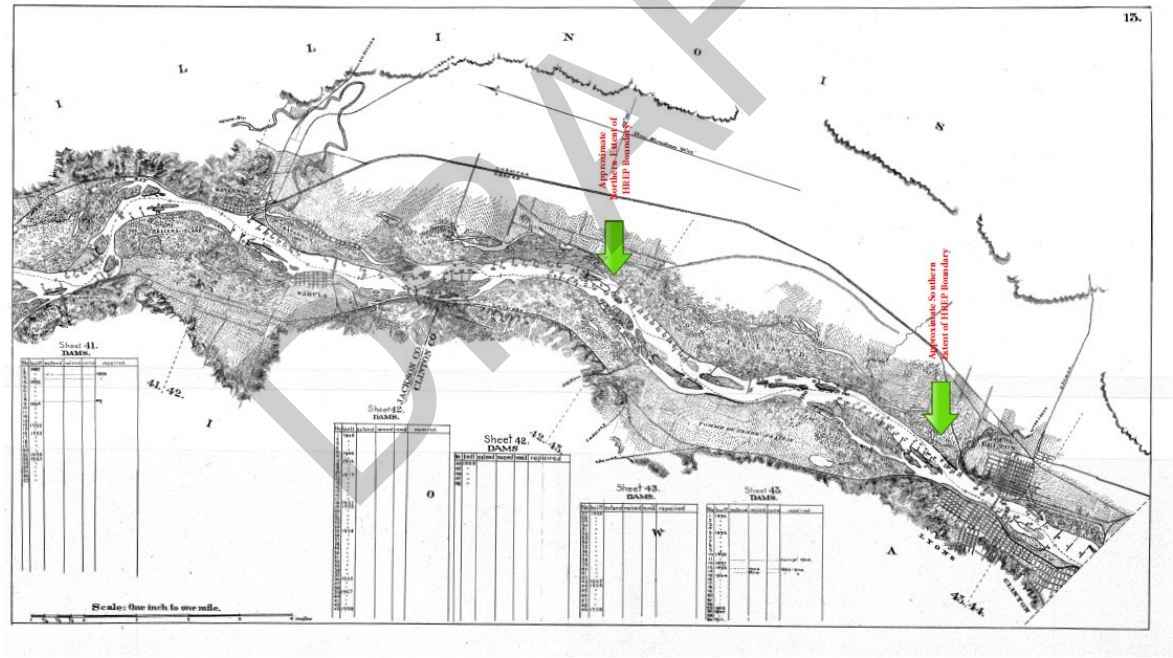

Figure 26. 1915 Hoffman Charts

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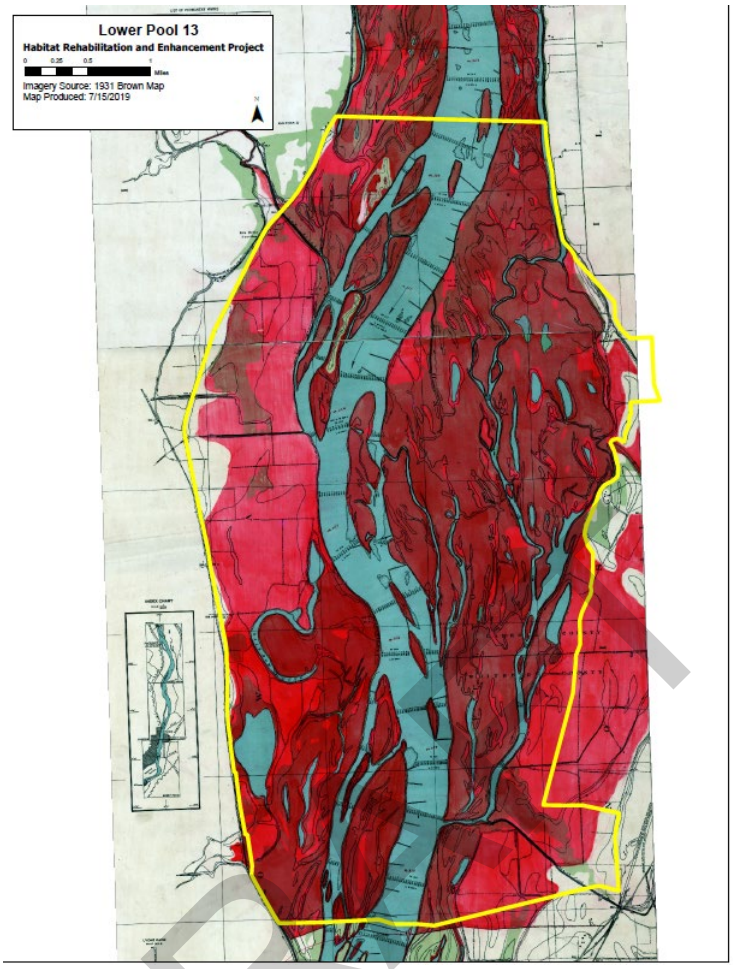

Figure 27. 1931 Brown's Map

2.11.2. Pre-Inundation Imagery.

Prior to inundation, much of the project area was shown to be floodplain forest and backwater channels. While many times the trees were harvested prior to inundation, stump fields remain submerged through the area. Excavation or access dredging through stump fields can be very difficult and inefficient. All excavation will be completed through mechanical methods (barge mounted crane or excavators), but avoidance of stump fields where possible will also for a more efficient method for access dredging. Additionally, placing features such as chevrons or rock mounds at the upstream or head end of previous landforms such as islands or higher ground, should allow for the rock mounds and chevrons to be on more stable ground and less likely to settle over time.

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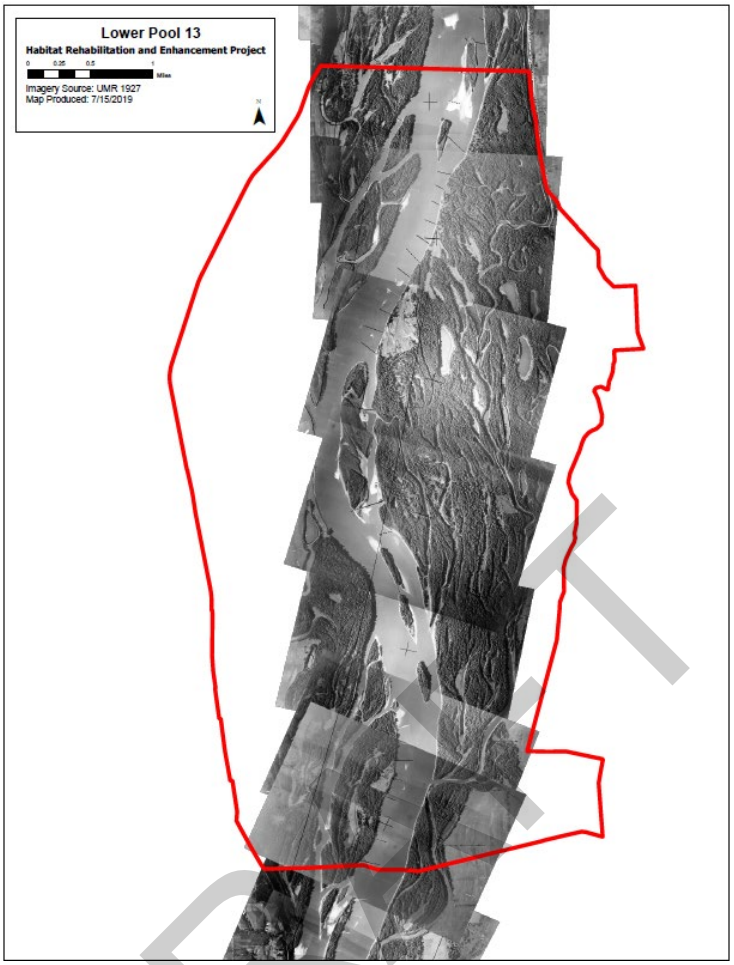

Figure 28. 1927 UMR Aerial Photography

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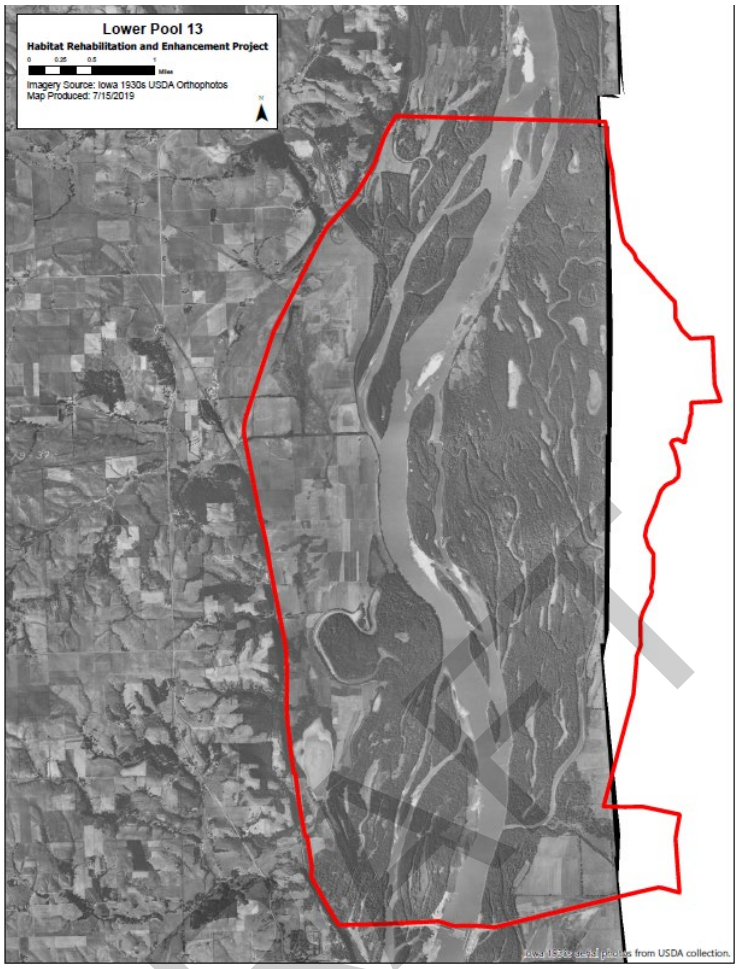

Figure 29. Iowa 1930s USDA Orthophotos

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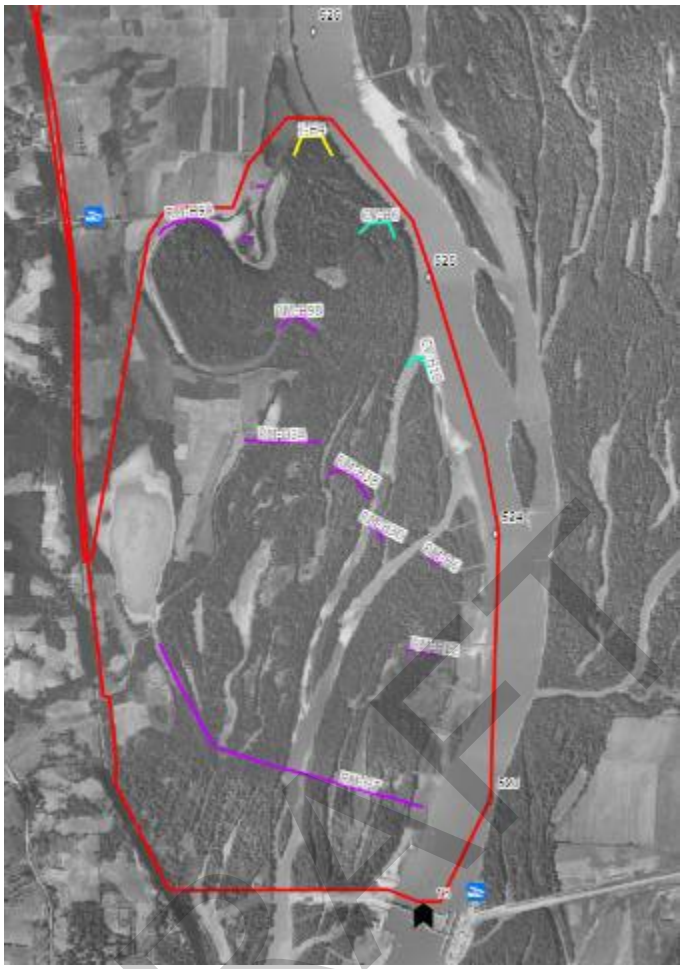

Figure 30. 1930s Aerial Photo (Pre-inundation)

2.11.3. Post-Inundation Imagery.

Post inundation imagery was reviewed to observe changes over time.

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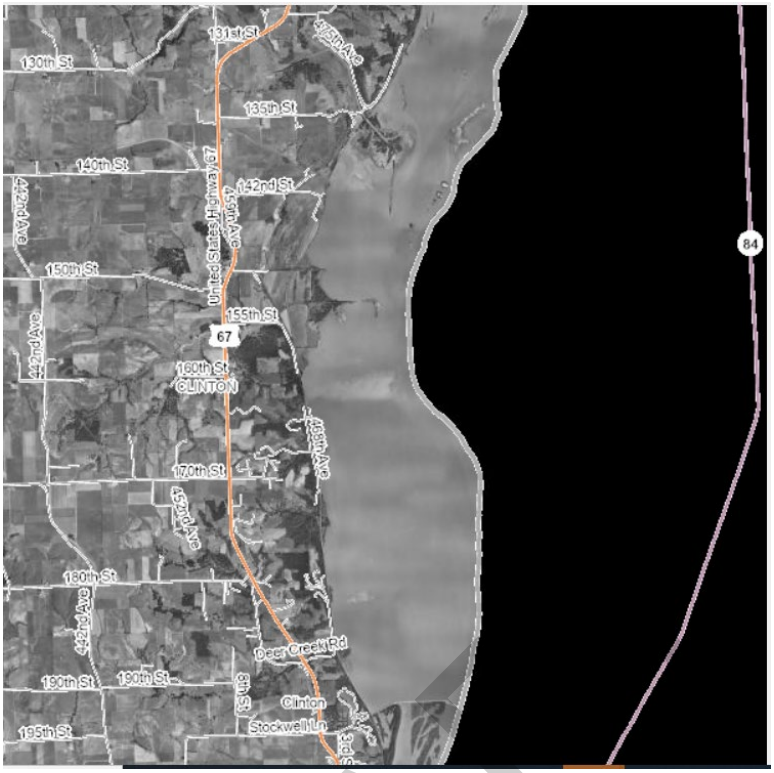

Figure 31. 1950s Aerial



Figure 32. 1960s Aerial



Figure 33. 1970s Aerial Photo



Figure 34. 1980s Aerial Photo



Figure 35. 1990s Aerial Photo

2.11.4. Current Imagery.

Current imagery is utilized in the GIS web server and on the plates.

2.12. Navigation Impacts.

Project features were situated to ensure that there are no adverse impacts to navigation. This includes avoiding construction of features within the navigation channel as well as avoiding any existing river training structures such as wing dams.

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Photograph 63. Navigation and Wing dam Avoidance

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Lateral Dikes



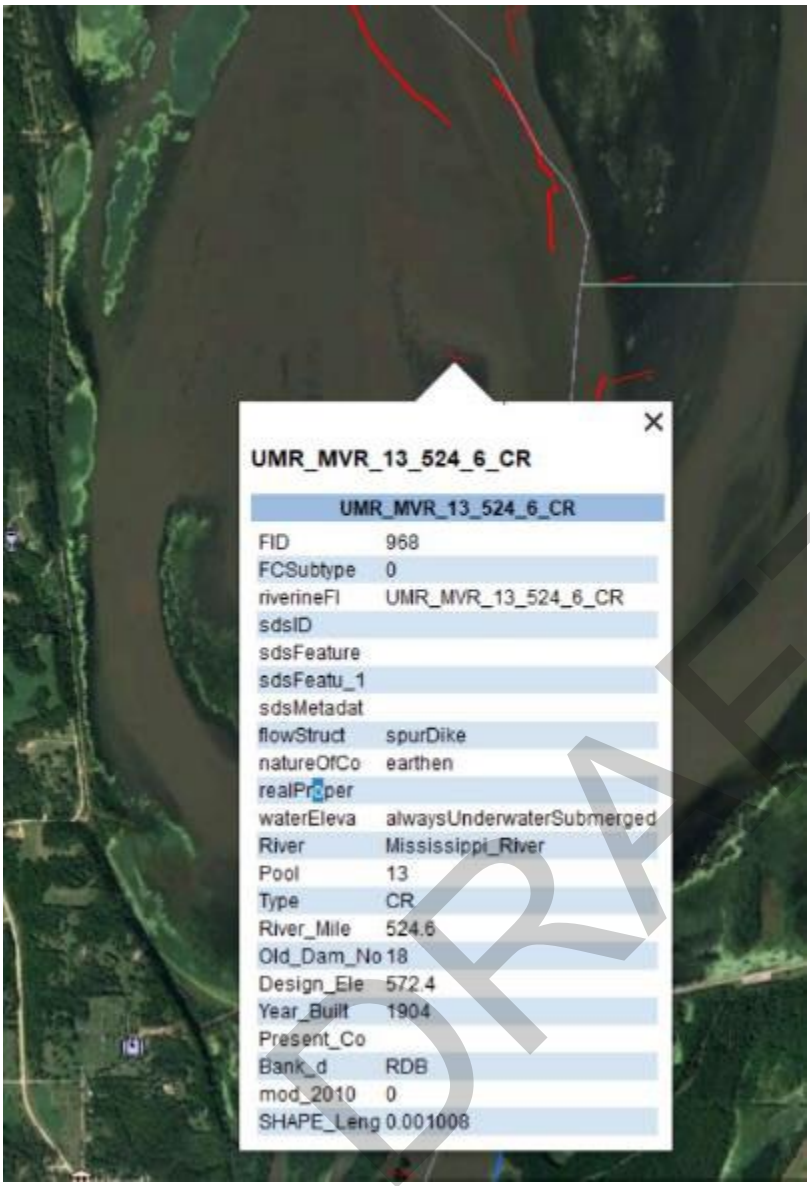
Name	RM Start	RM End	Design Elevation	Assumed Material	Date Last Edited	Year Built
Submerged Shoreline Protection	525.3	526.7		Dirt, stone	Sept 12, 2014	
Submerged Shoreline Protection, Island 282 Lower	526.7	527.0		Dirt, stone	Sept 12, 2014	

Old Dams



Old Dam No	RM	Design Elevation	Length	Assumed Material	Date Last Edited	Year Built
18	524.6	572.4		Earthen	May 30, 2012	1904
17	524.1	572.1		Earthen	May 30, 2012	1904
22	524.1	569.1		Earthen	May 30, 2012	1904
21	524.0	572.1		Earthen	May 30, 2012	1904
27	523.8	572		Earthen	Sept 12, 2014	1924
28	523.6	572		Earthen	Sept 12, 2014	1924
29	523.4	571.9		Earthen	Sept 12, 2014	1924
30	523.2	571.8		Earthen	Sept 12, 2014	1924
31	523.1	571.7		Earthen	May 30, 2012	1924
32	522.8	571.6		Earthen	Sept 12, 2014	1924
33	522.7	571.5		Earthen	Sept 12, 2014	1924

Structure in SW Pool



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Old Dam No	RM	Design Elevation	Length	Assumed Material	Date Last Edited	Year Built
UMR-MVR-13-524_6_CR	524.6	572.4		Earthen		1904

2.13. Access Dredging.

Locations where features were sited are very shallow and will require access dredging to be able to construct features at each site. Efforts were made to used minimize the number of access dredge cuts required to reduce overall project costs. Additionally, the location of these dredge cuts was situated in deeper water where available and in areas to avoid tree stumps.

2.14. Recreational Boating Impacts.

Lower Pool 13 is used by recreational boaters throughout most of the year when in non-frozen conditions. Bulgers Hollow is the boat ramp closest to the features, and alignment, location and height of features was considered in layout considerations. RM-H9A in particular is located closest to this boat ramp. Public notification coordination with the Iowa DNR and US FWS will occur to inform boaters of this change. Additionally, RM-H9A to be constructed such that some portions of the structure break the water surface at flat pool to further assist recreational boaters with locating this structure.

Other submerged features will not be marked. These features are similar to riprap wing dams already in place in Pool 13 and are expected to make similar water surface changes that experienced boaters will recognize. Additionally, the features are proposed to be constructed in shallow water conditions, so it is unlikely that a boater will be approaching these structures at a high speed.

Access dredge cuts were located in historic channels where possible, which serve as slightly deeper location in the pool. These dredge cuts will serve for recreational boating access following construction until they are sedimented in over time.

2.15. Floodplain impacts.

Feature sizes and locations were analyzed to ensure that there would no negative impact to the Floodplain. Further information on this analysis is in Attachment A Hydraulics and Hydrology.

2.16. Hazardous, Toxic and Radioactive Waste (HTRW).

Historic activity in Lower Pool 13 identified areas of avoidance for the construction of any feature. These areas are shown as no work locations. No dredging or construction of features is allowed in this location. More information is available in Attachment H Hazardous, Toxic and Radioactive Waste.

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Figure 36. No Work Area

2.17. Cultural and Historic Sites.

Feature layouts were situated to avoid all cultural and historic sites within the project area.

2.18. Real Estate Boundaries.

Features and their impacts are all located within federal property limits. More information is available in Appendix C, *Real Estate*.

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Figure 37. Real Estate Parcels

3. REAL ESTATE AND RELOCATIONS (C-6.2 AND C-6.3)

Information regarding real estate needs is included in the main report and Appendix C, *Real Estate*.

4. C-5. ENVIRONMENTAL ENGINEERING

The following environmental engineering factors shall be incorporated into each aspect of the project.

4.1. C-5.1. Use of environmentally renewable materials.

Materials used for this project will consist of native stone and dredged material.

4.2. C-5.2. Design of positive environmental attributes into the project.

This ecosystem restoration project will have a positive influence on the environment.

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4.3. C-5.3. Inclusion of environmentally beneficial operations and management for the project.

4.4. C-5.4. Beneficial uses of spoil or other project refuse during construction and operation.

Material excavated for access dredging will be placed at a site in a manner to support nesting bird habitat.

4.5. C-5.5. Energy savings features of the design.

The design will be completed in a manner to reduce the amount of access dredging or rework requires to construct all features, creating an overall energy savings by not have to perform rework.

4.6. C-5.6. Maintenance of the ecological continuity in the project with the surrounding area and within the region.

This ecosystem restoration project will improve the ecological needs of the area, and is consistent with refuge goals. More information is available in the main report.

4.7. C-5.7. Consideration of indirect environmental costs and benefits.

Habitat benefits were determined as described in the main report. NEPA compliance addresses ecological impacts.

4.8. C-5.8. Integration of environmental sensitivity into all aspects of the project.

4.9. C-5.9. The perusal of the Environmental Review Guide for Operations (ERGO) with respect to environmental problems that have become evident at similar existing projects and, through foresight during this design stage, have been mitigated/addressed in the project design.

4.10. C-5.10. Incorporation of environmental compliance measures into the project design

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APPENDIX E
ENGINEERING

ATTACHMENT B
CIVIL AND ENVIRONMENTAL ENGINEERING

ATTACHMENT B-A
INITIAL HABITAT SUITABILITY INDEX-LTRM DATA 1998-2018

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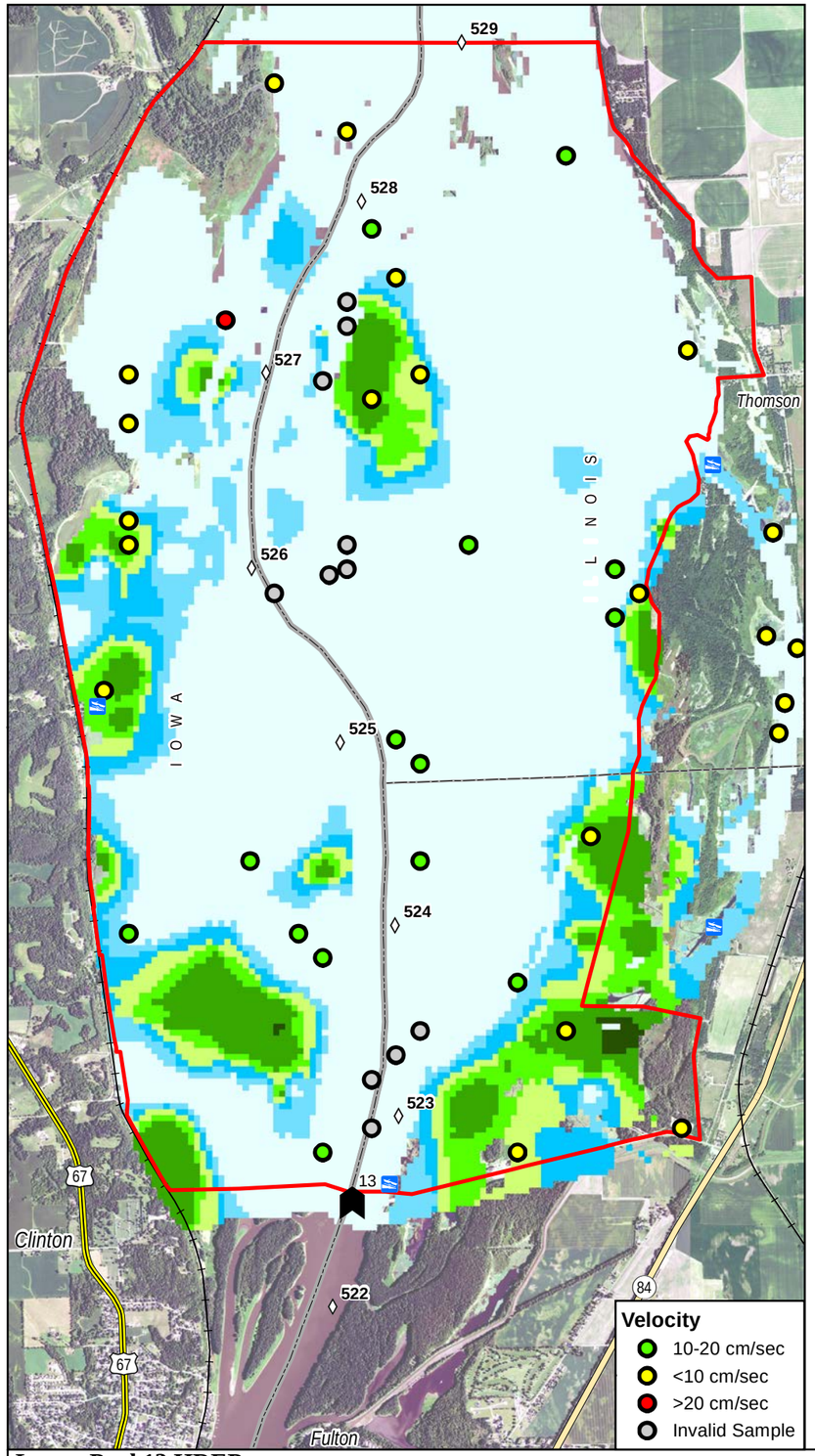

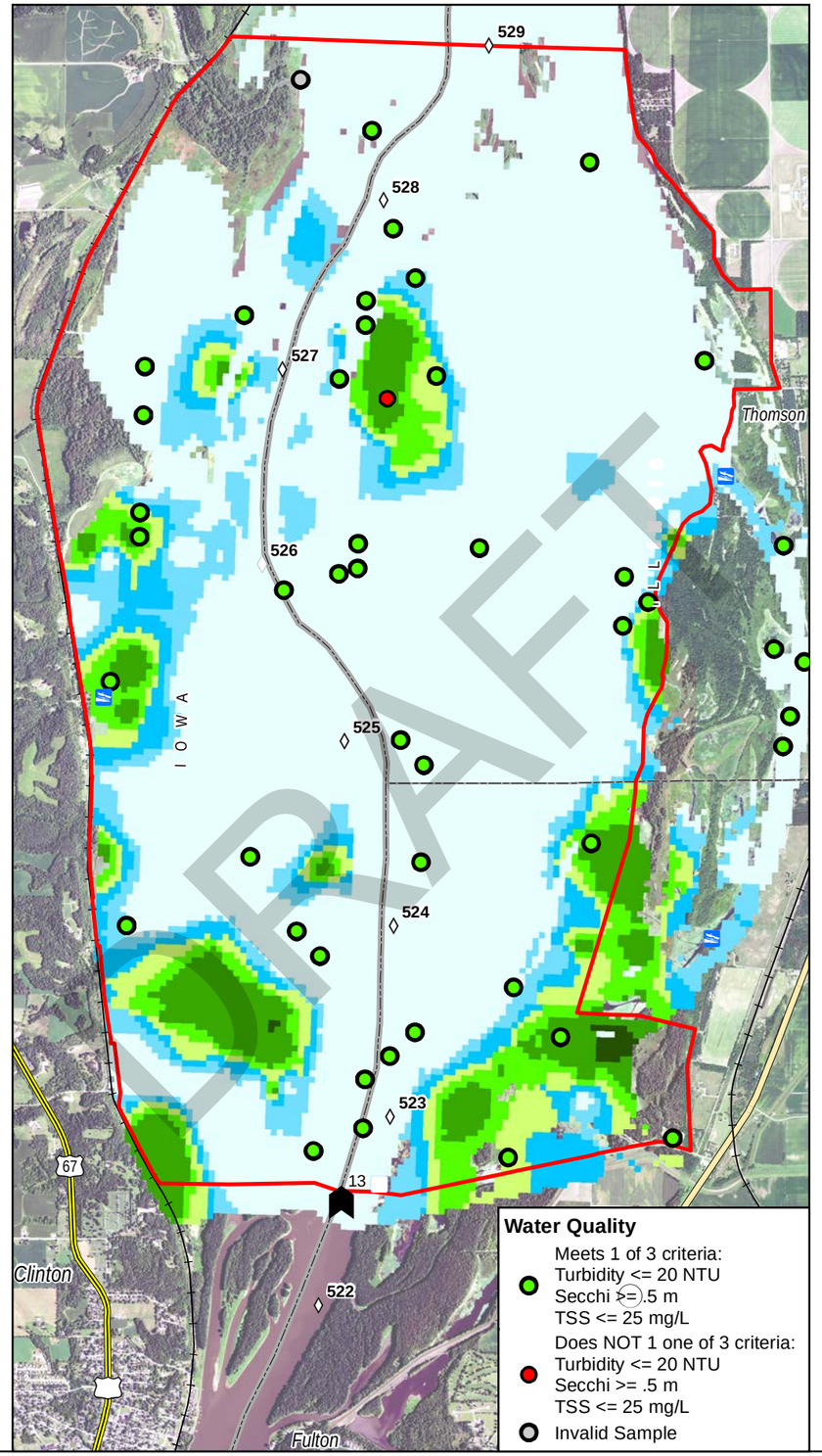

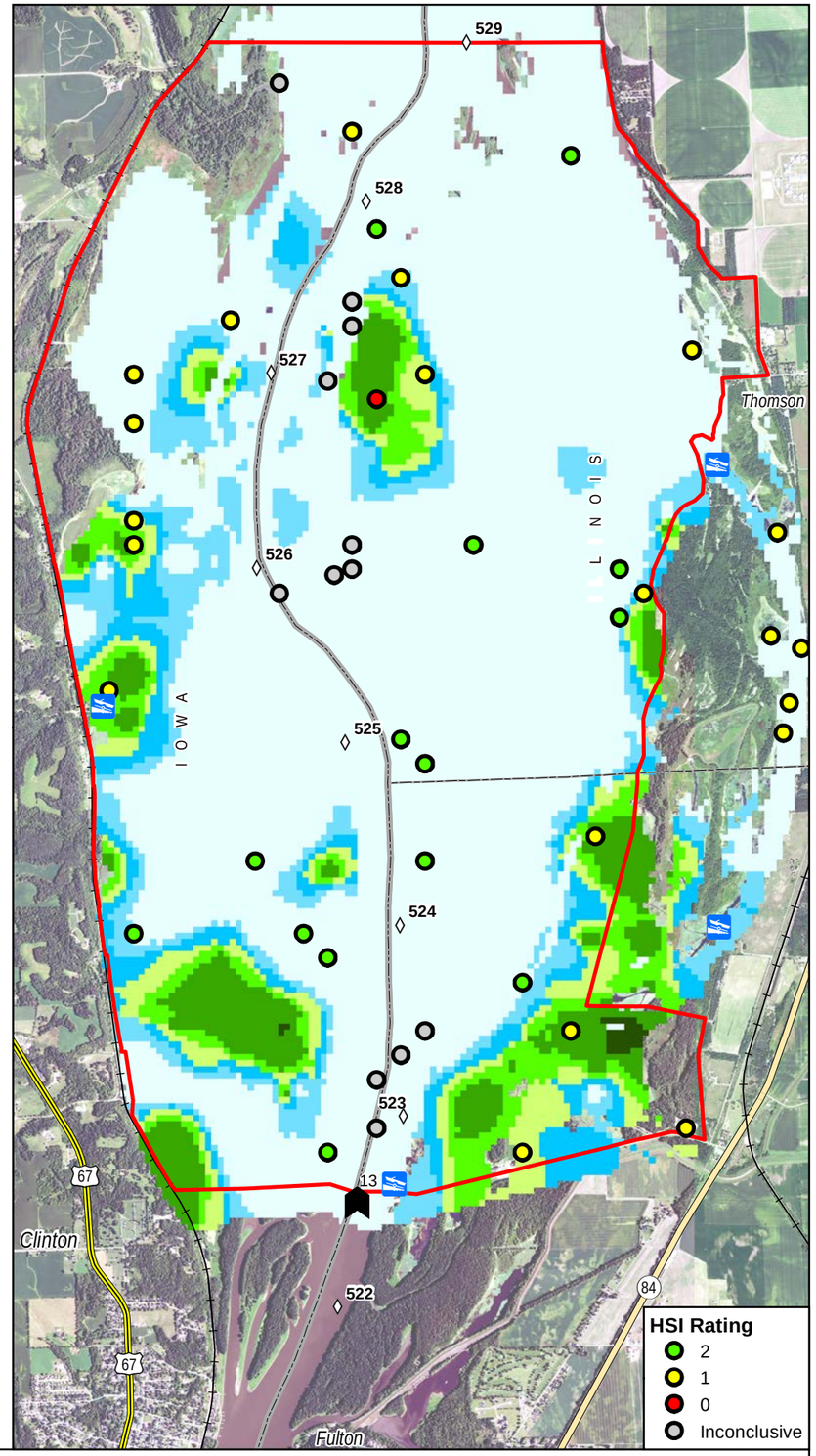

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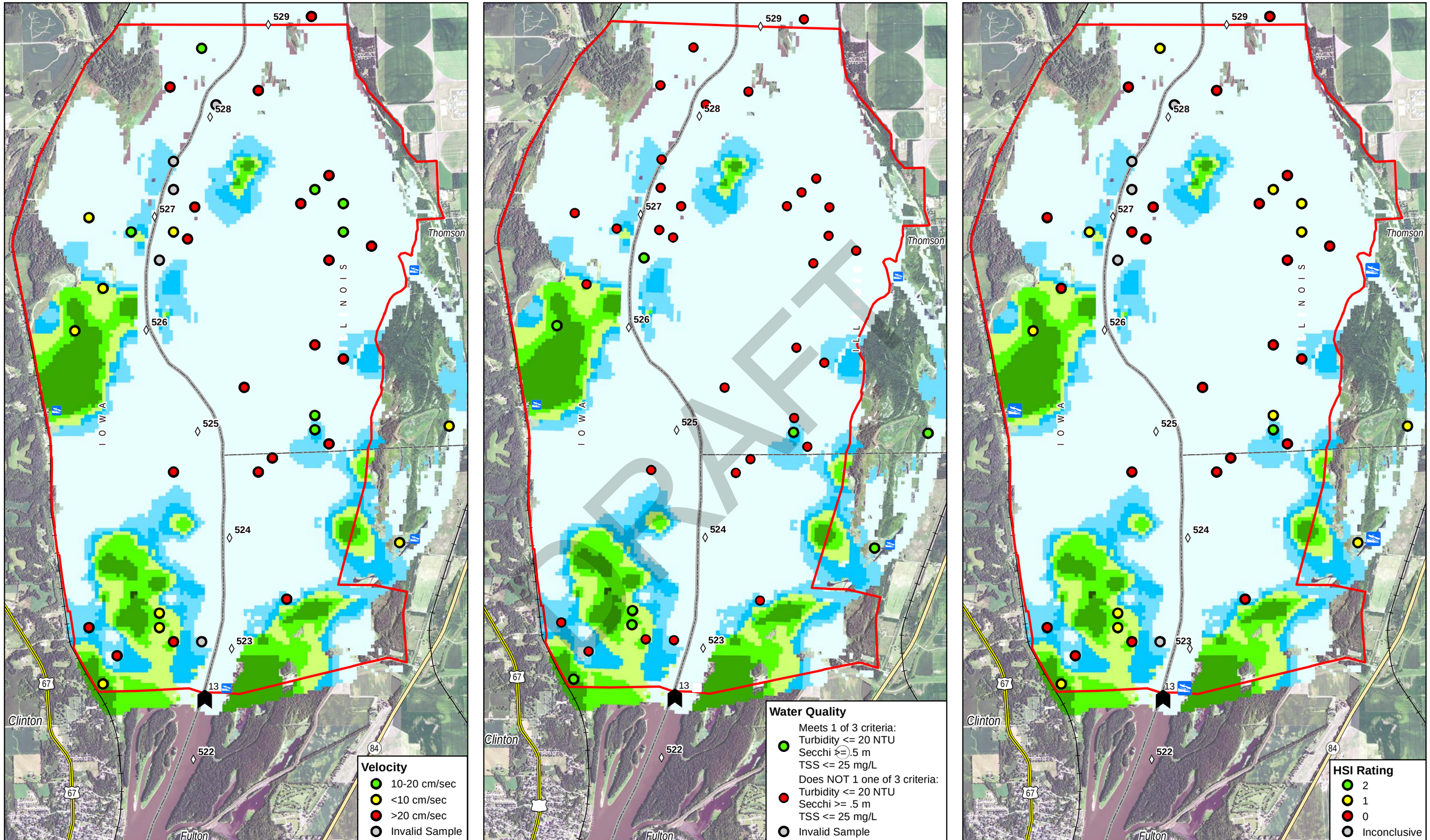
Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 1998
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
5
4
3
2
1
0 Low

N

US Army Corps of Engineers
Rock Island District



Lower Pool 13 HREP
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LTRM SRS Water Quality July-August 1999
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
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0 Low

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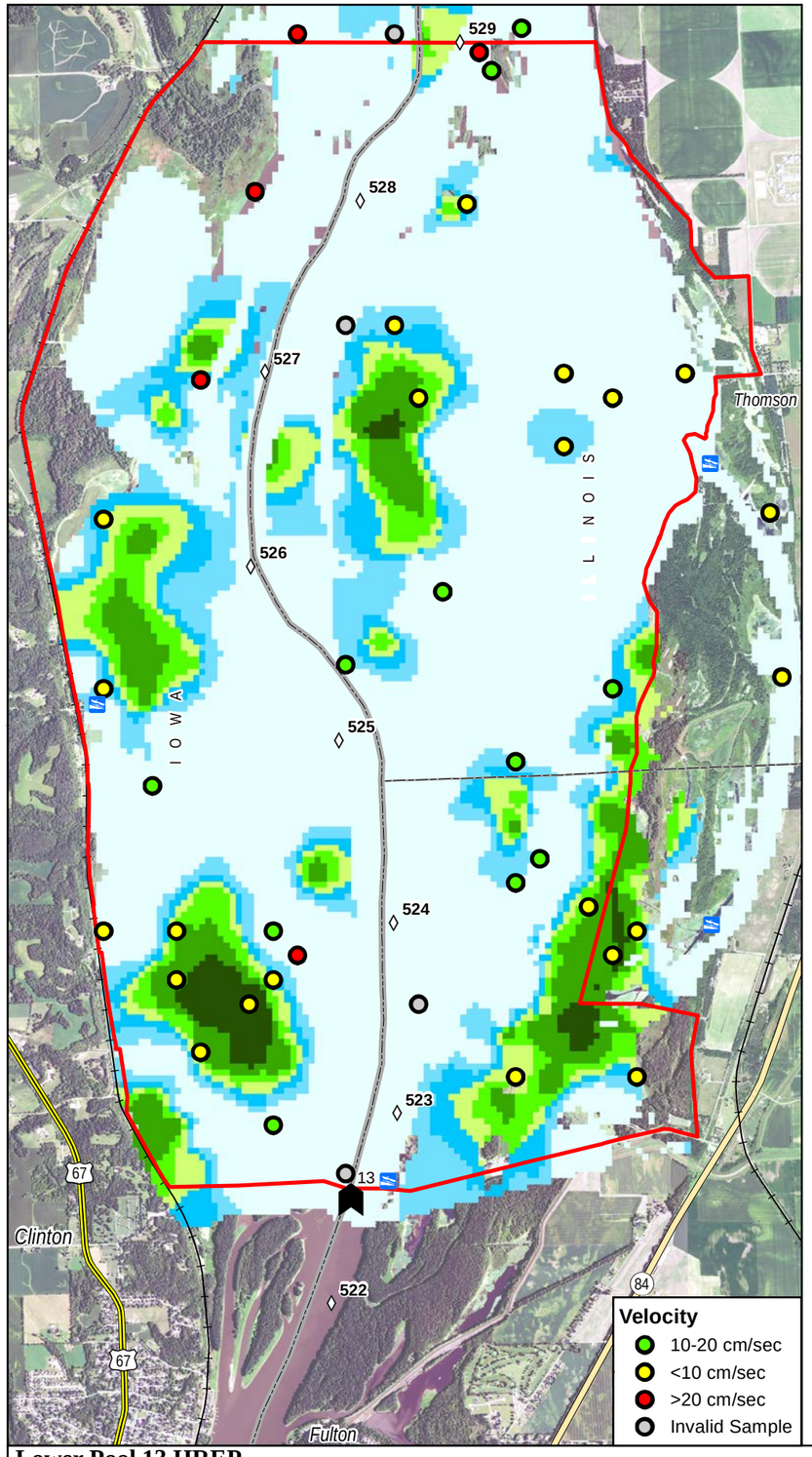
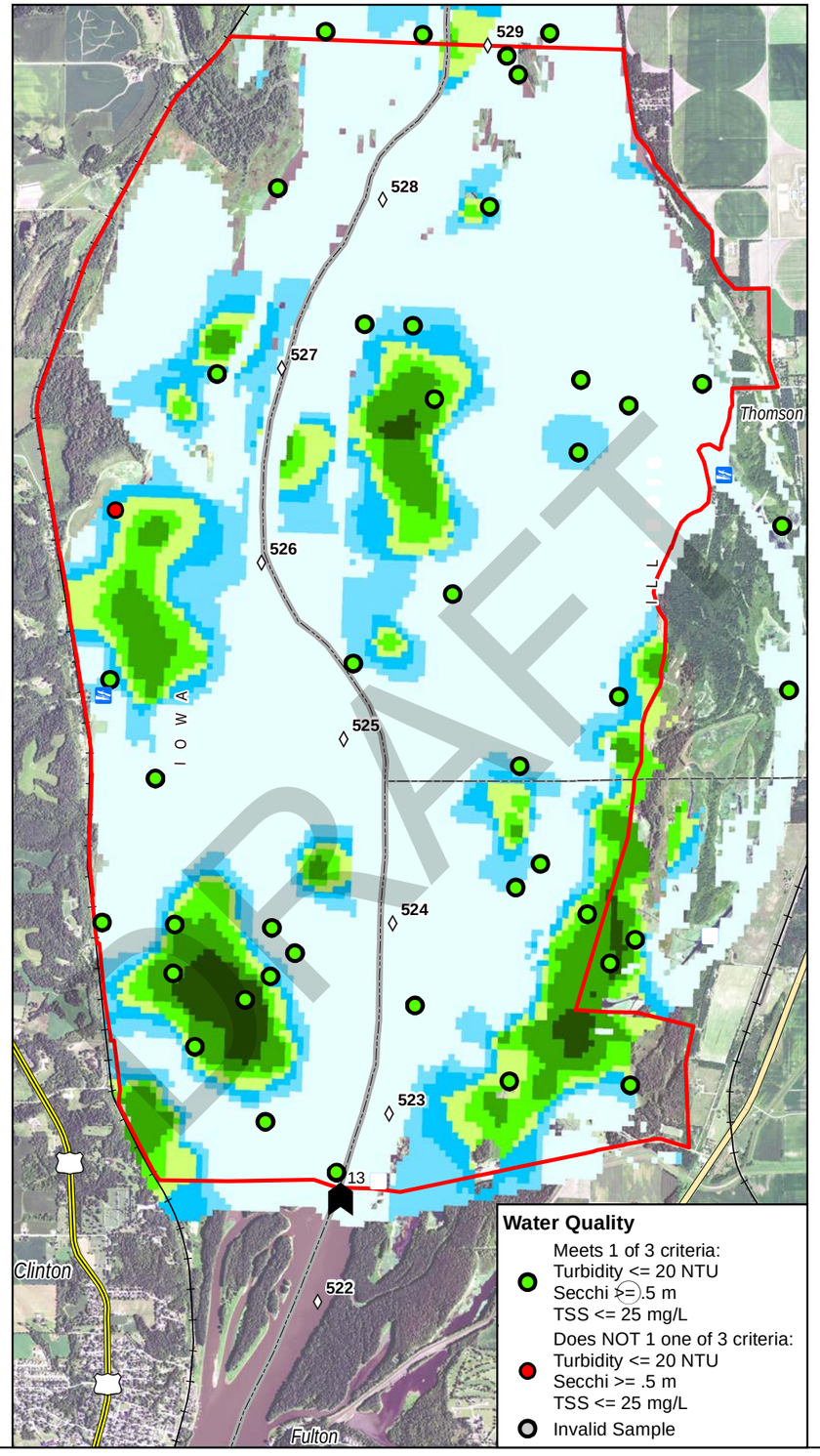
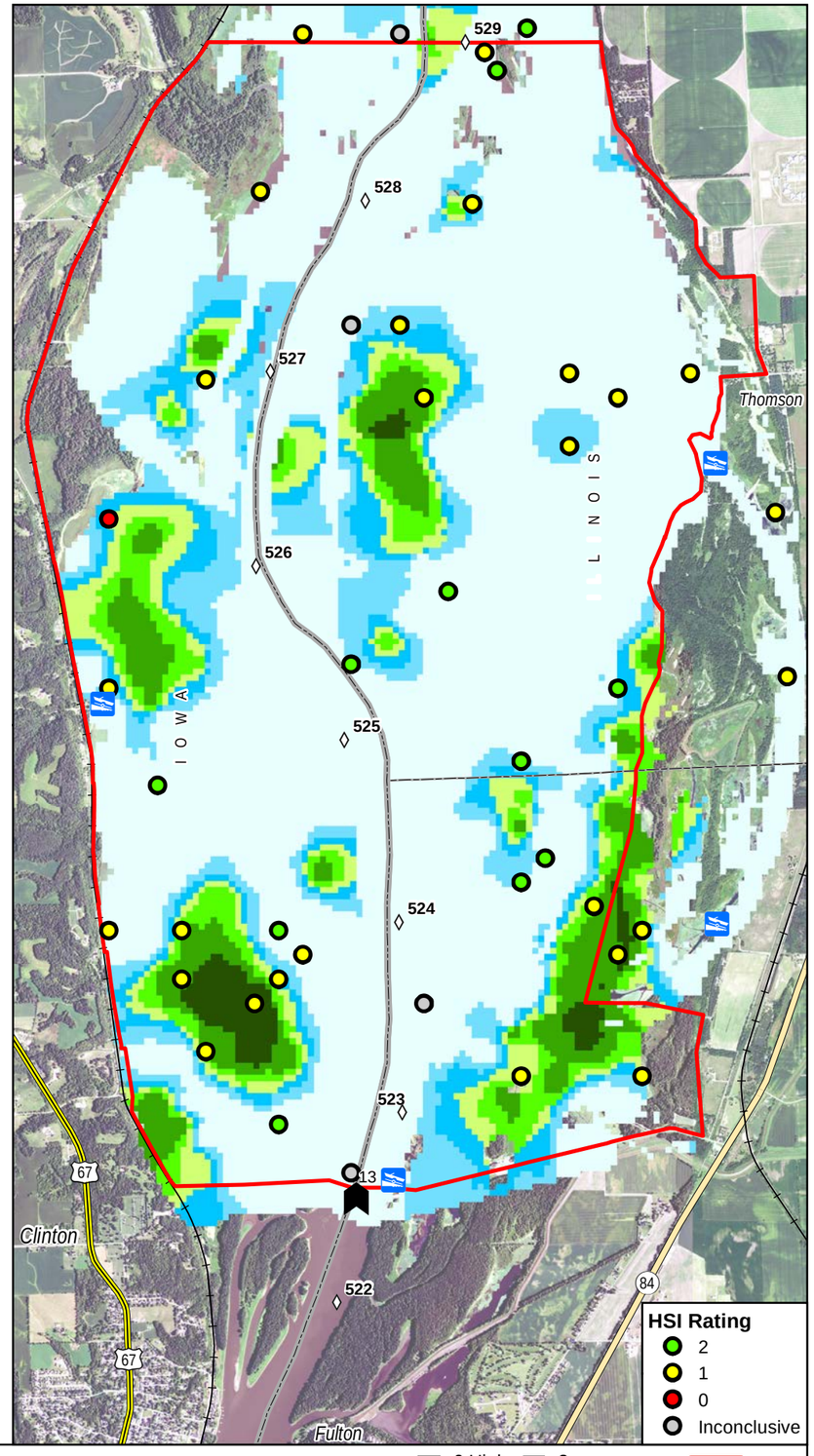
US Army Corps of Engineers
Rock Island District







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Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2000
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
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0 Low

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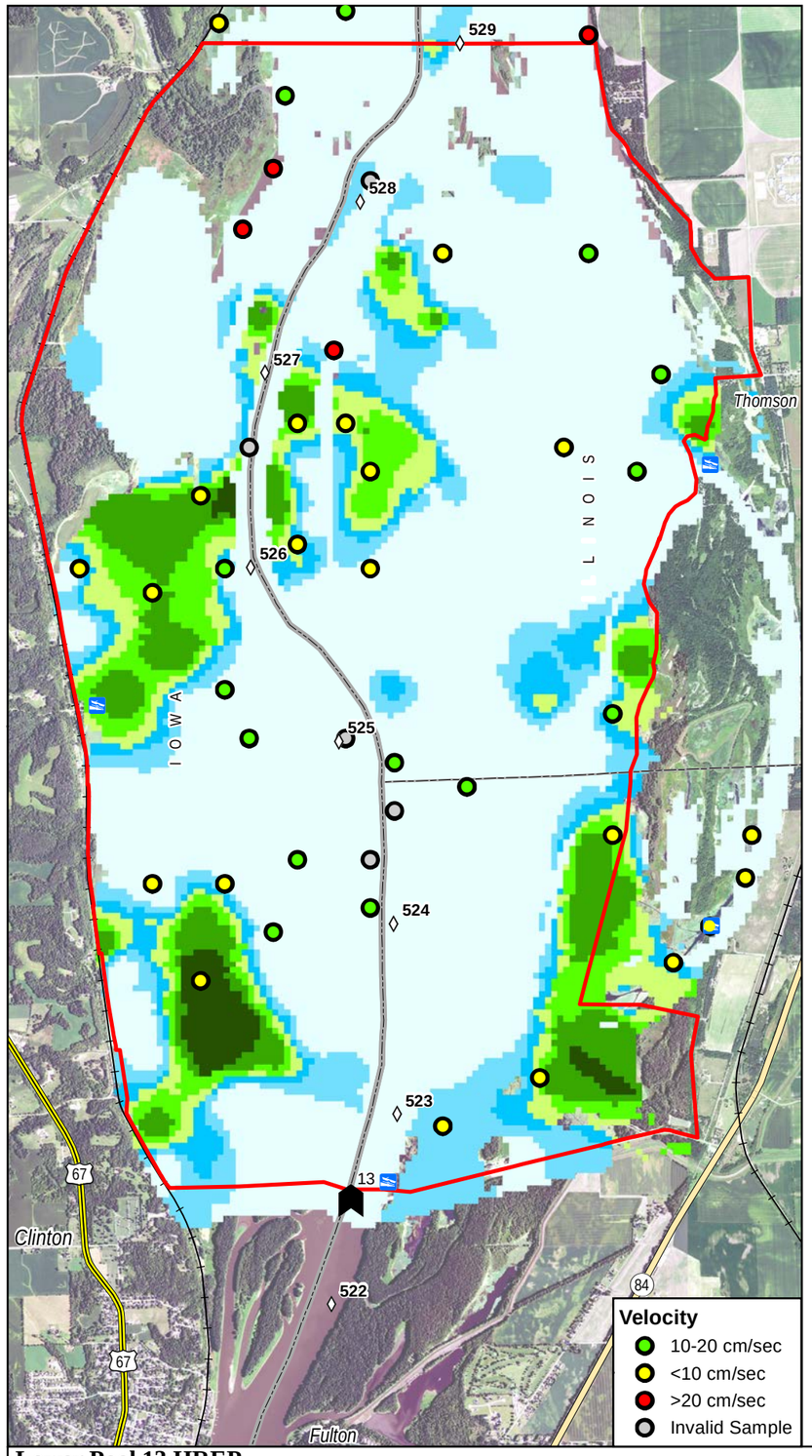
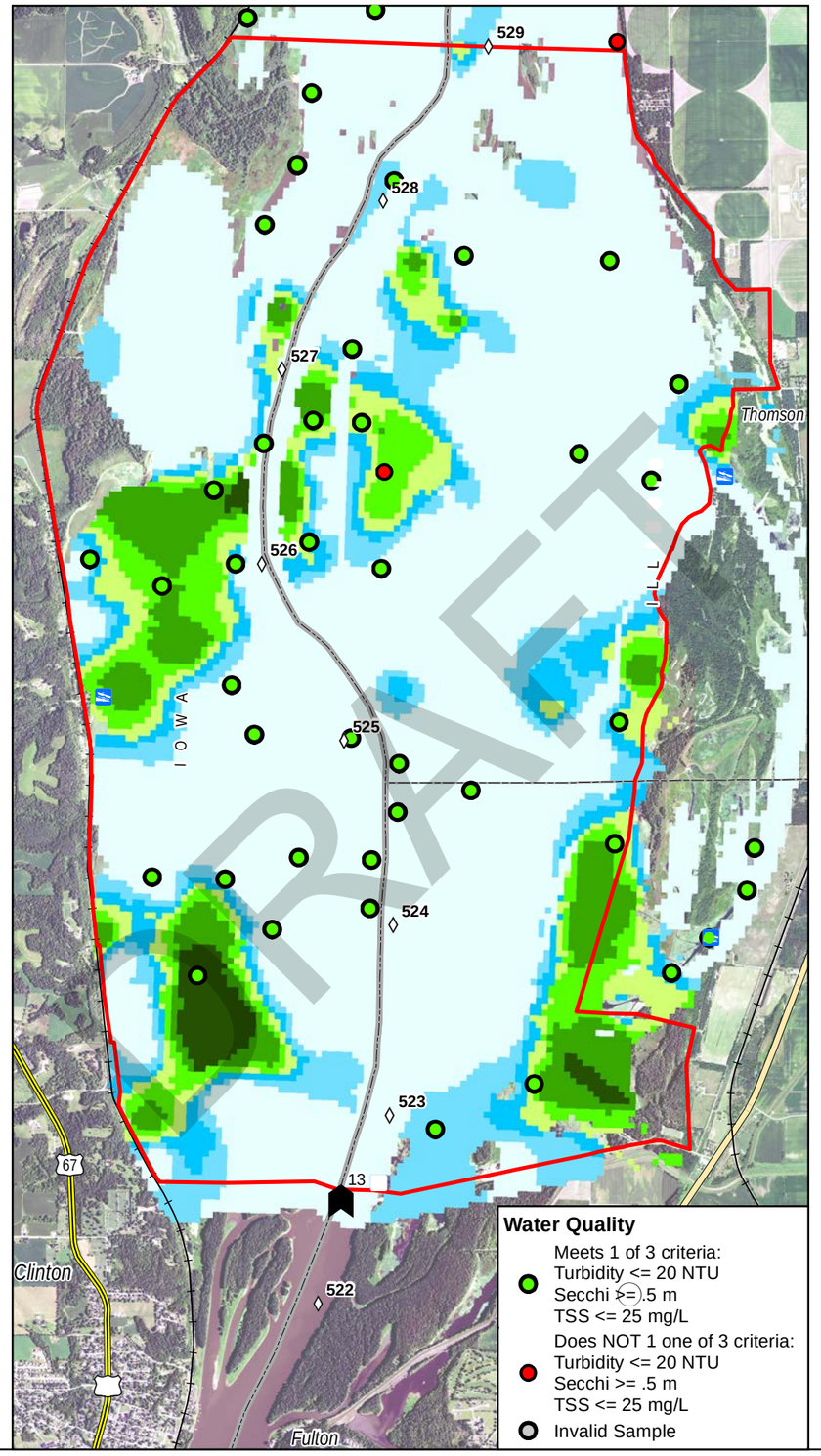
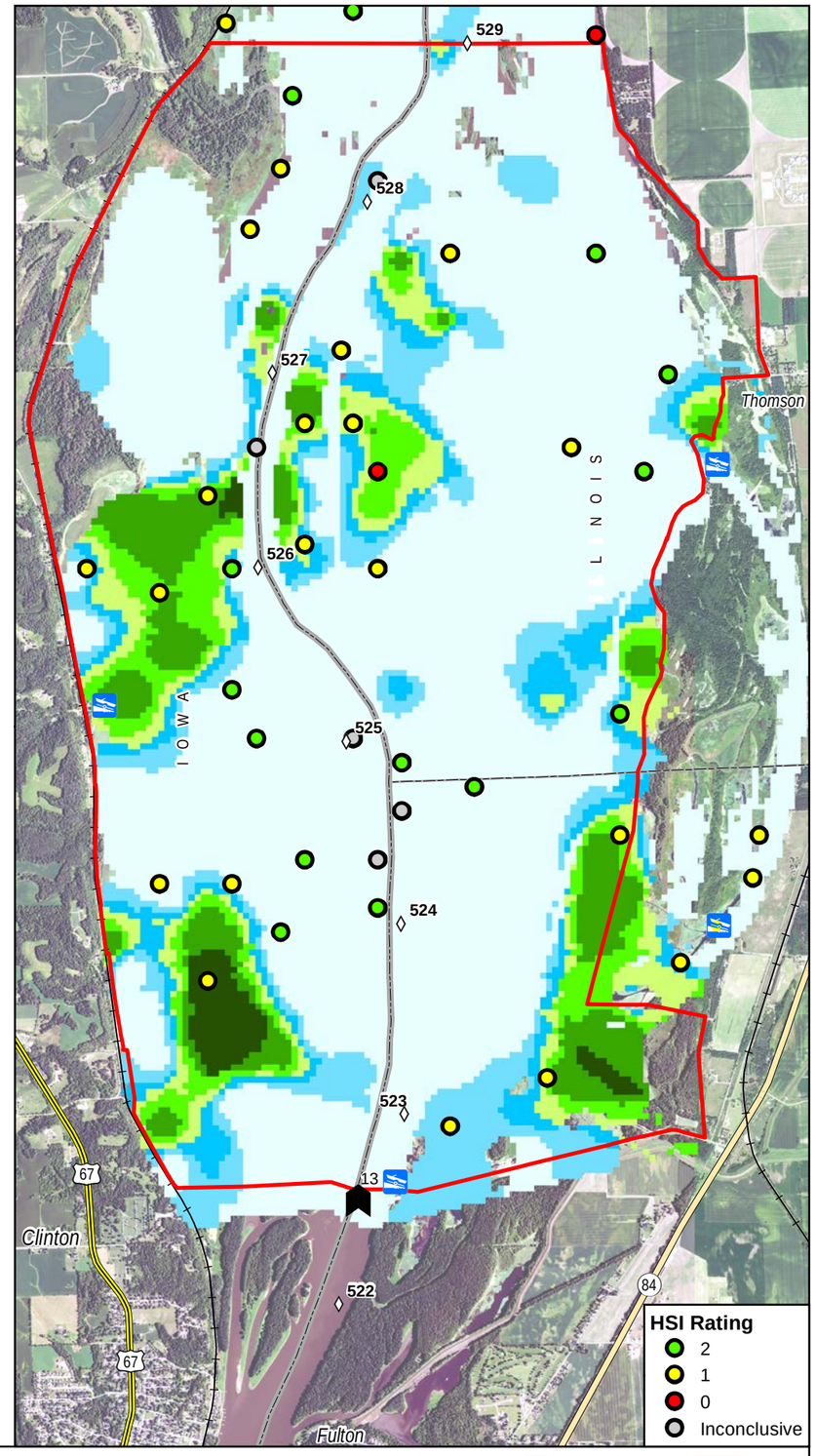
US Army Corps of Engineers
Rock Island District







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Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2001
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
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5
4
3
2
1
0 Low

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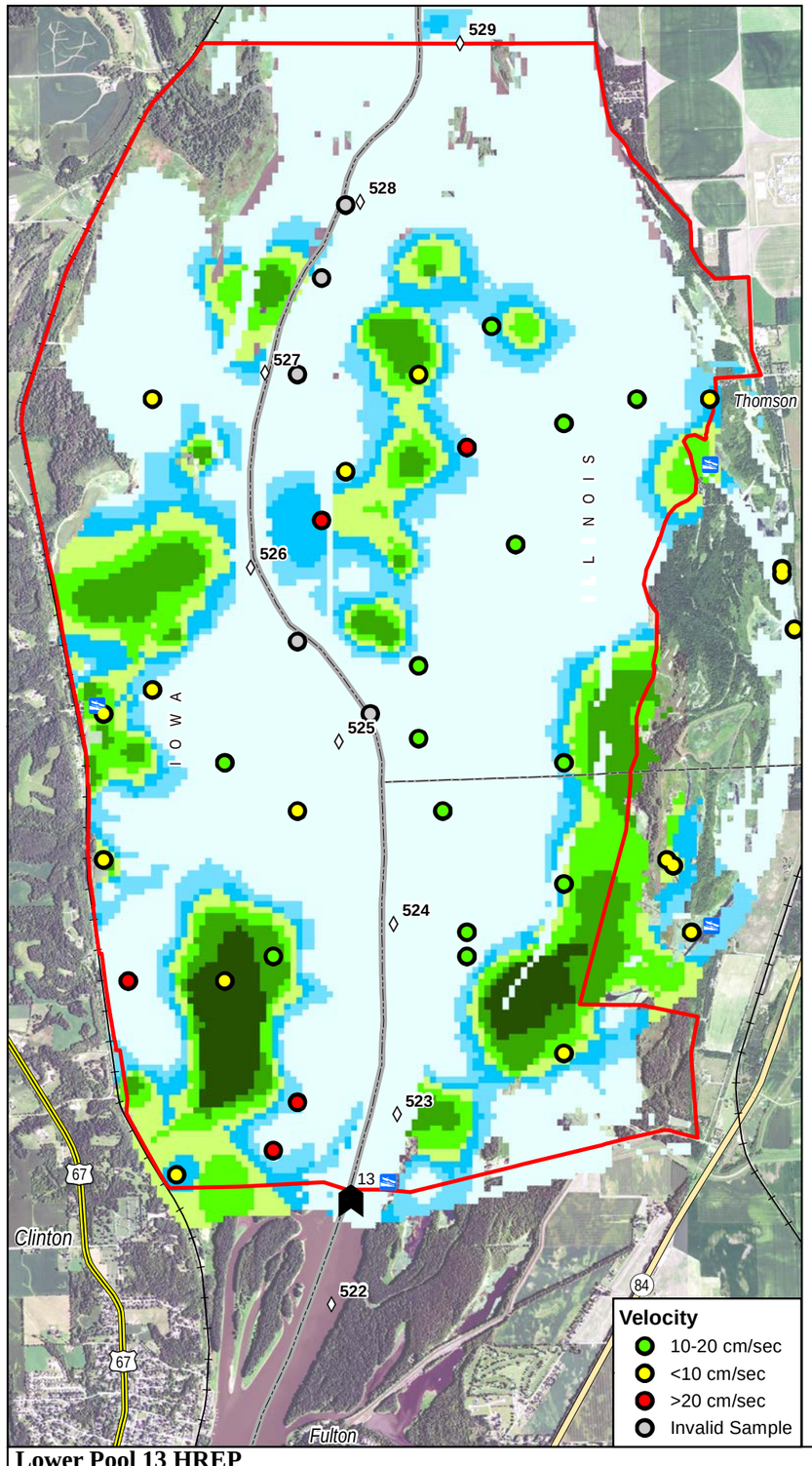
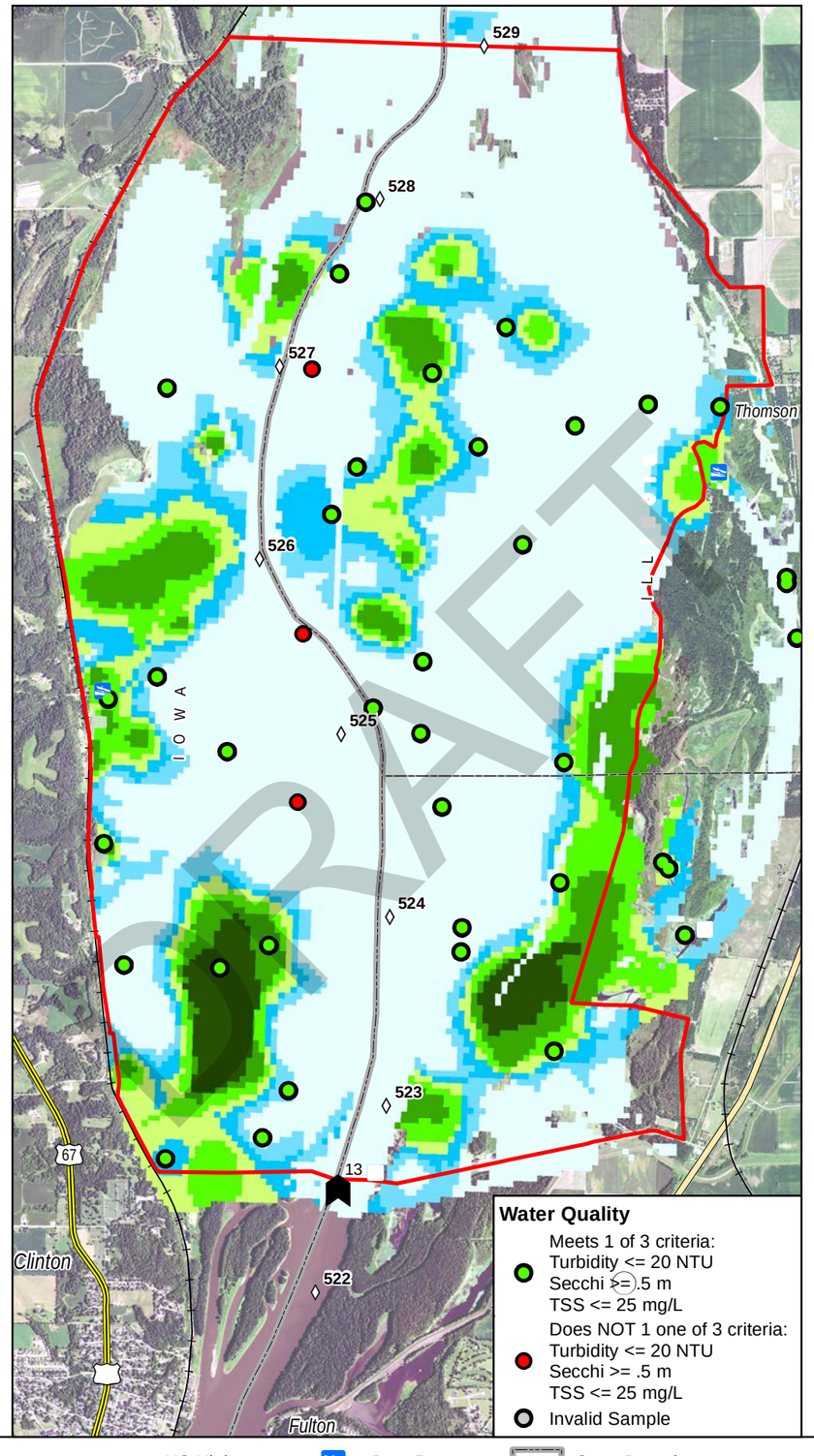
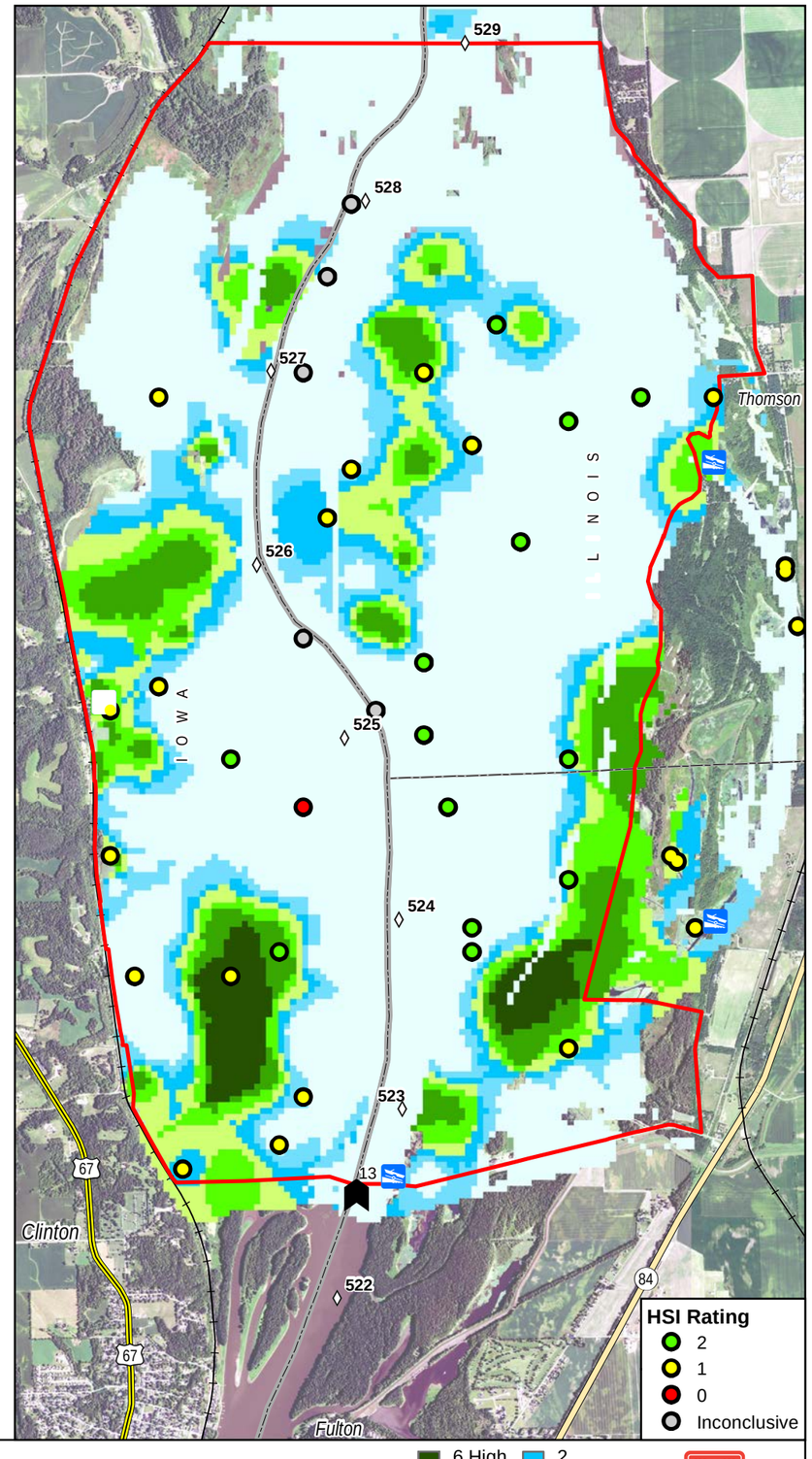
US Army Corps of Engineers
Rock Island District







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Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2002
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
5
4
3
2
1
0 Low

N

US Army Corps of Engineers
Rock Island District

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529
528
527
526
525
524
523
522
13
67
84
IOWA
ILLINOIS
Thomson
Clinton
Fulton

Velocity
- 10-20 cm/sec
- <10 cm/sec
- >20 cm/sec
- Invalid Sample

Water Quality
- Meets 1 of 3 criteria:
  Turbidity <= 20 NTU
  Secchi >=.5 m
  TSS <= 25 mg/L
- Does NOT 1 one of 3 criteria:
  Turbidity <= 20 NTU
  Secchi >= .5 m
  TSS <= 25 mg/L
- Invalid Sample

HSI Rating
- 2
- 1
- 0
- Inconclusive

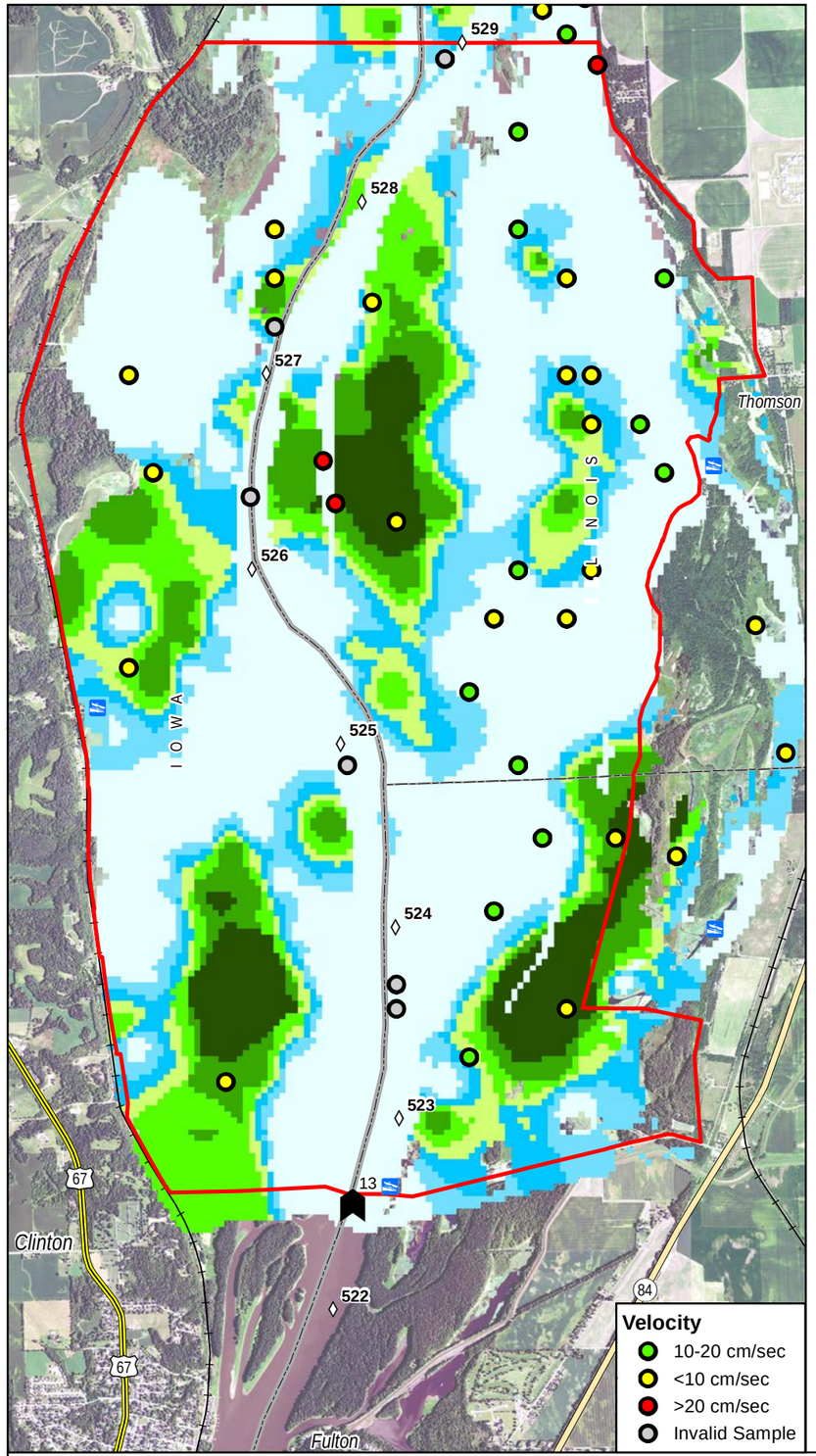
Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2004
Map Produced: 5/29/2020

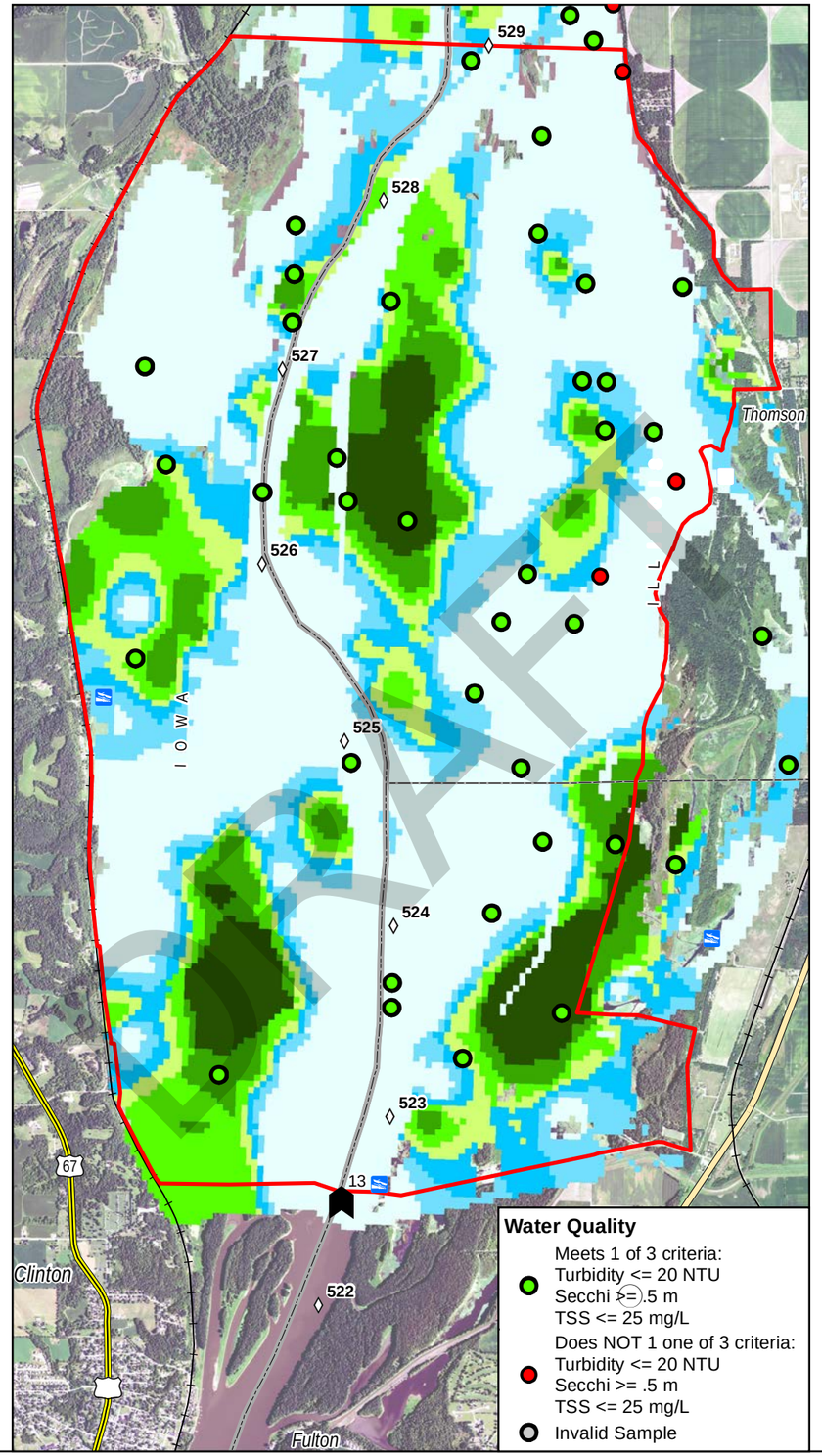
US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

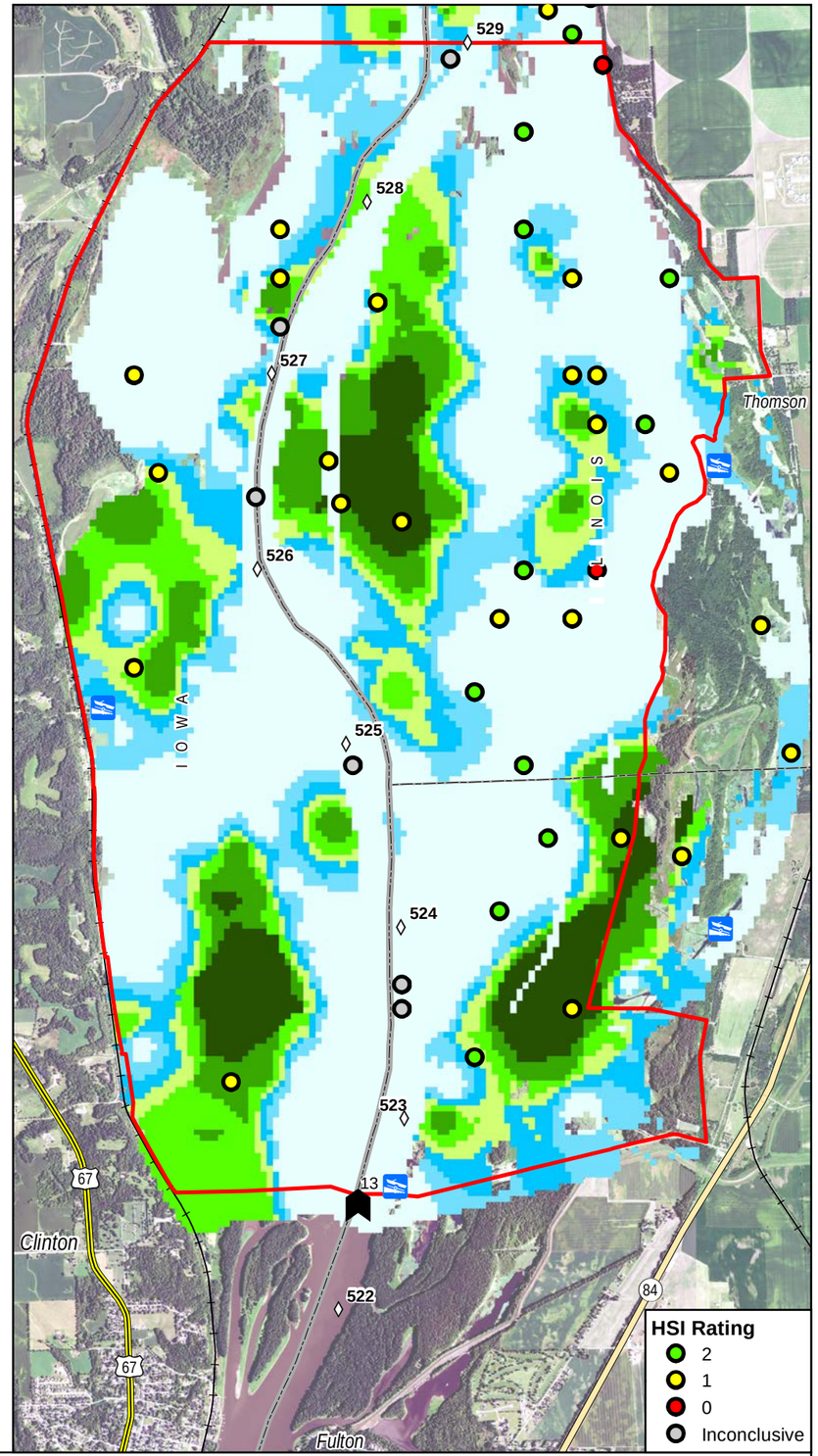
Relative Probability of Vallisneria
6 High
5
4
3
2
1
0 Low

N

US Army Corps of Engineers
Rock Island District







Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2005
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
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0 Low

N

US Army Corps of Engineers
Rock Island District

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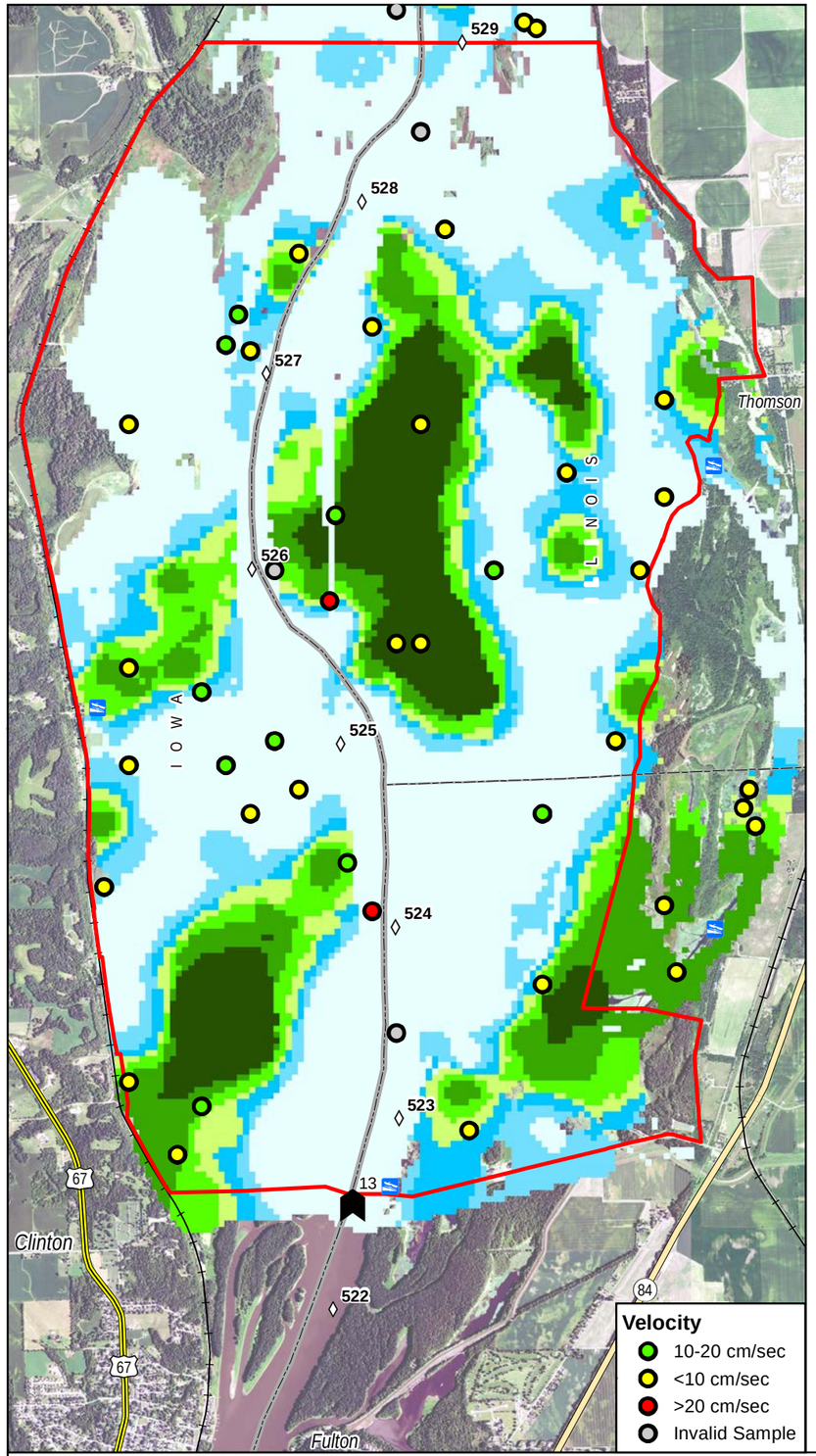

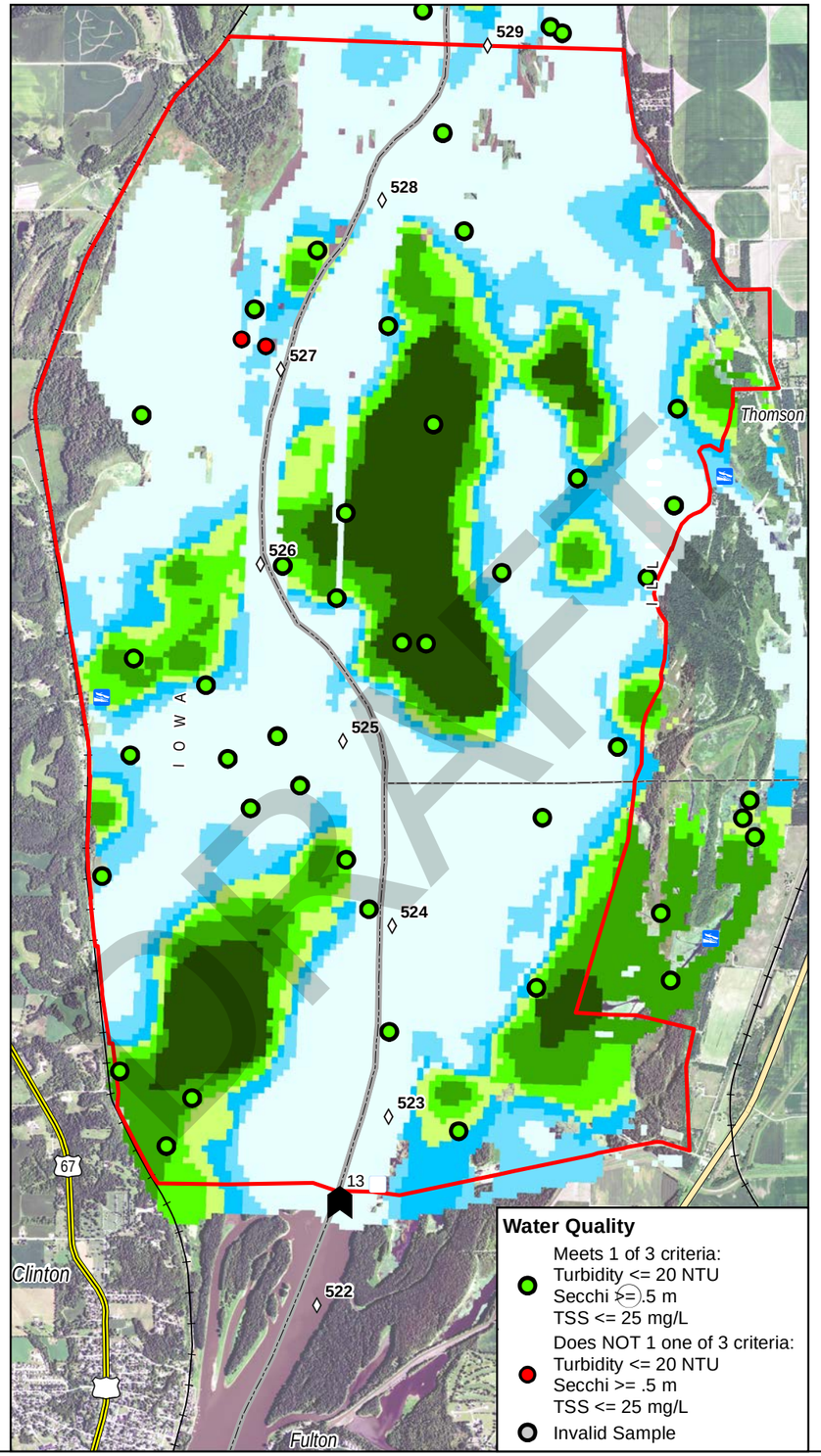

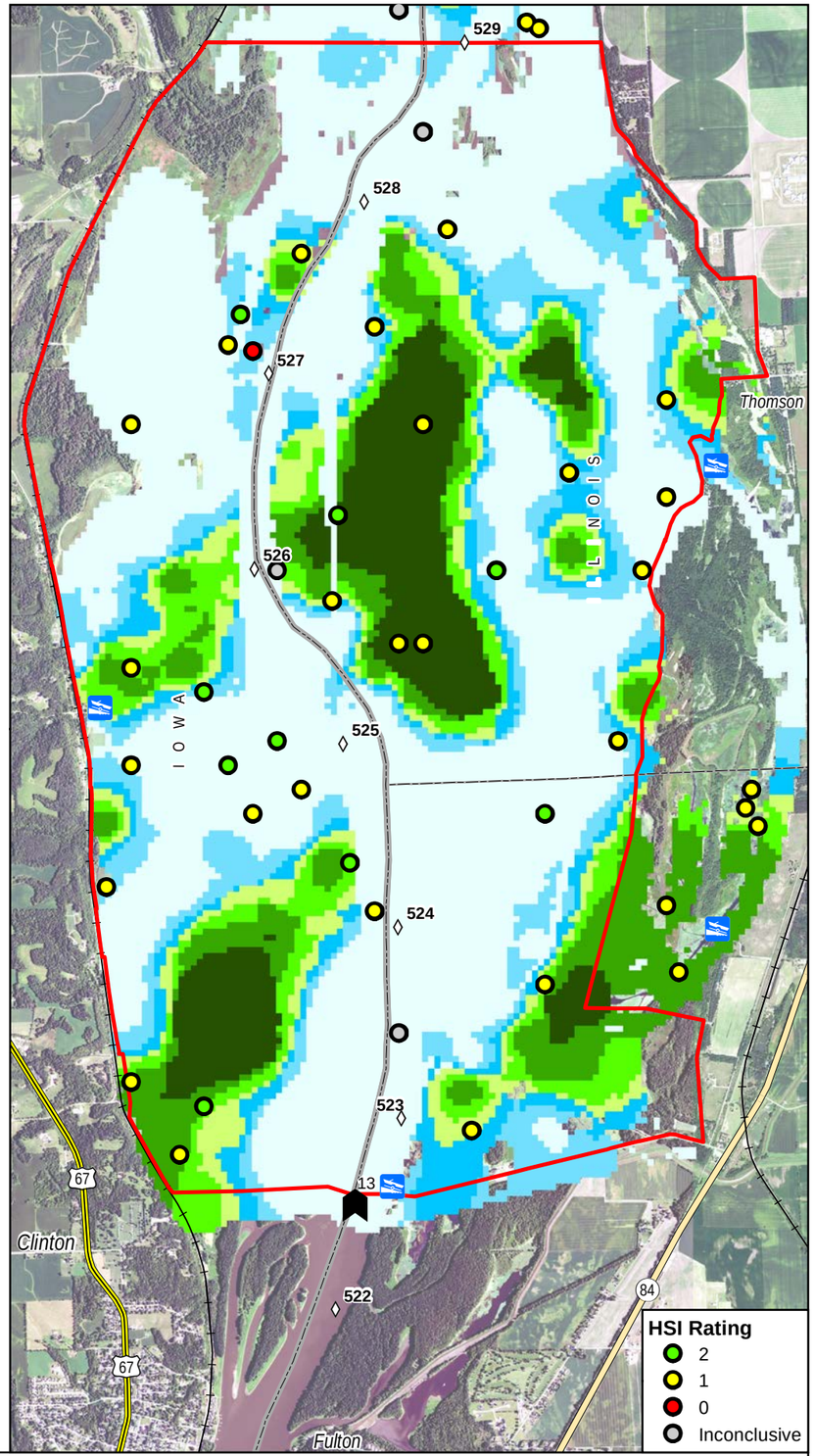

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Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2006
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
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0 Low

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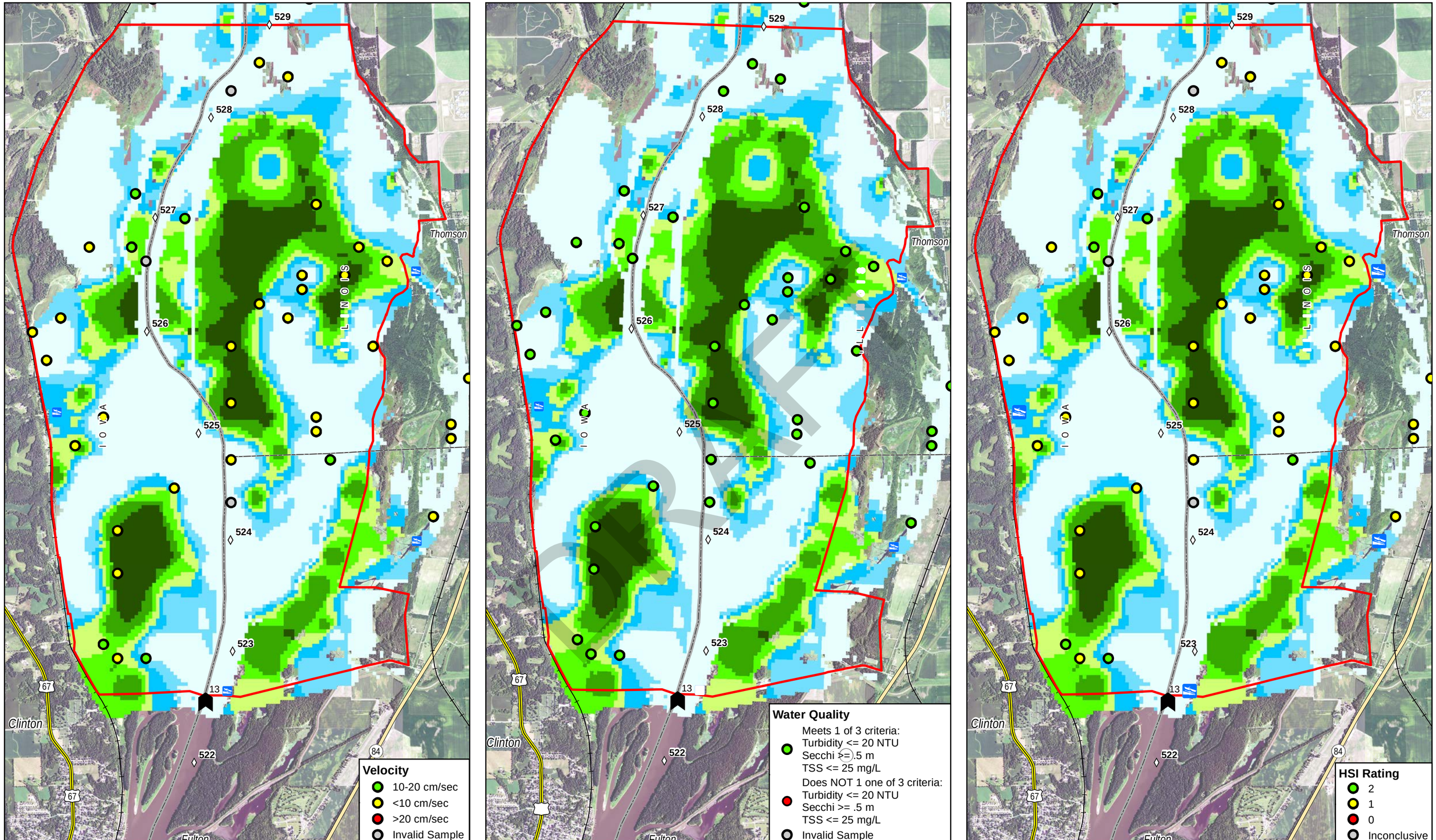
US Army Corps of Engineers
Rock Island District



Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2007
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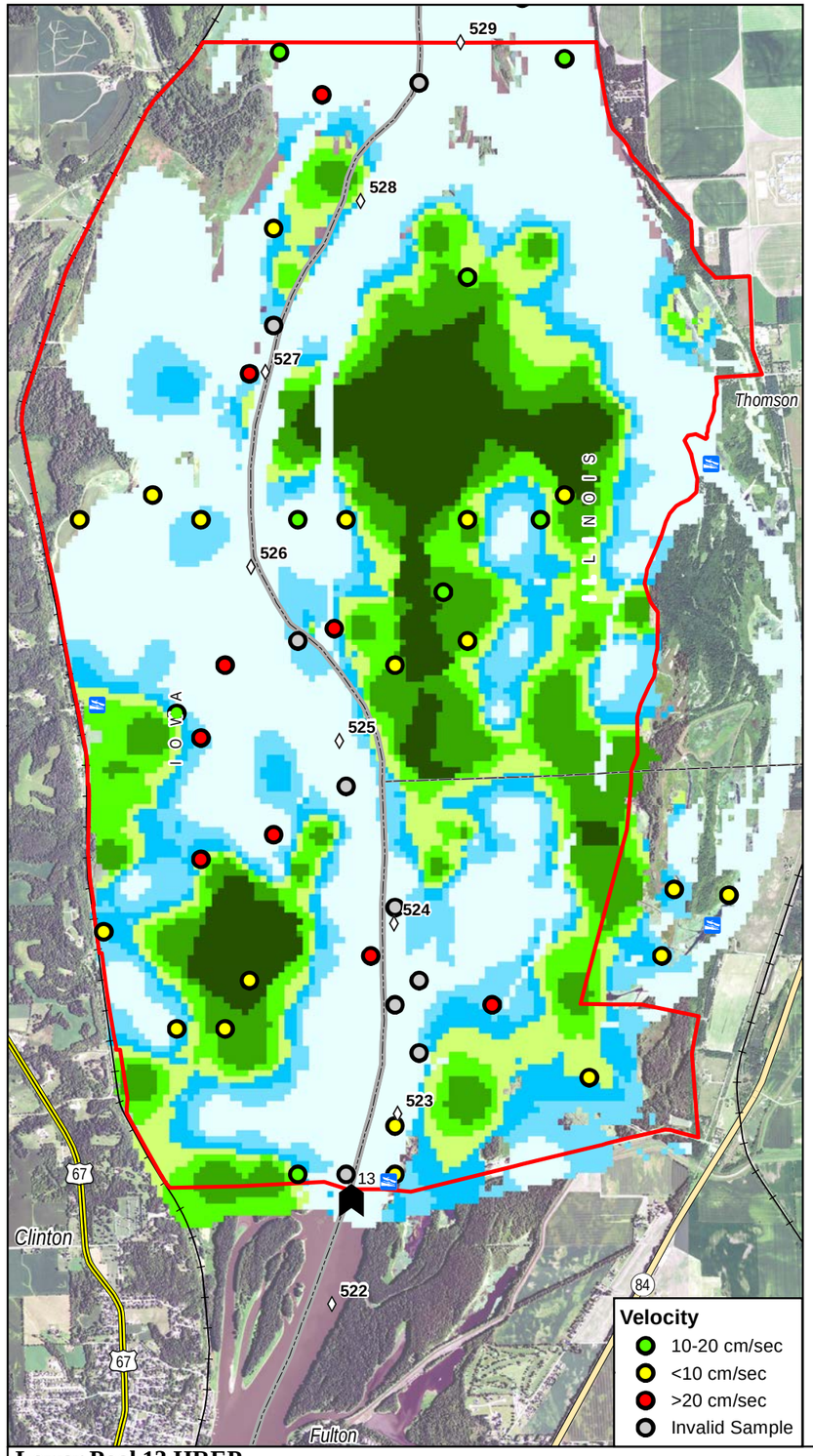

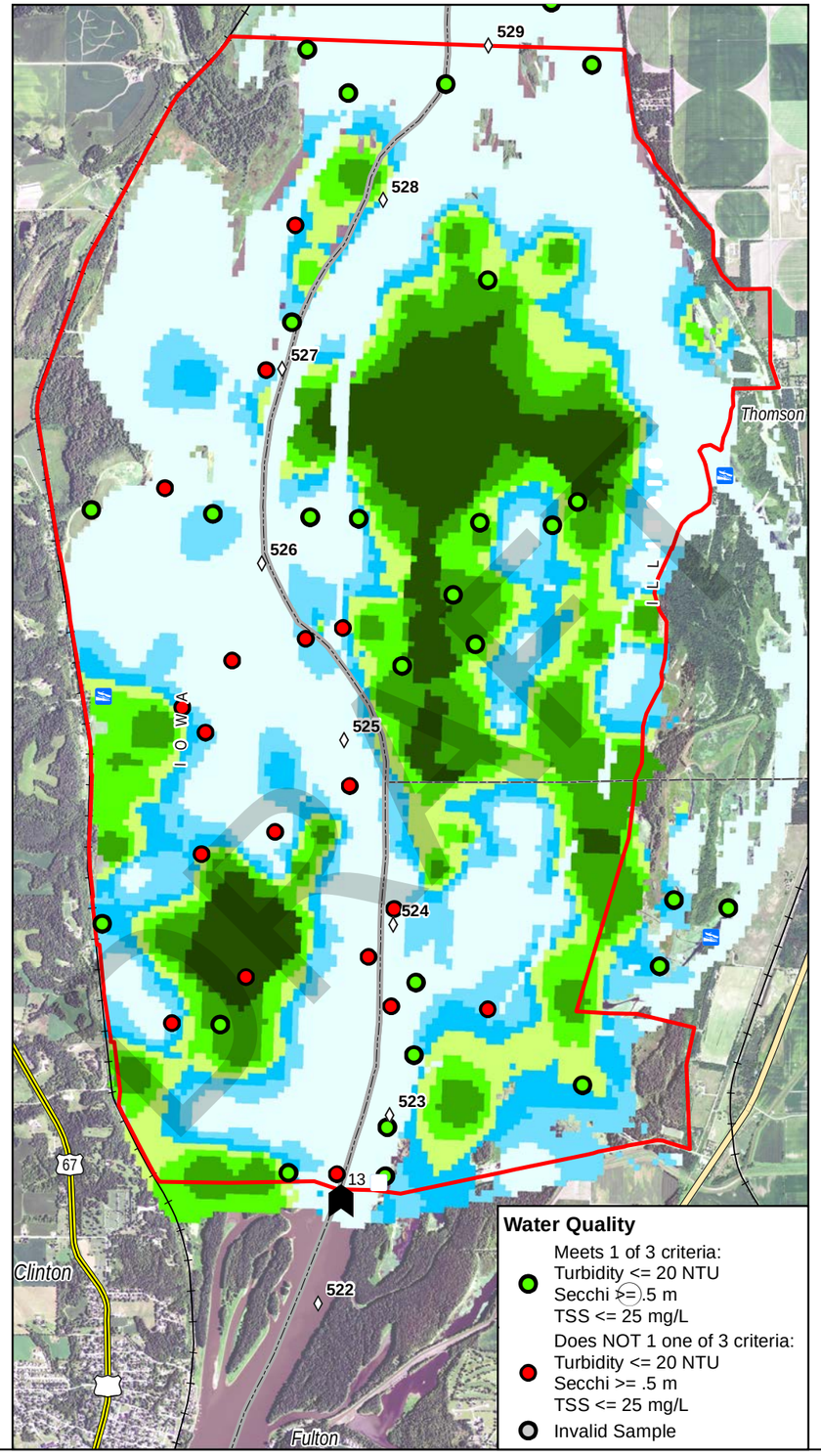

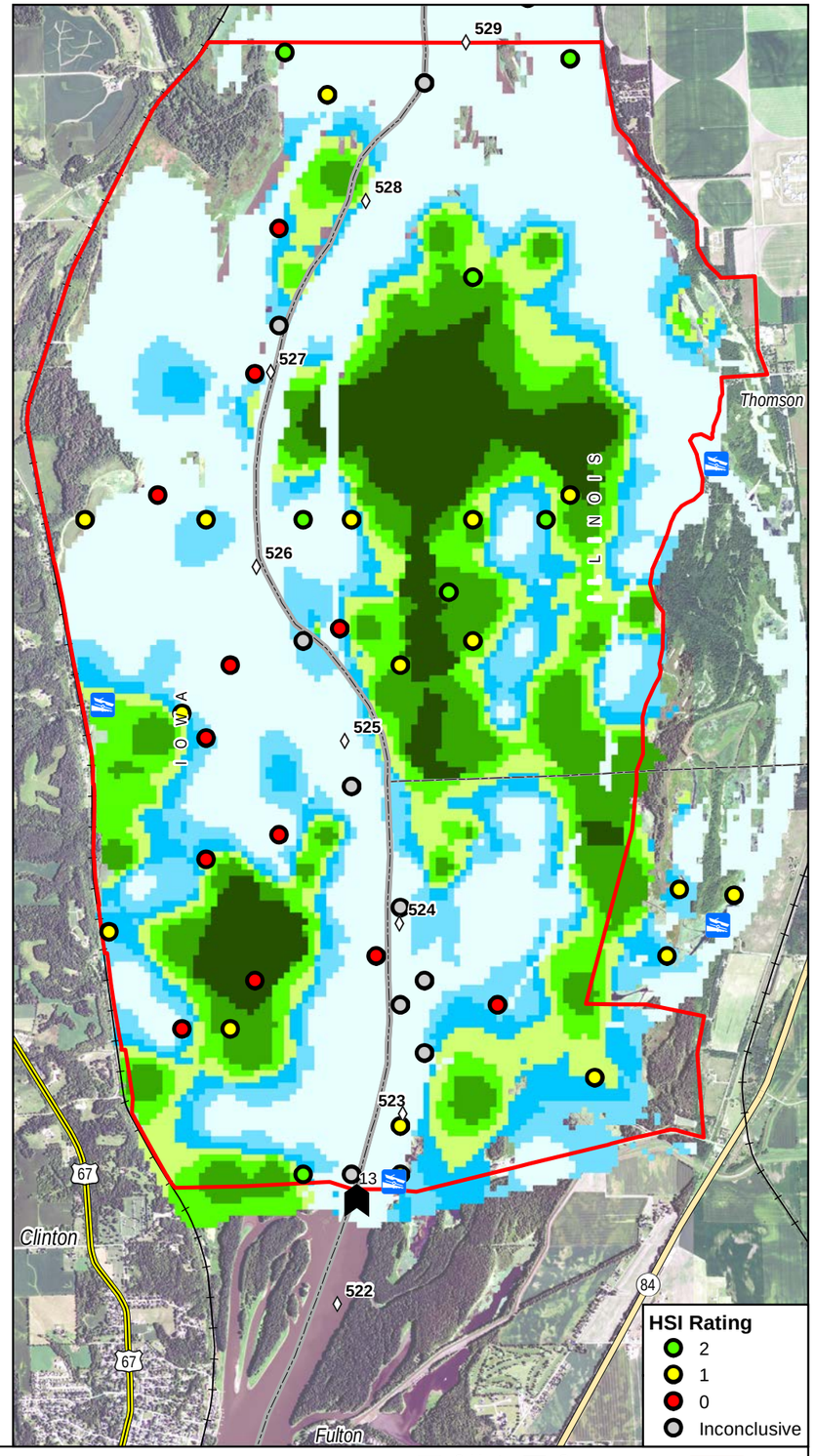

Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2008
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
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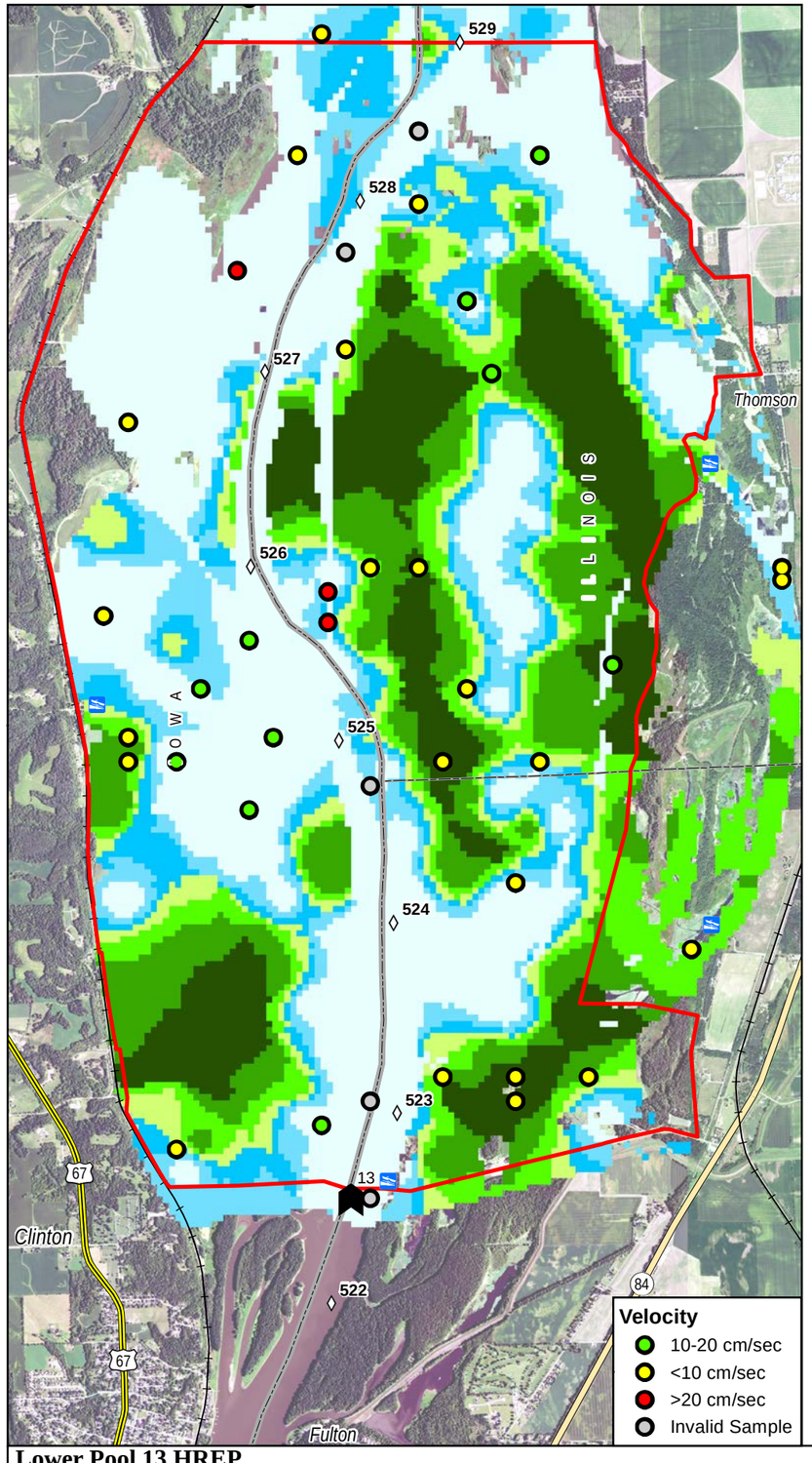
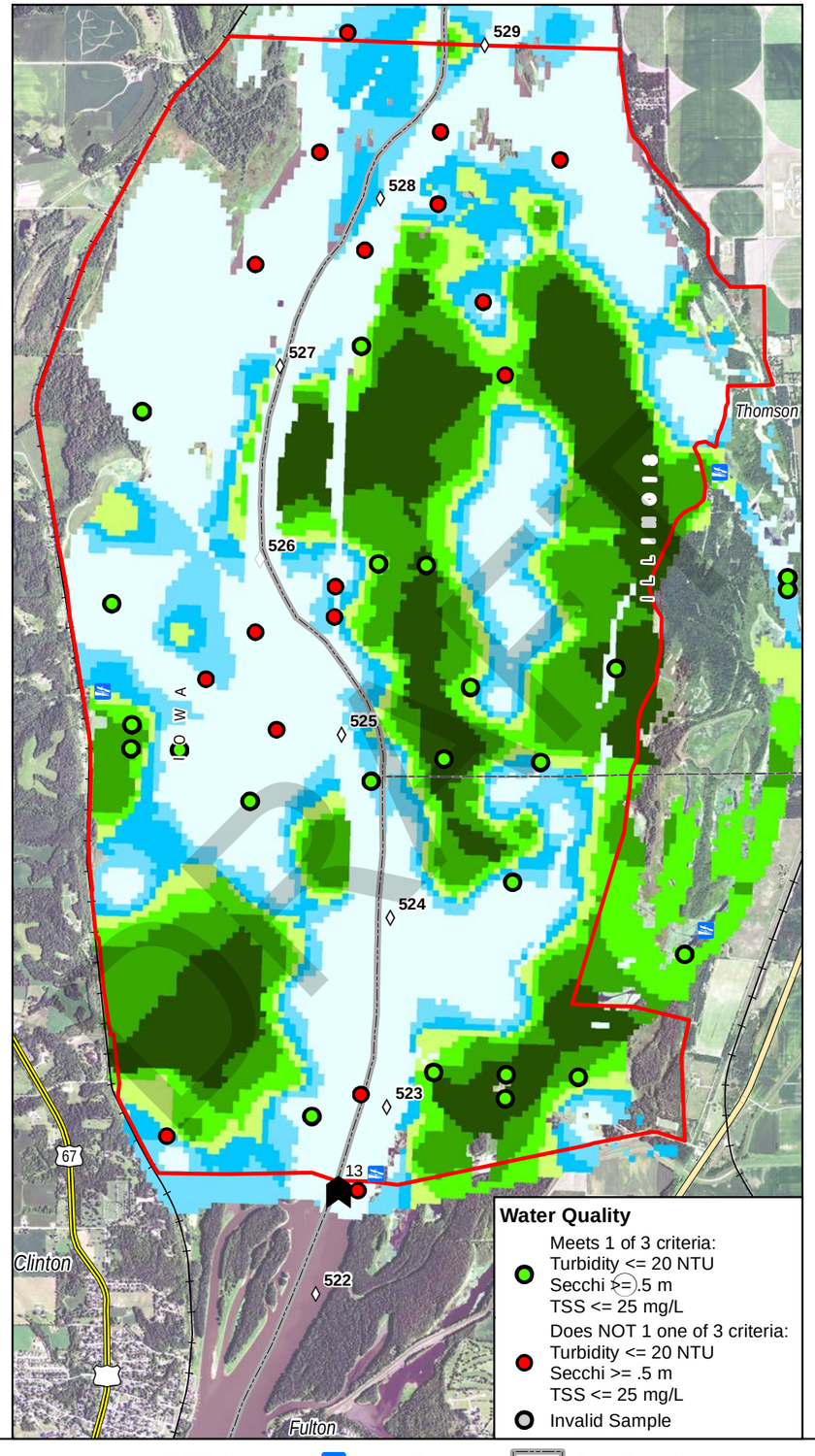
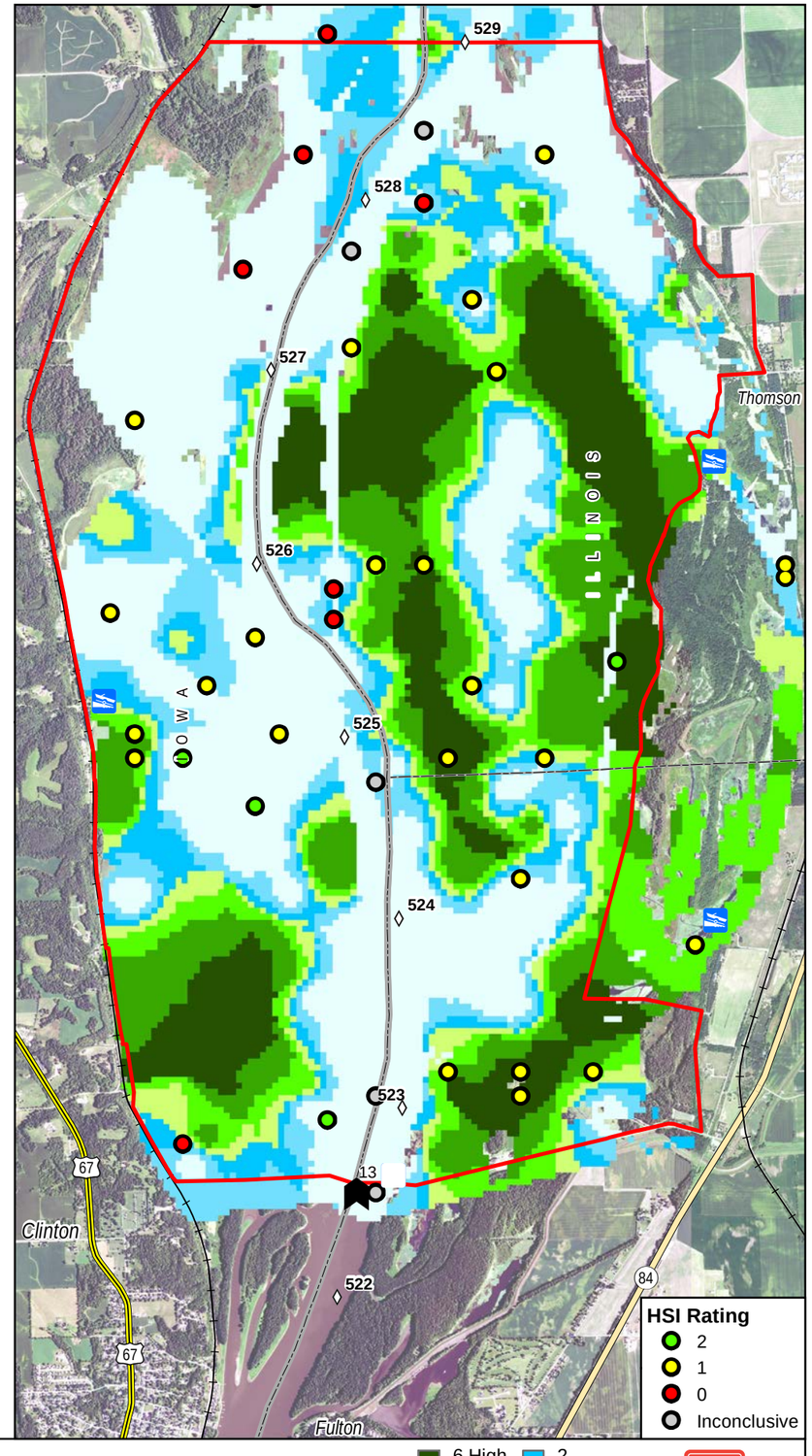
US Army Corps of Engineers
Rock Island District







Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2009
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
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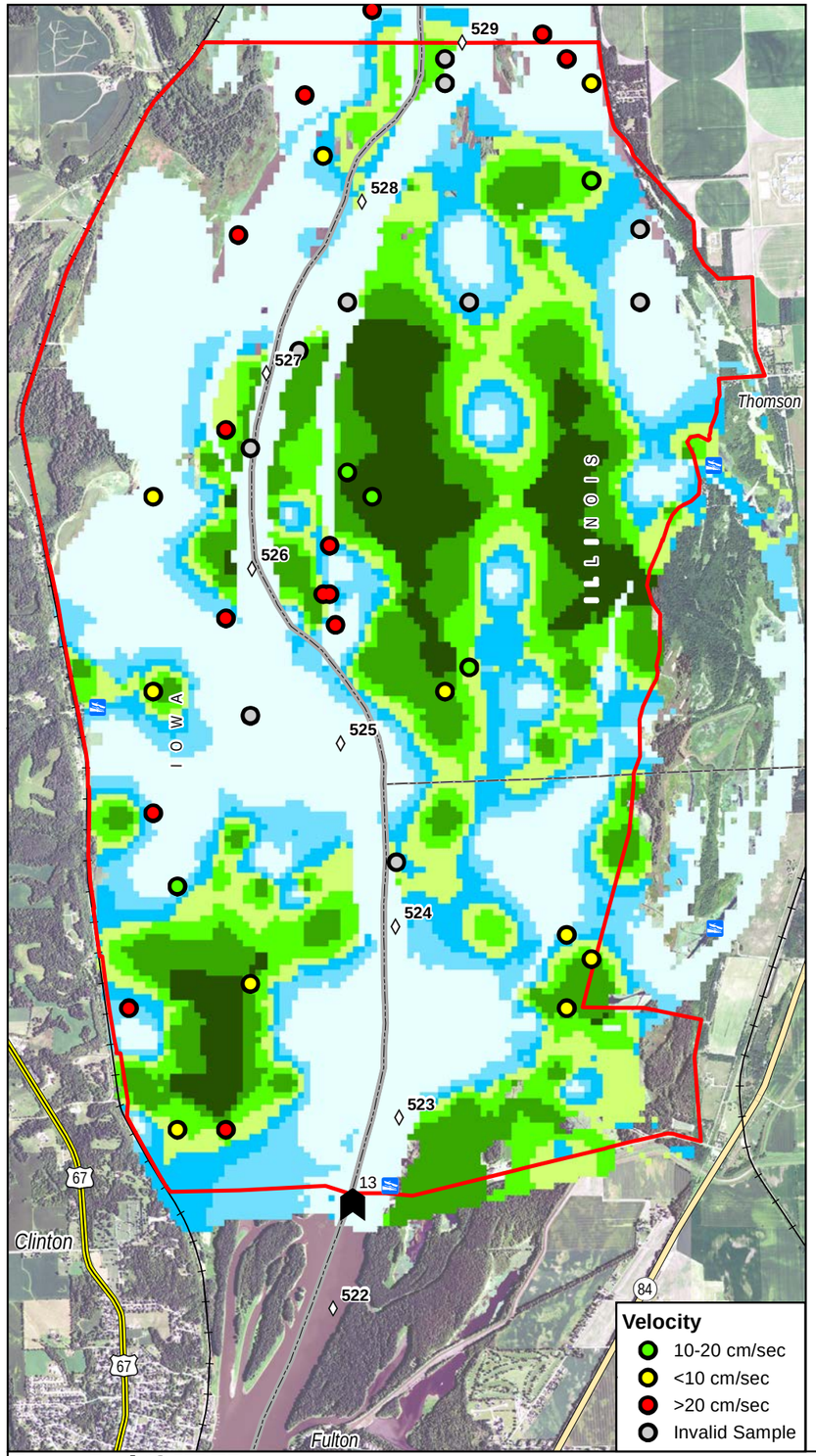
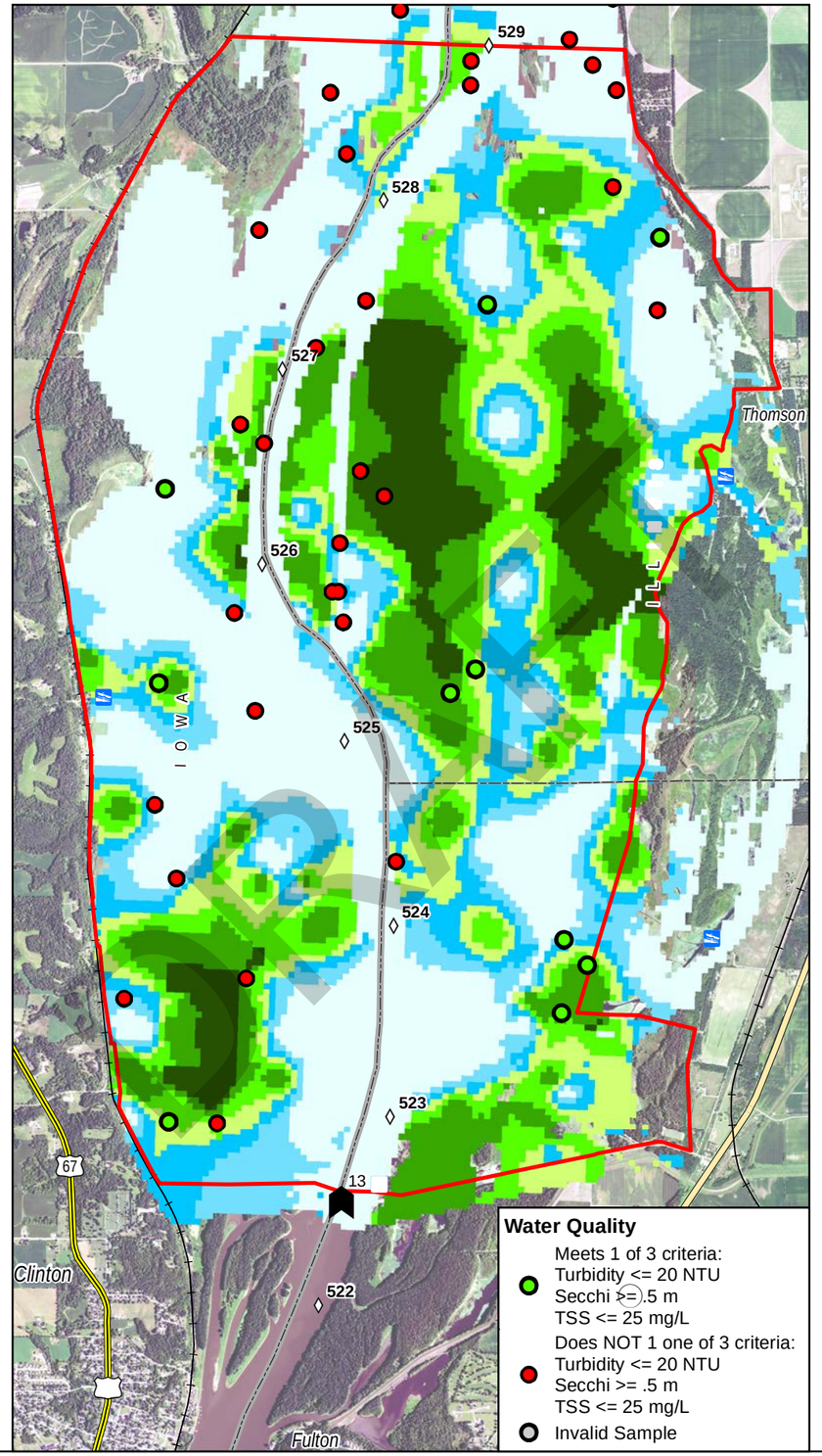
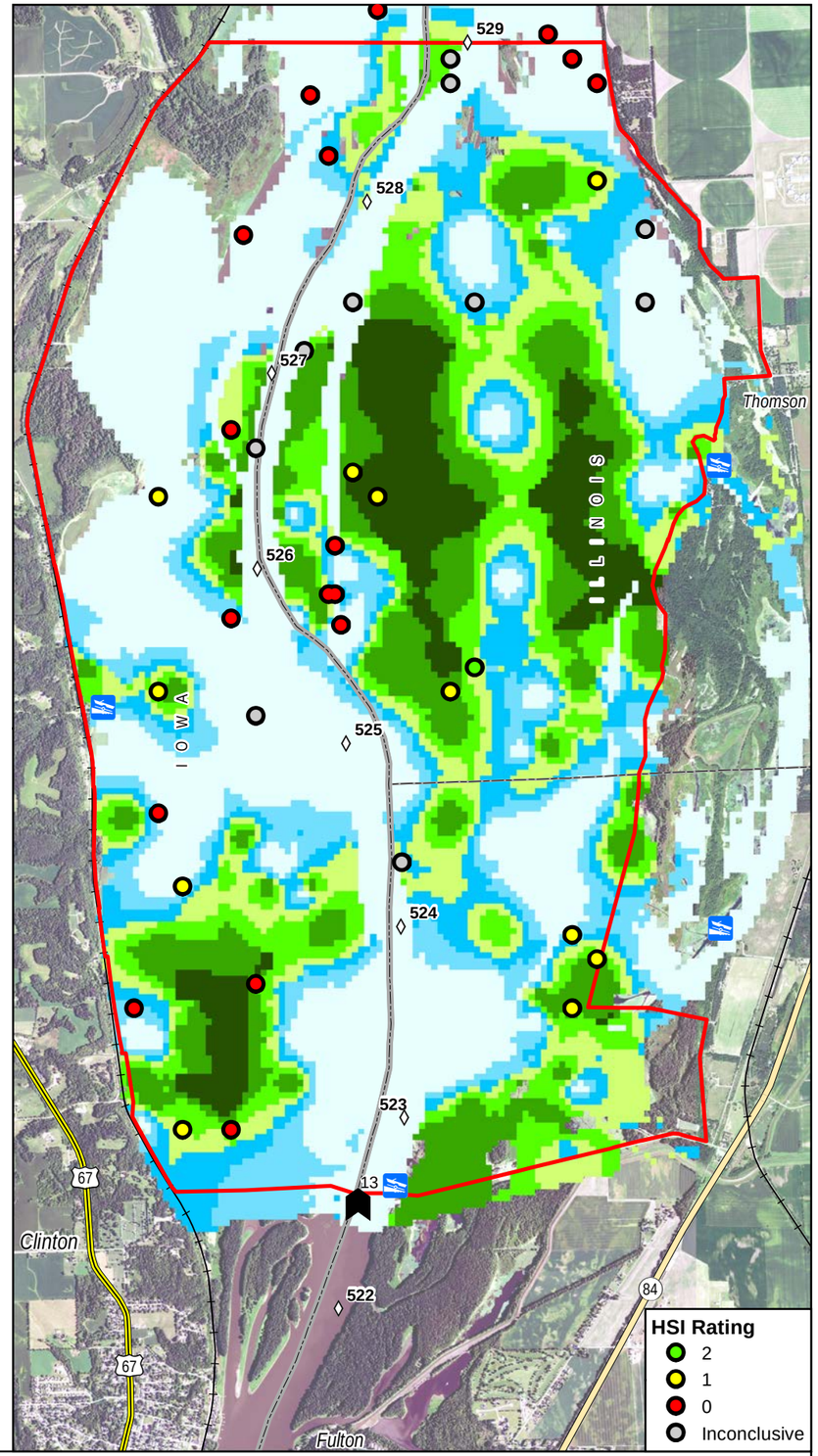
US Army Corps of Engineers
Rock Island District







Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2010
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
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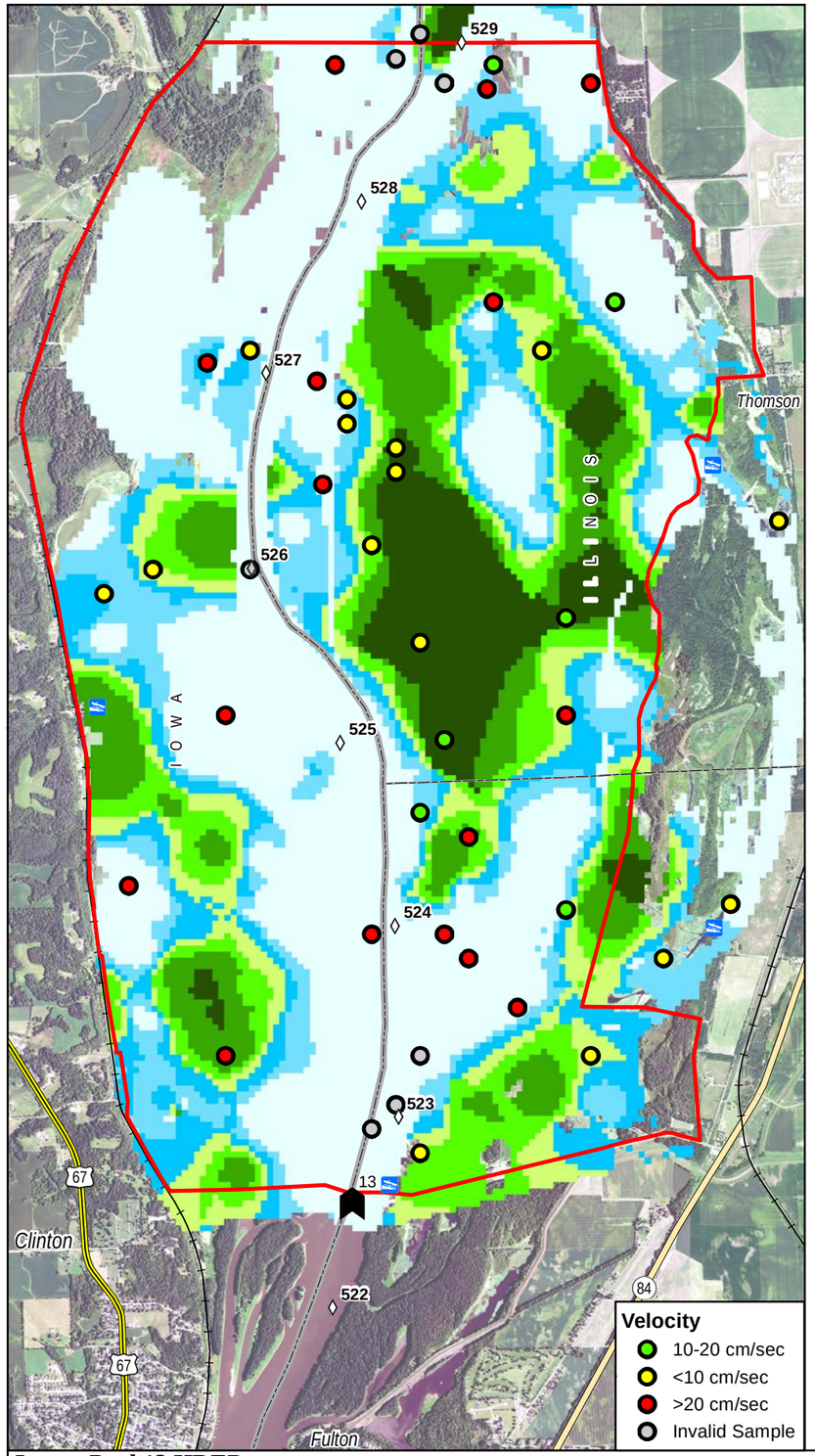
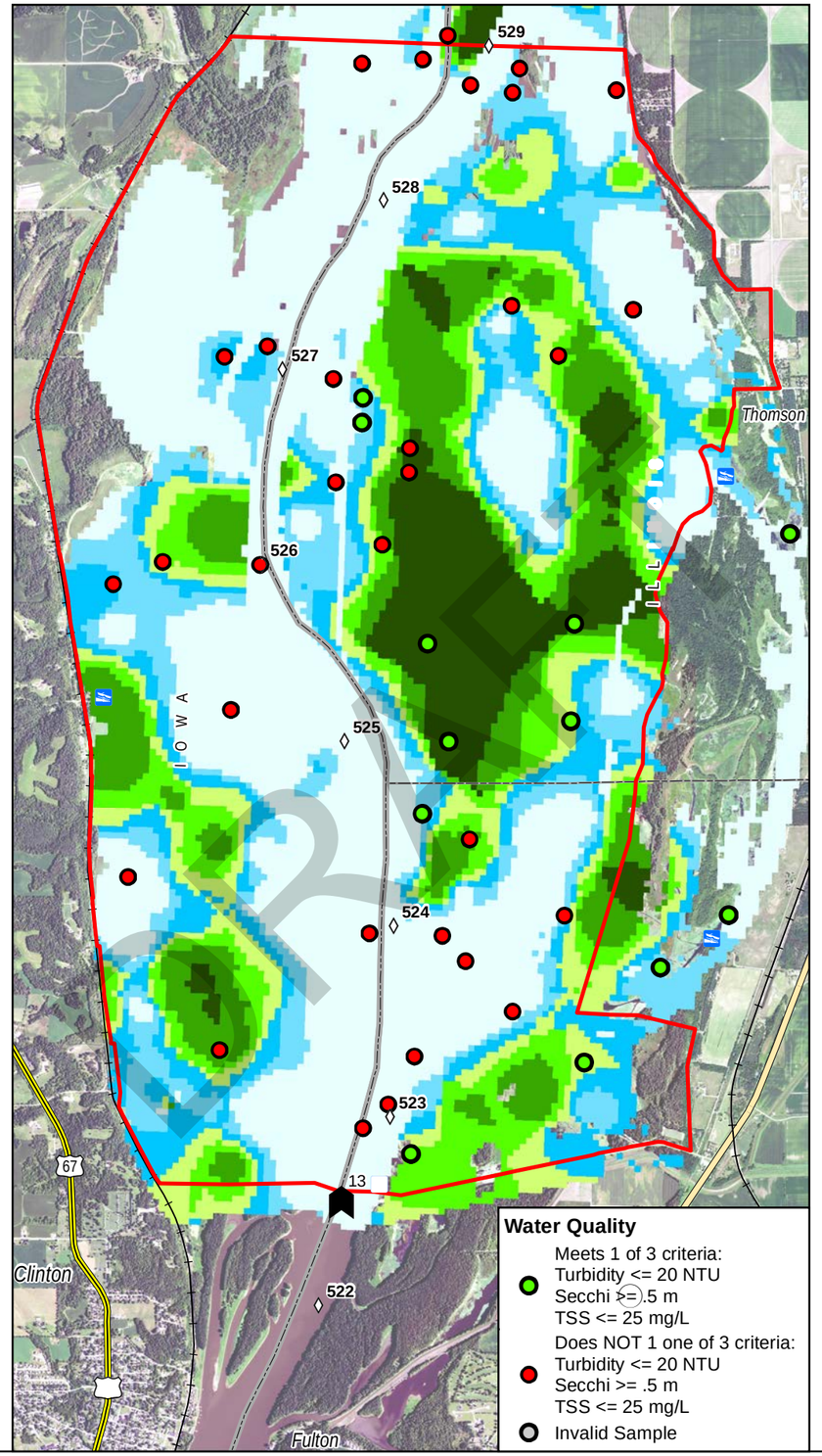
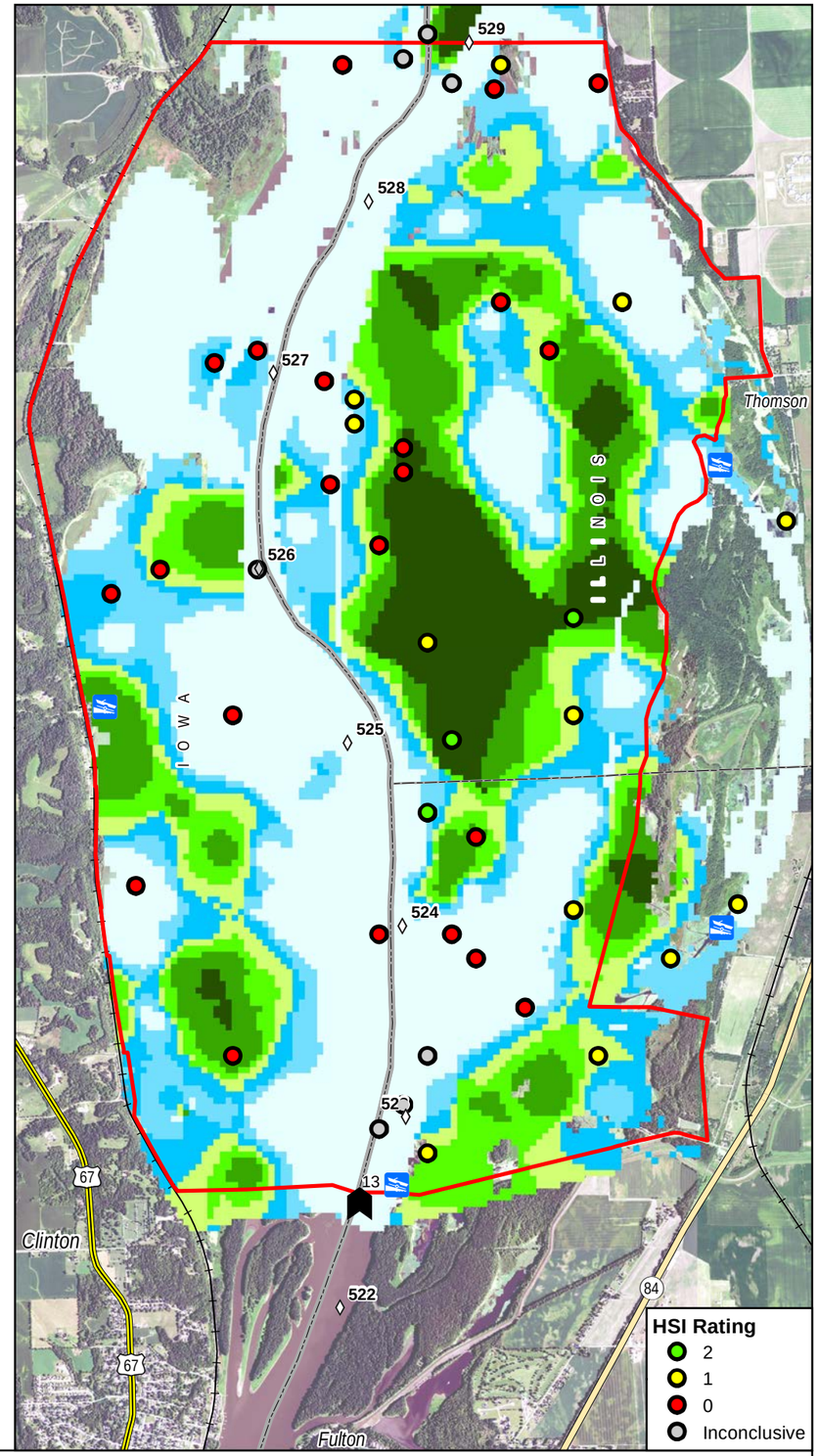
US Army Corps of Engineers
Rock Island District







Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2011
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
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0 Low

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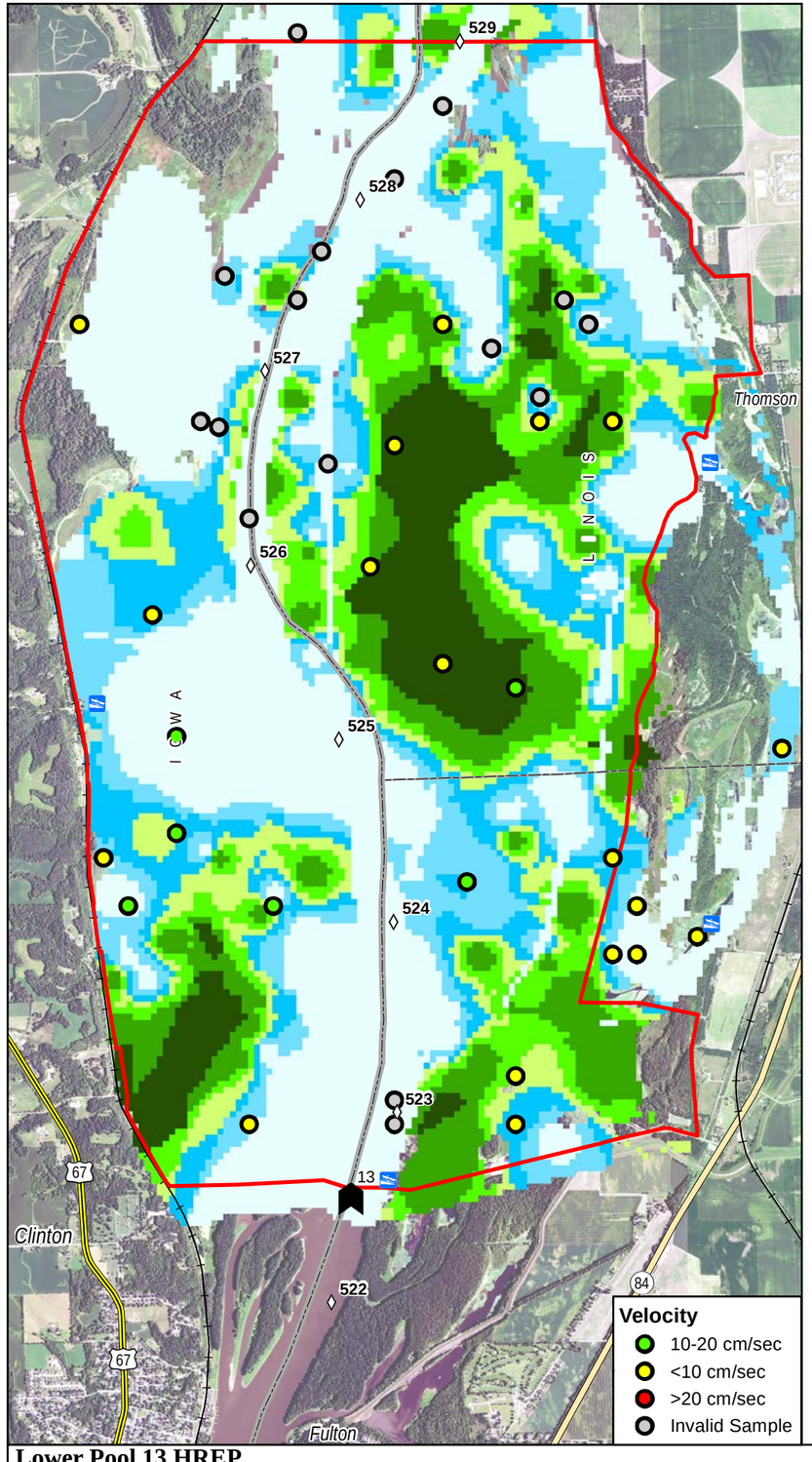
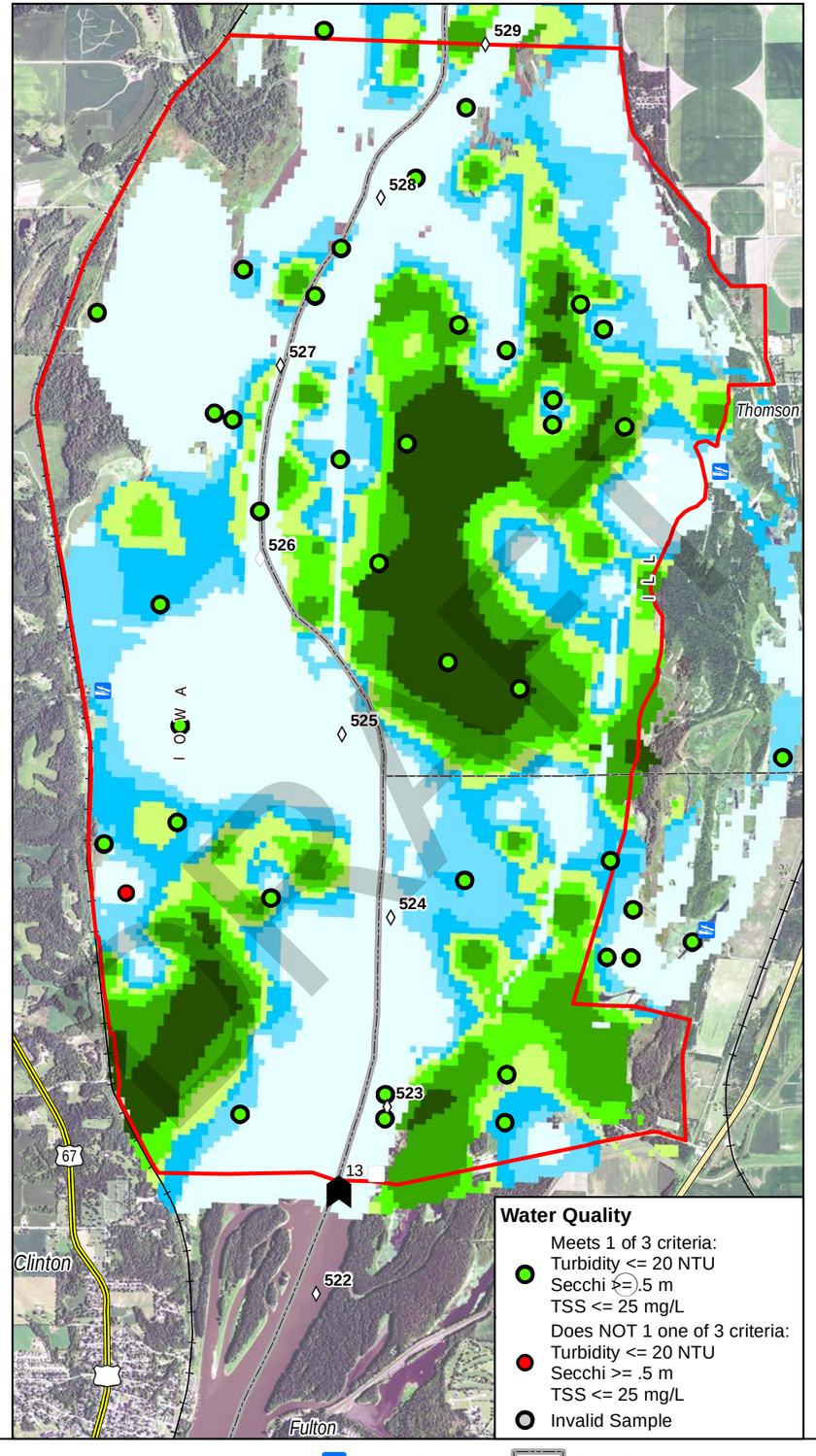
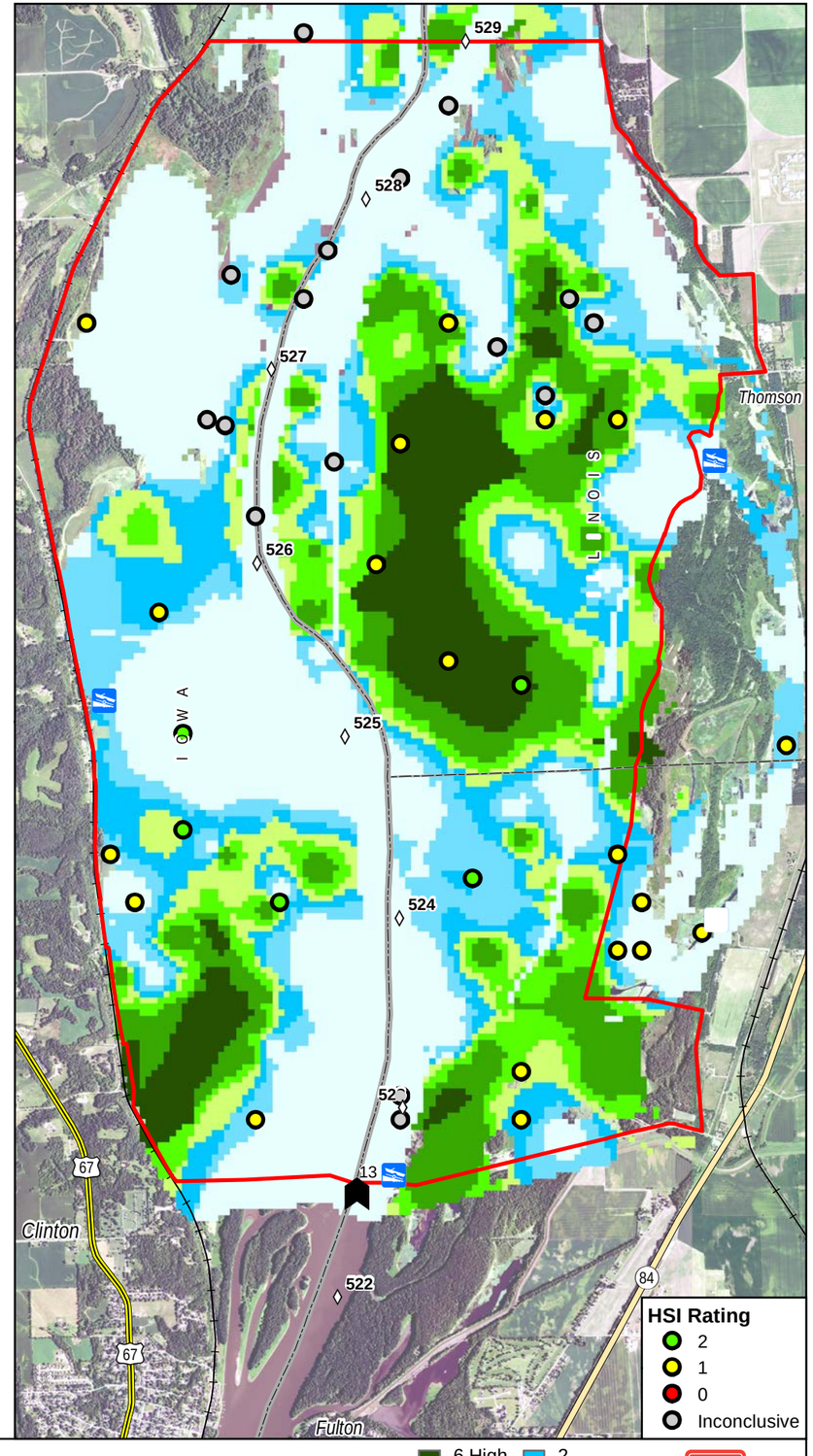
US Army Corps of Engineers
Rock Island District







Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2012
Map Produced: 5/29/2020

US Highways
State Highways
Railroads
Boat Ramps
Lock & Dam 13
River Miles
State Boundary
Project

Relative Probability of Vallisneria
6 High
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US Army Corps of Engineers
Rock Island District

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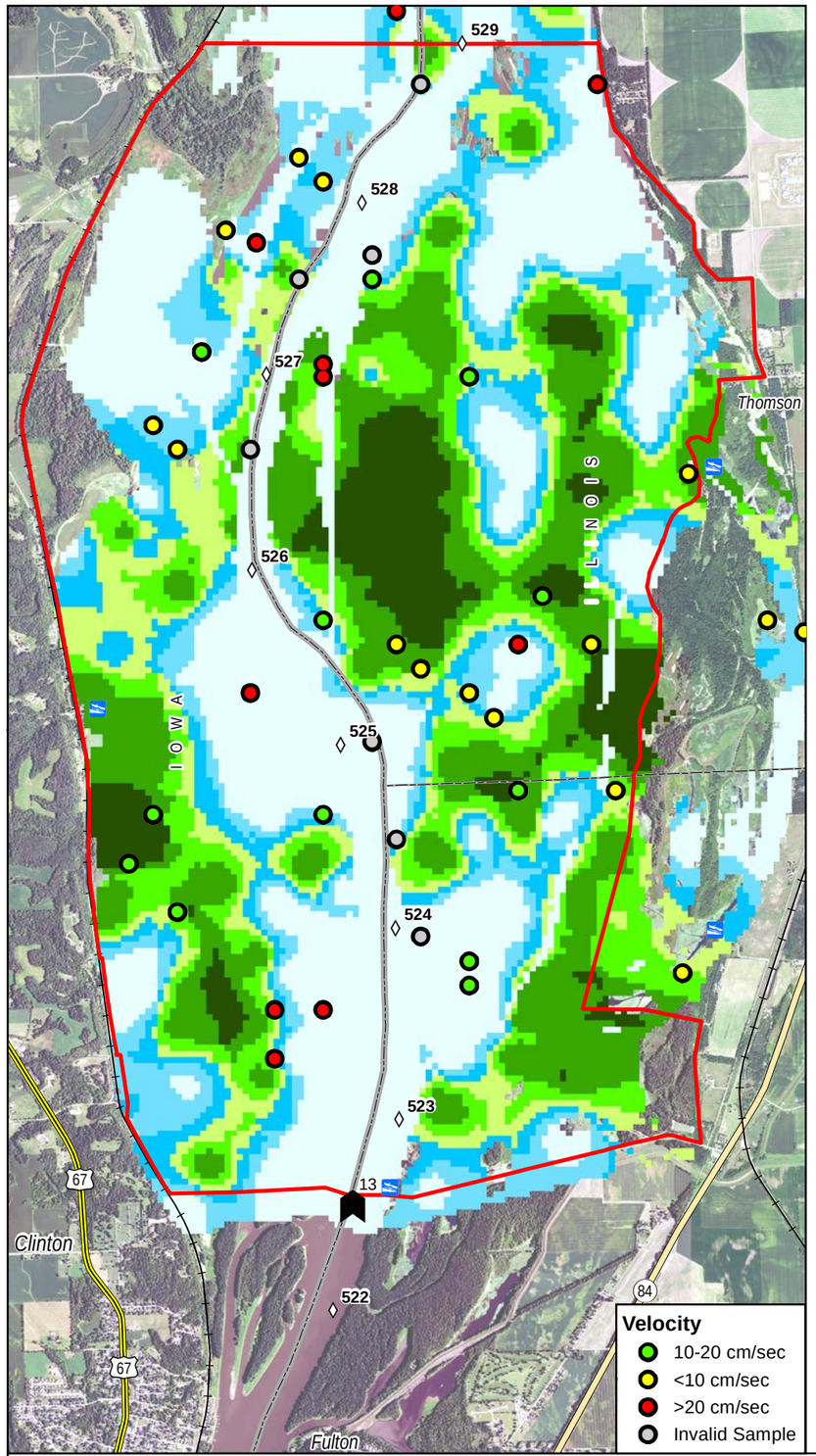

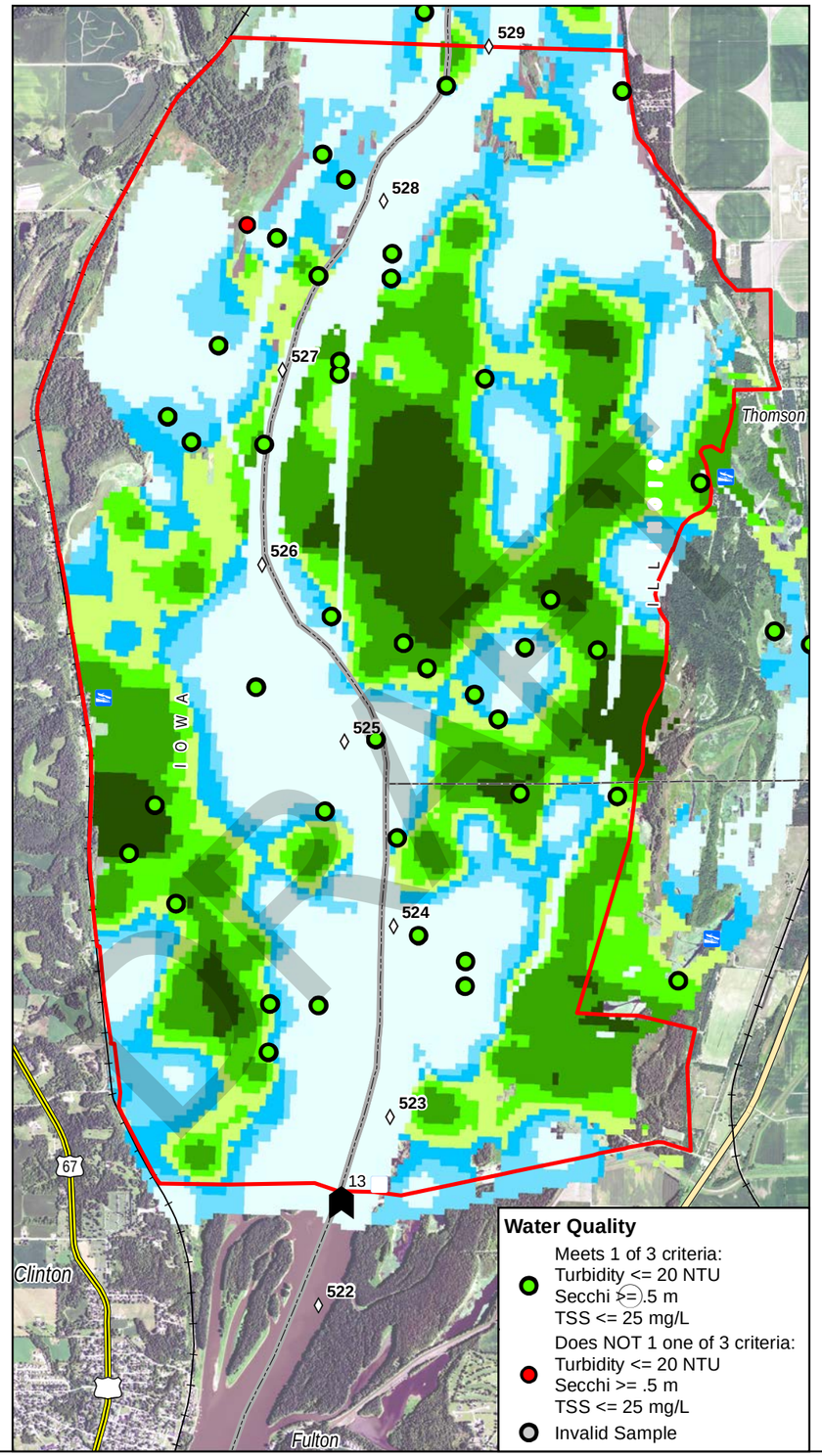

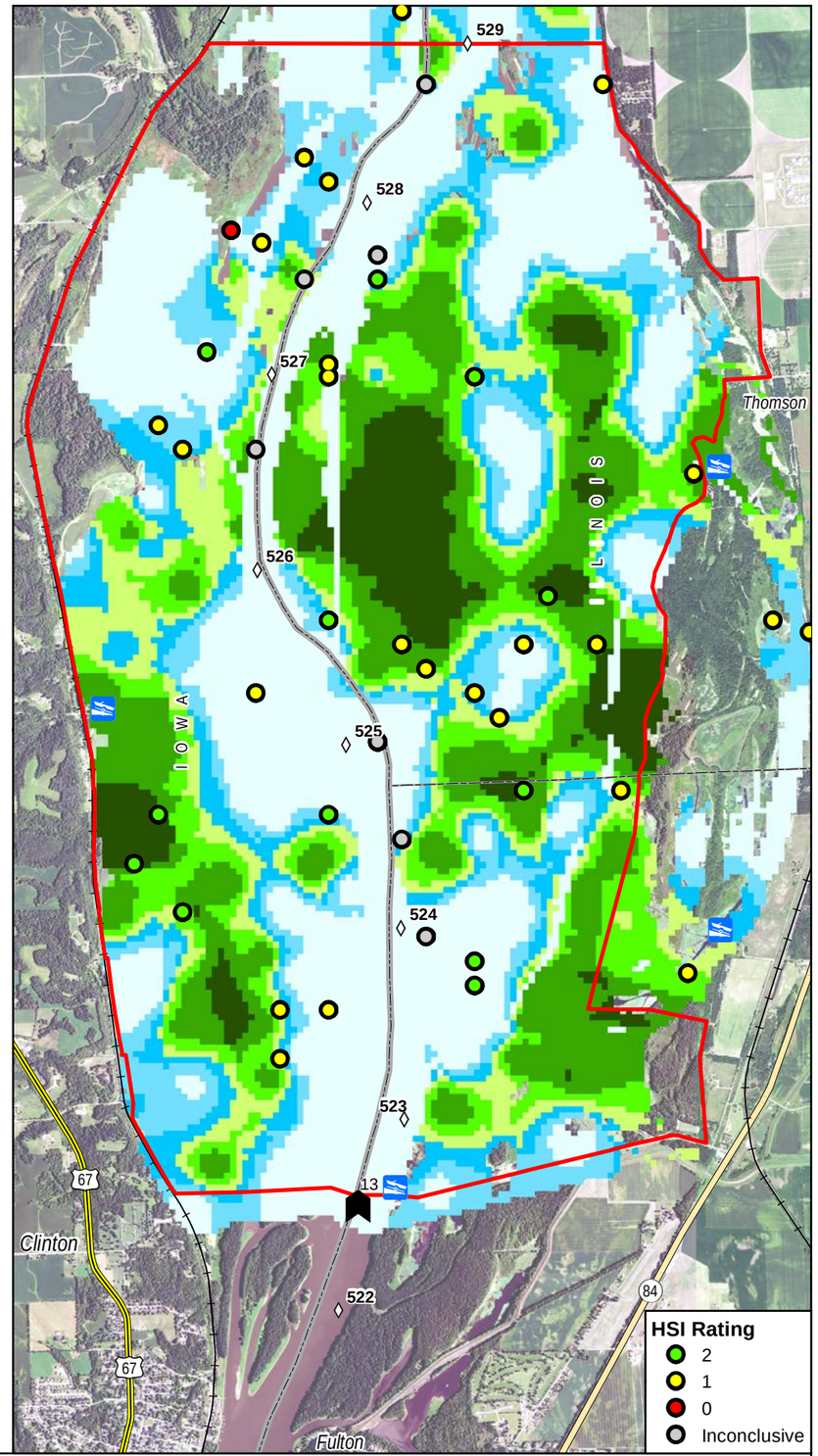

Lower Pool 13 HREP
Optimum Habitat for Vallisneria
LTRM SRS Water Quality July-August 2013
Map Produced: 5/29/2020

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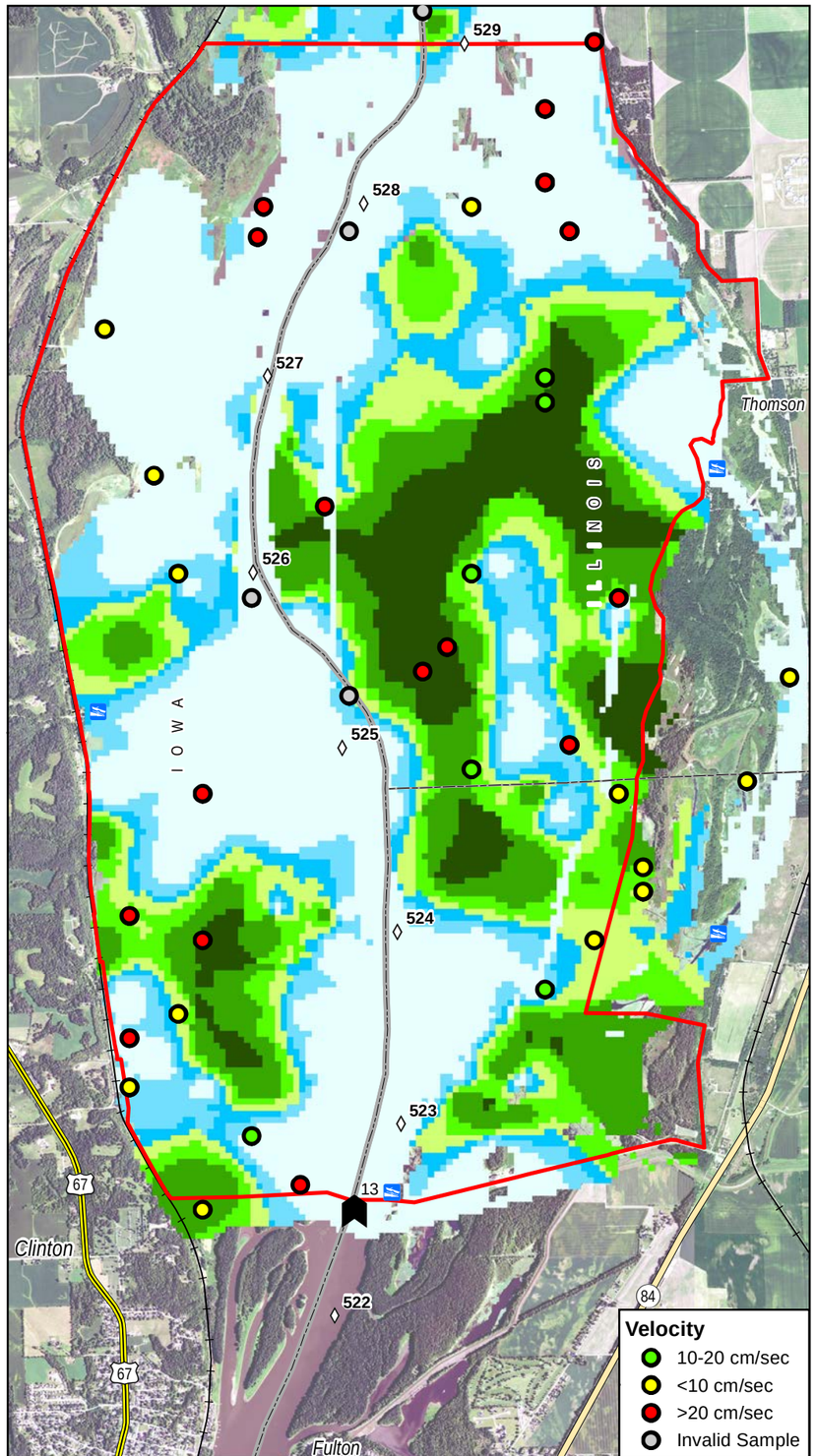

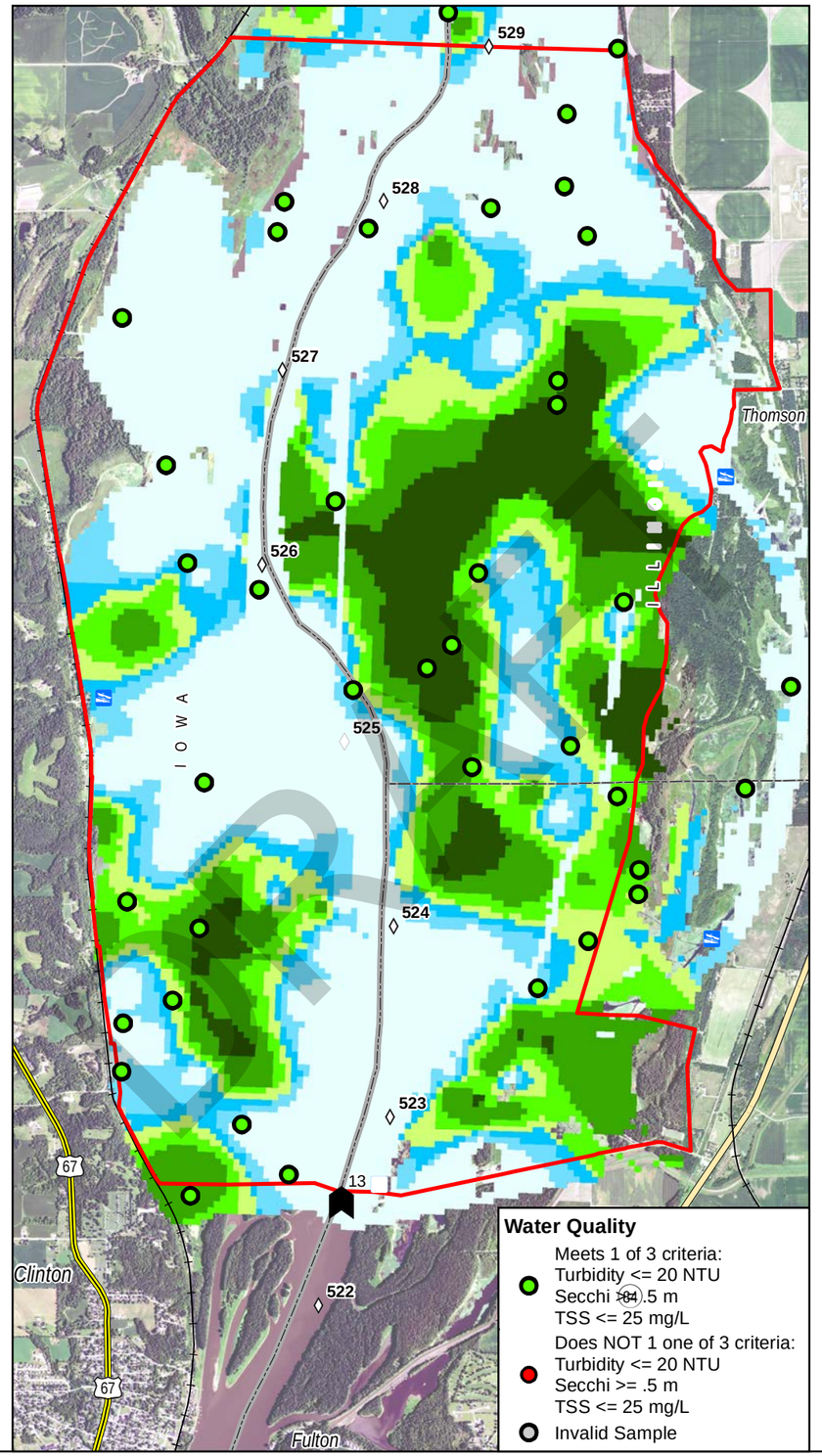

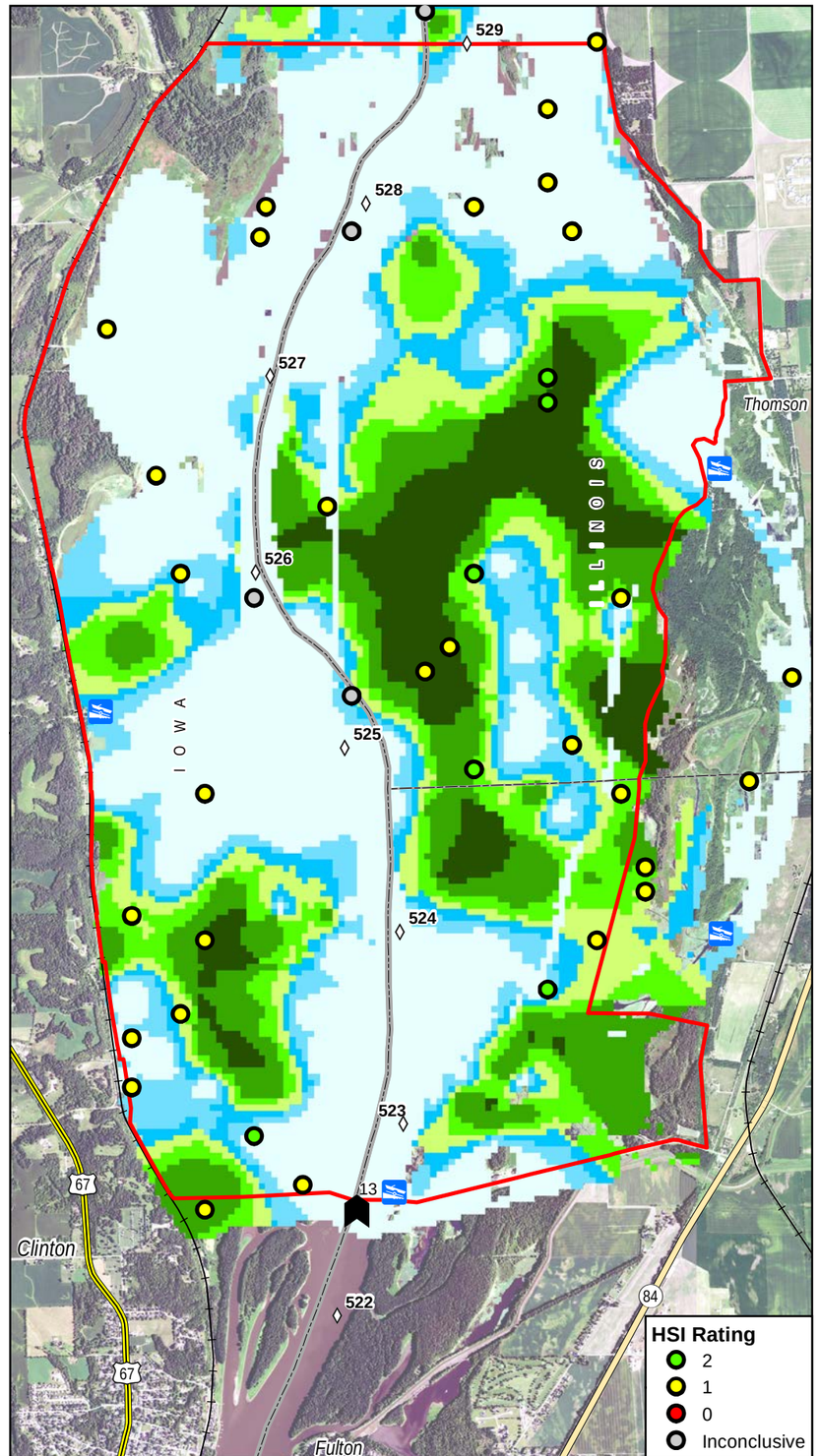

Lower Pool 13 HREP
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LTRM SRS Water Quality July-August 2014
Map Produced: 5/29/2020

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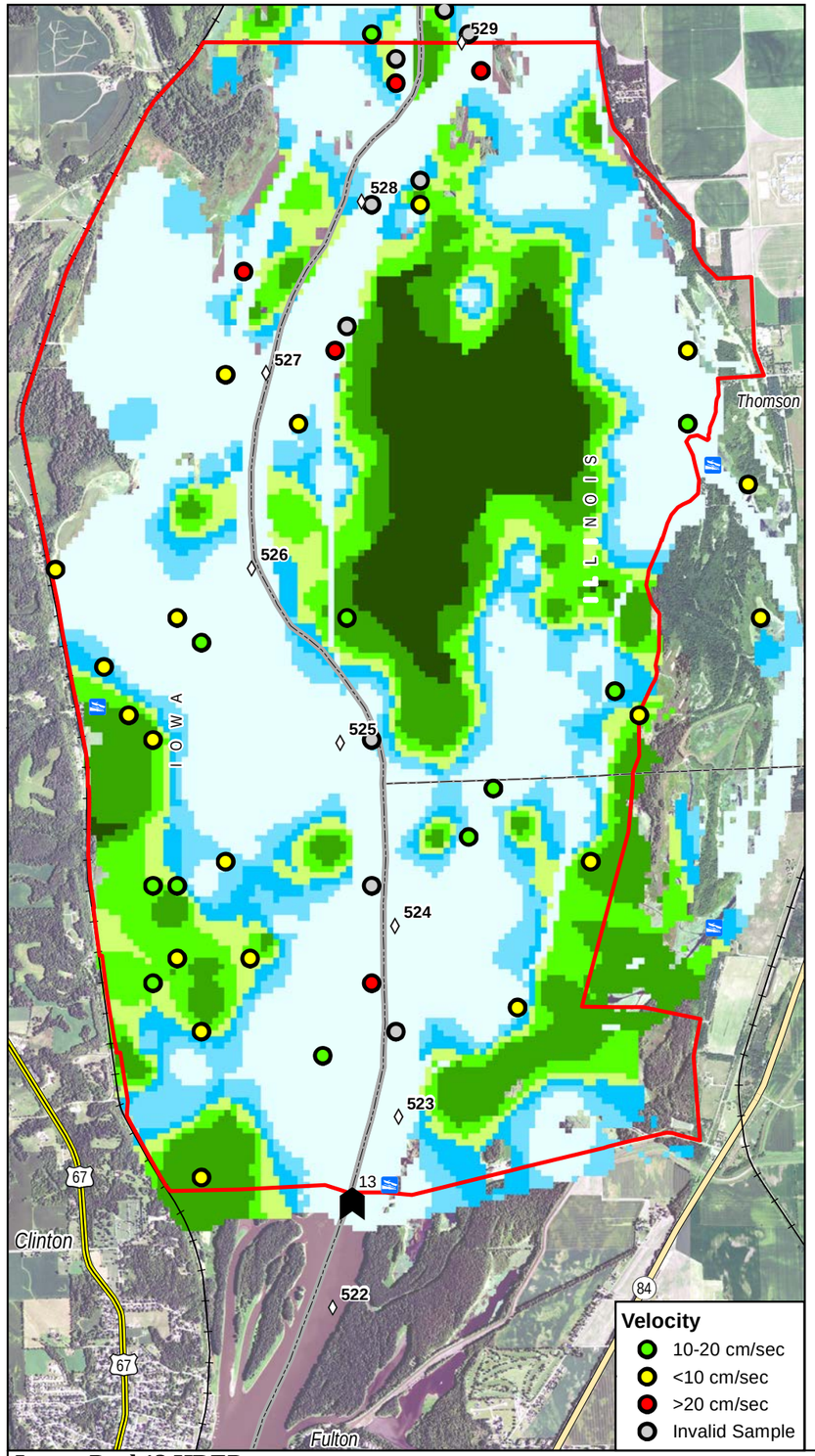

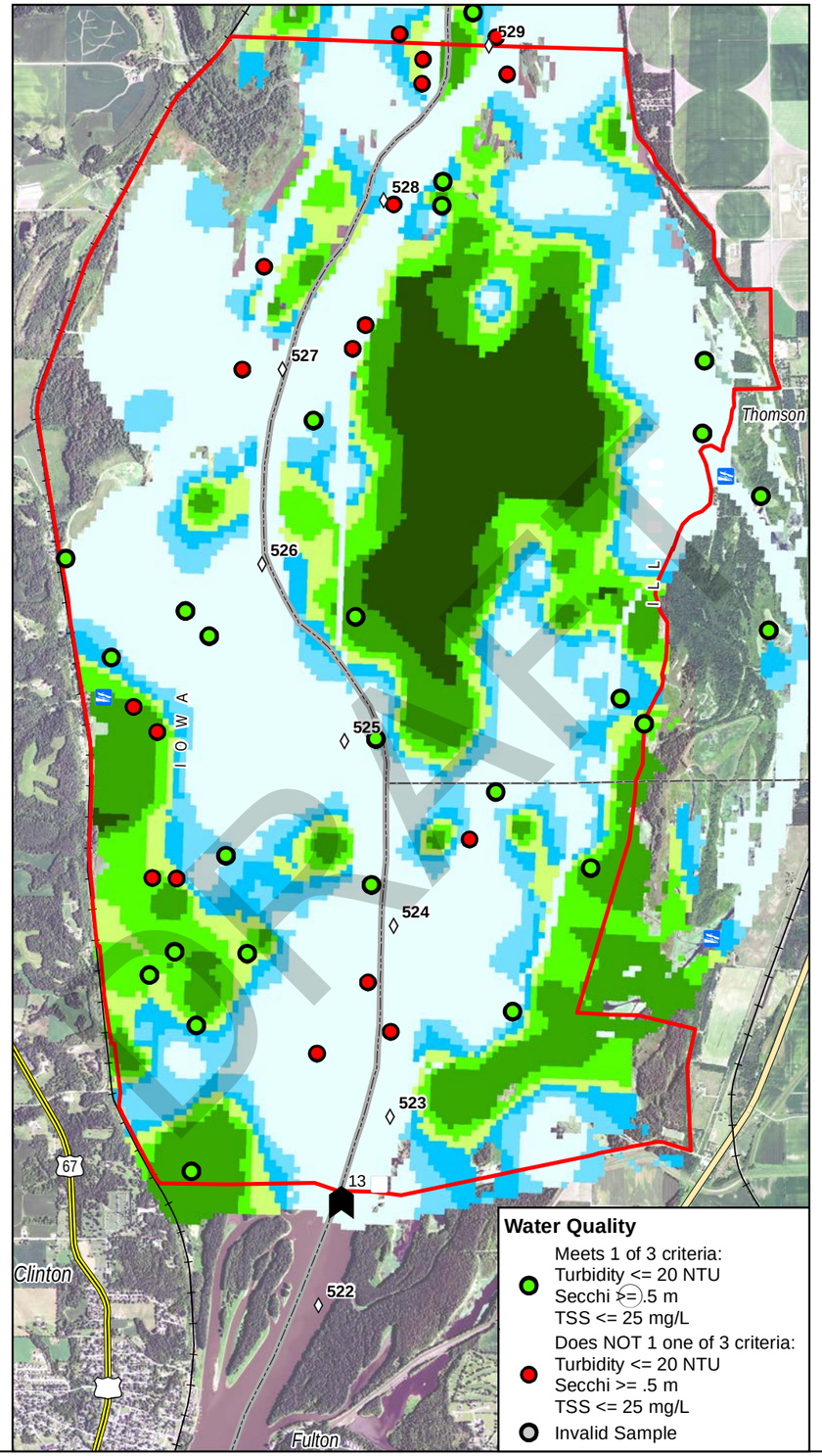

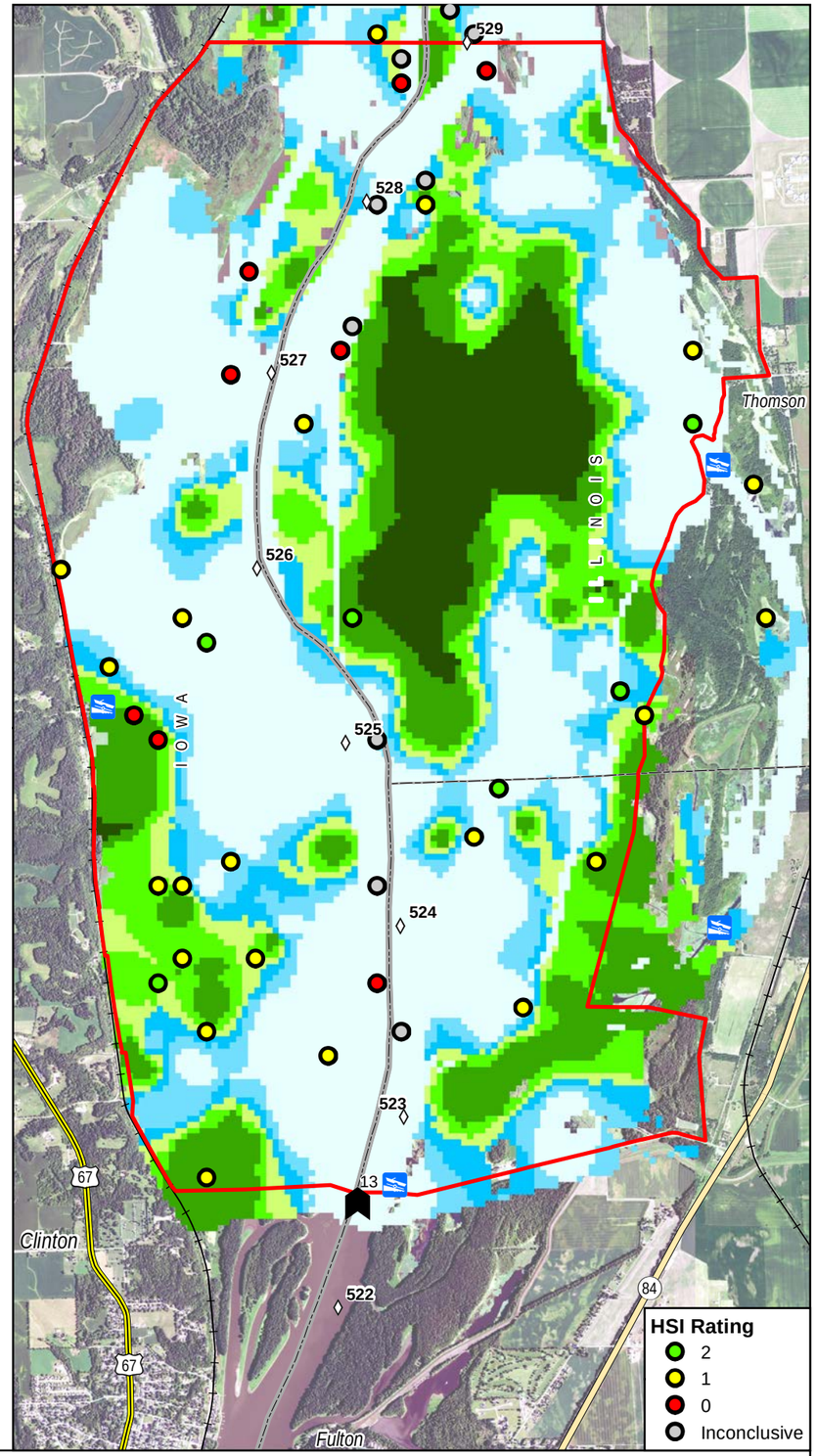

Lower Pool 13 HREP
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LTRM SRS Water Quality July-August 2015
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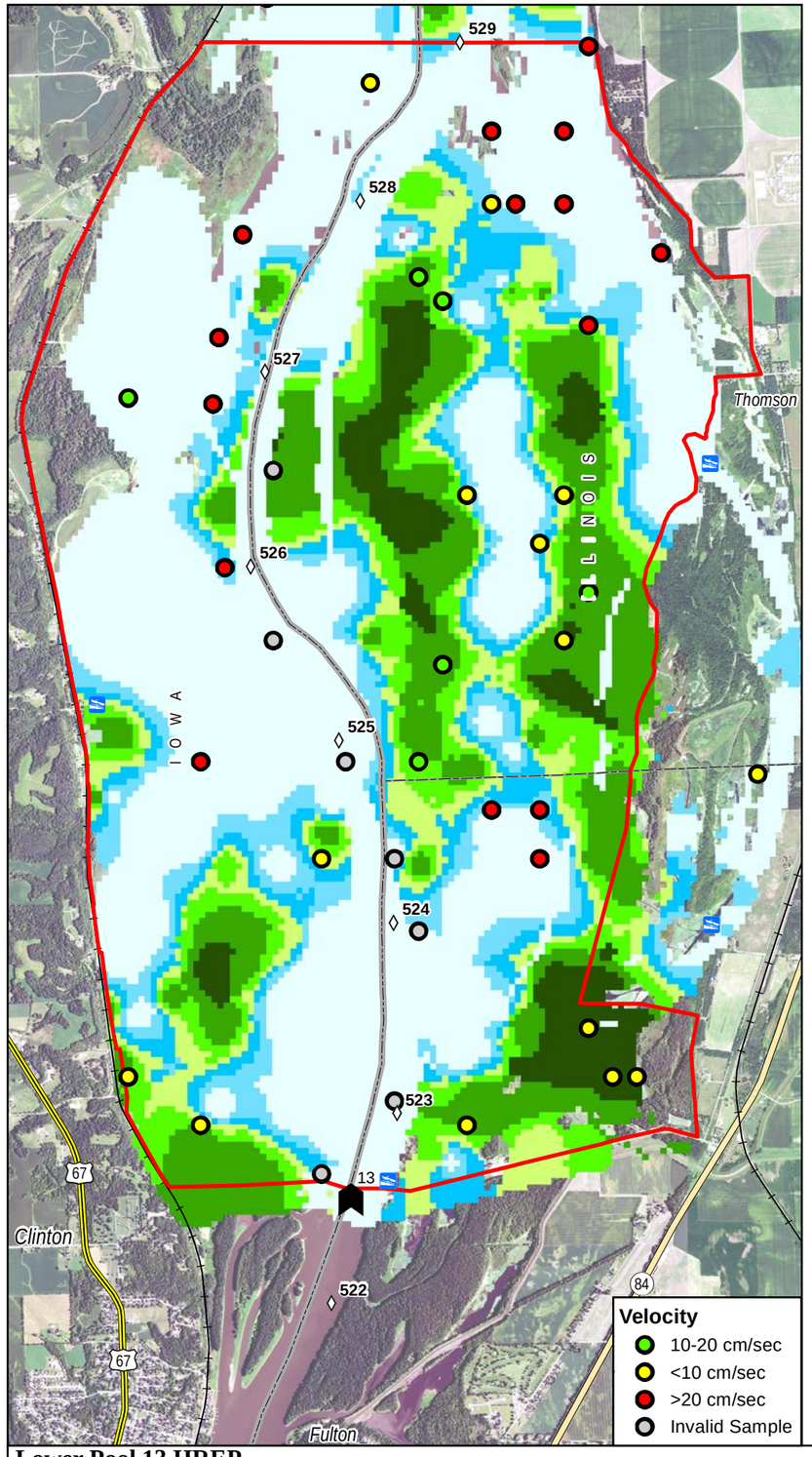

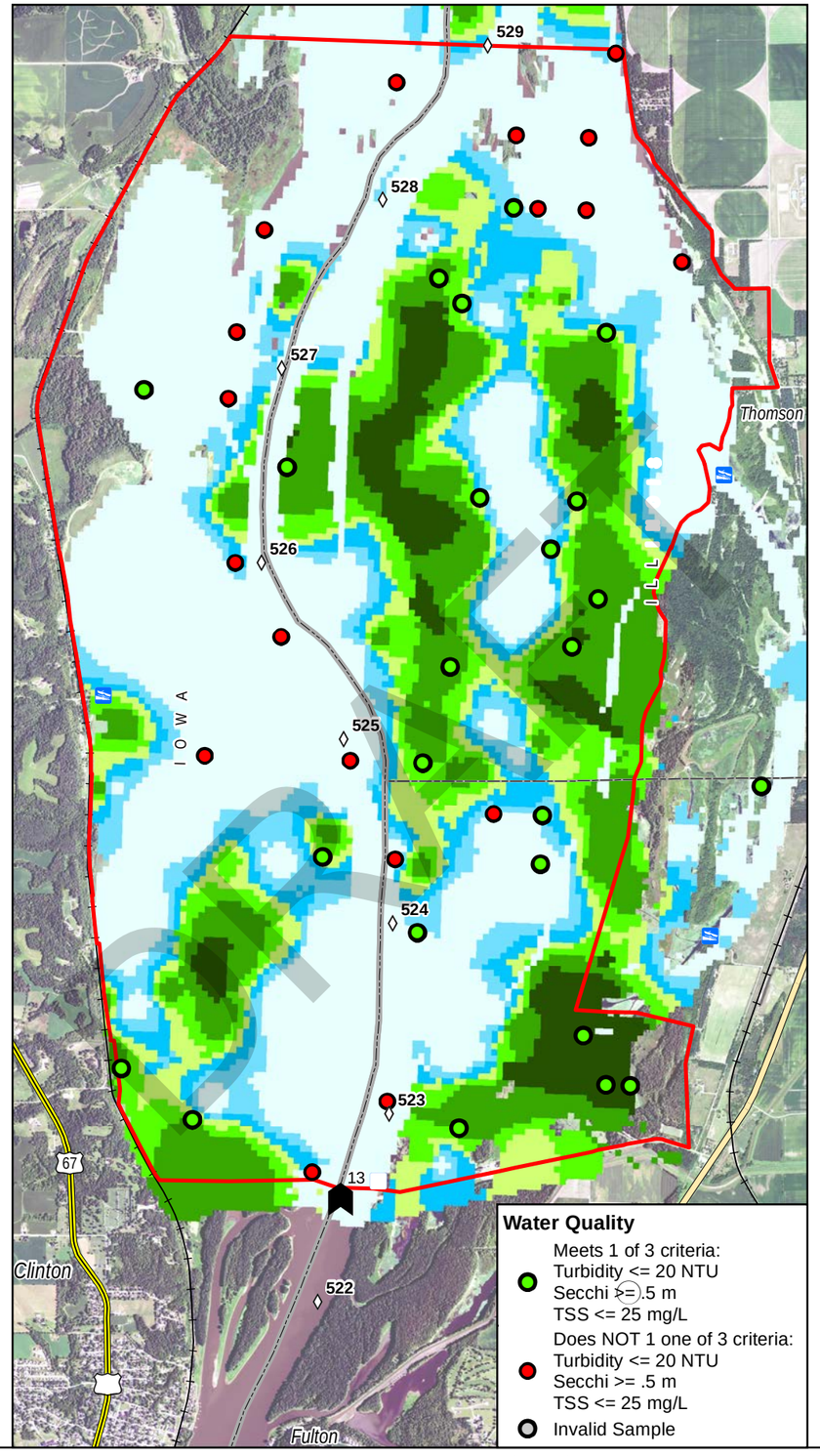

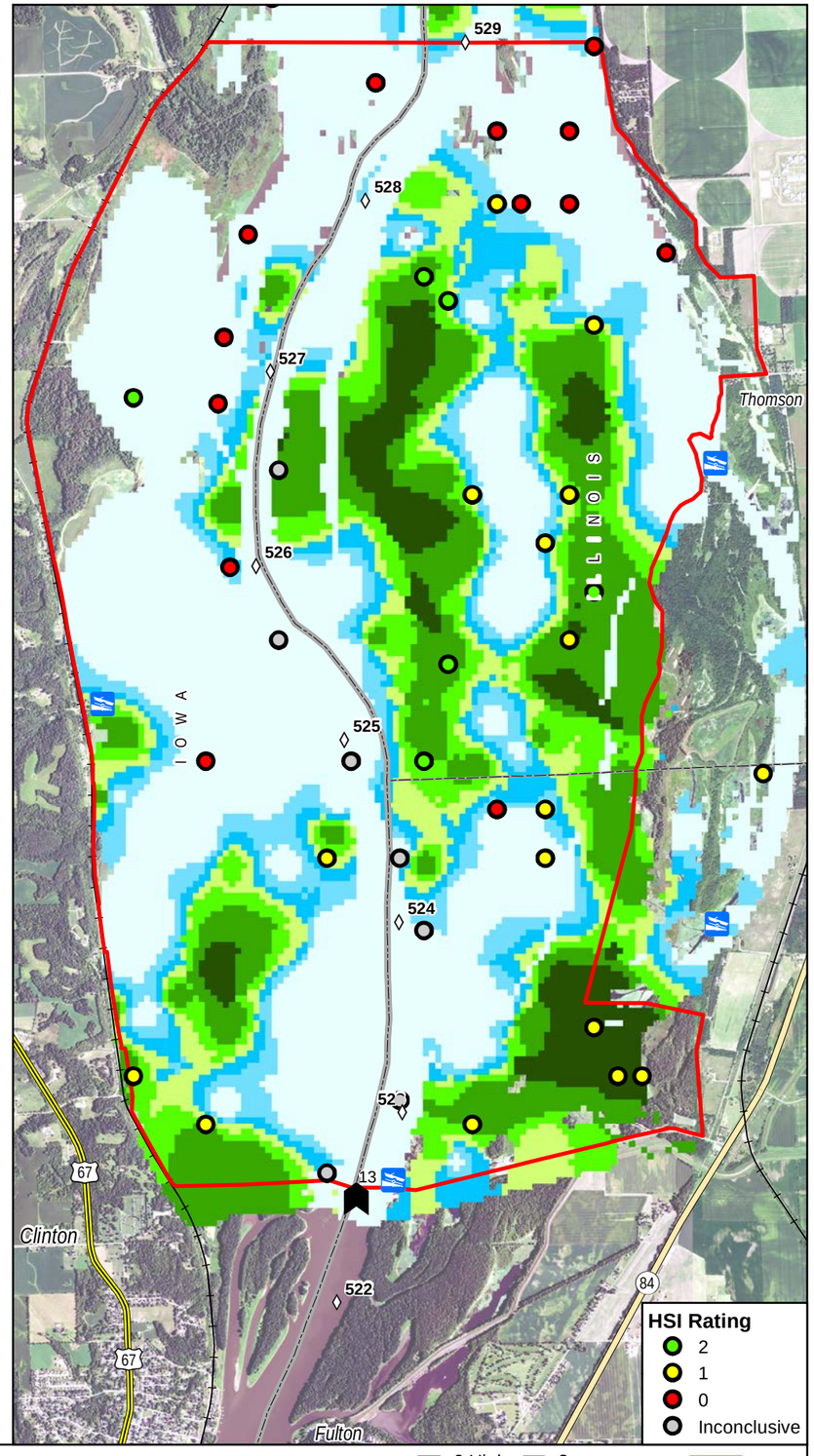

Lower Pool 13 HREP
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LTRM SRS Water Quality July-August 2016
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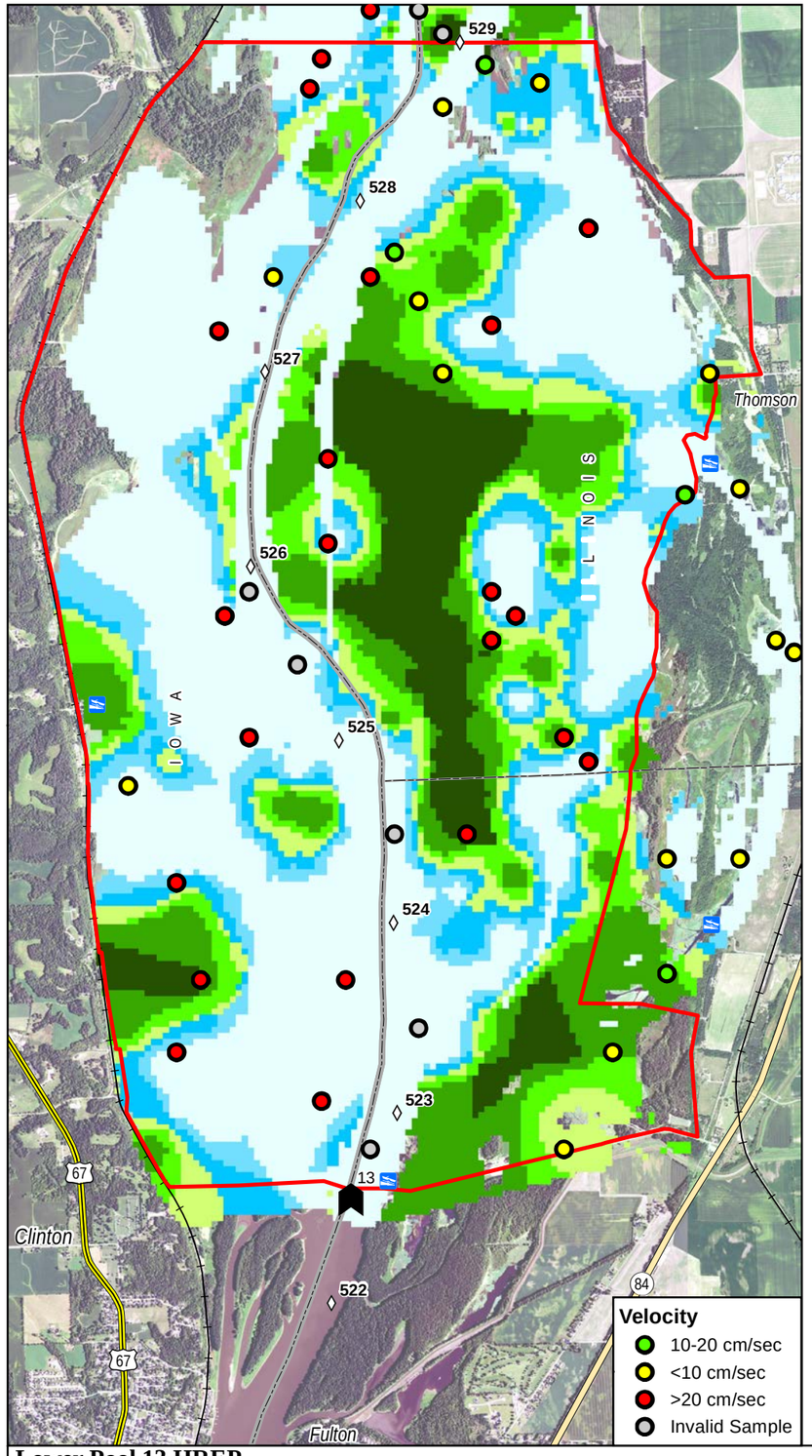

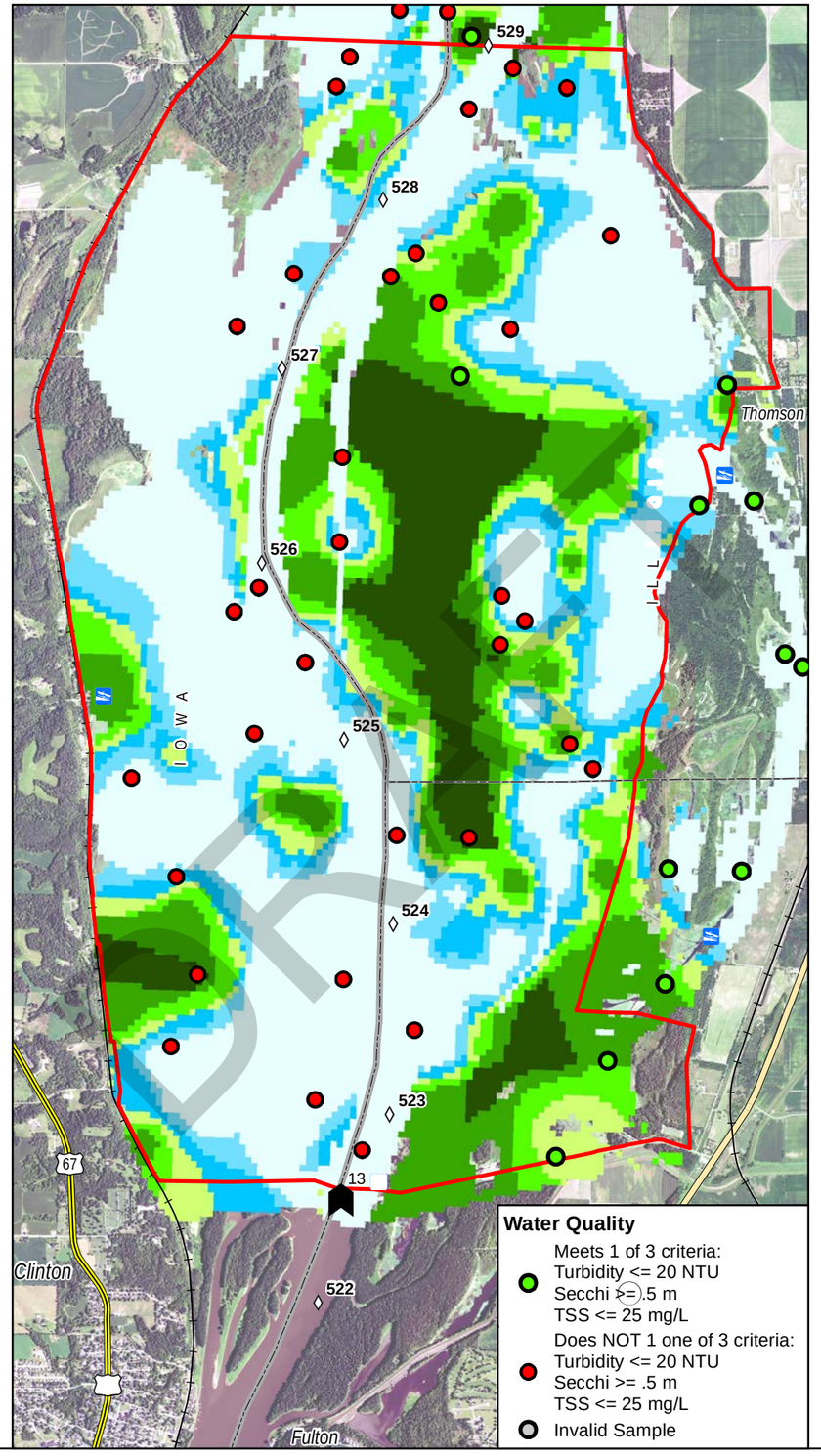

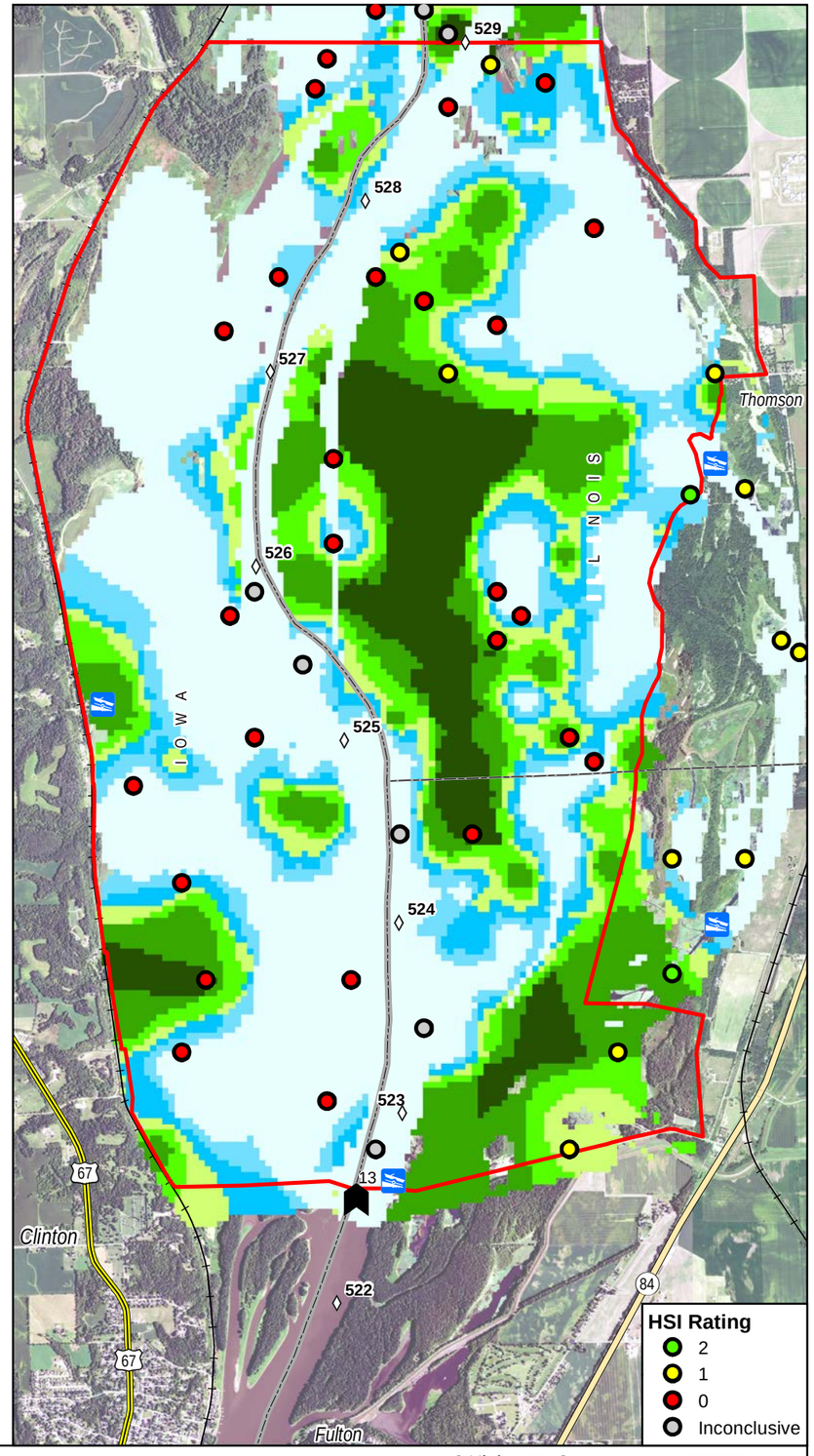

Lower Pool 13 HREP
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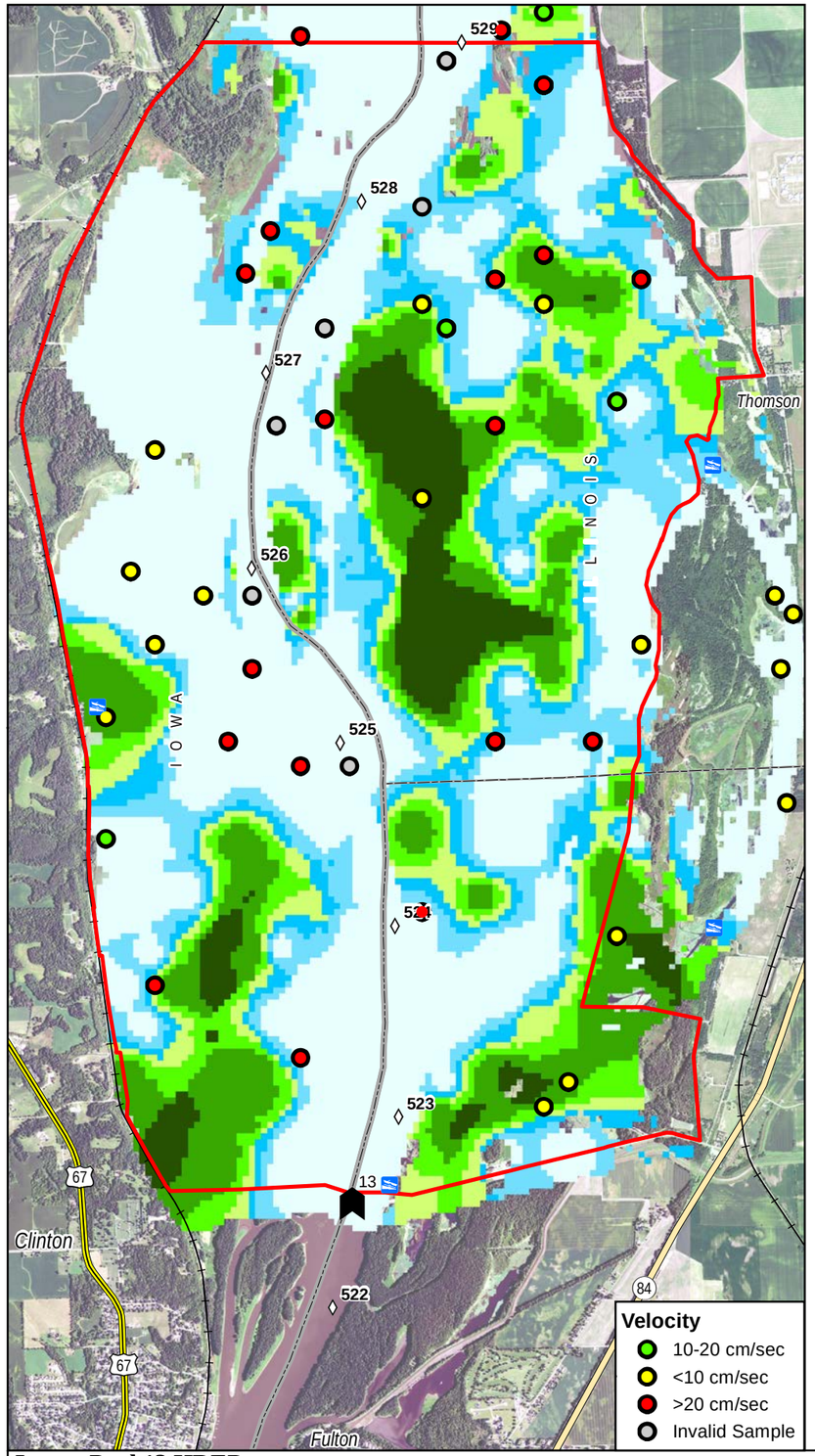

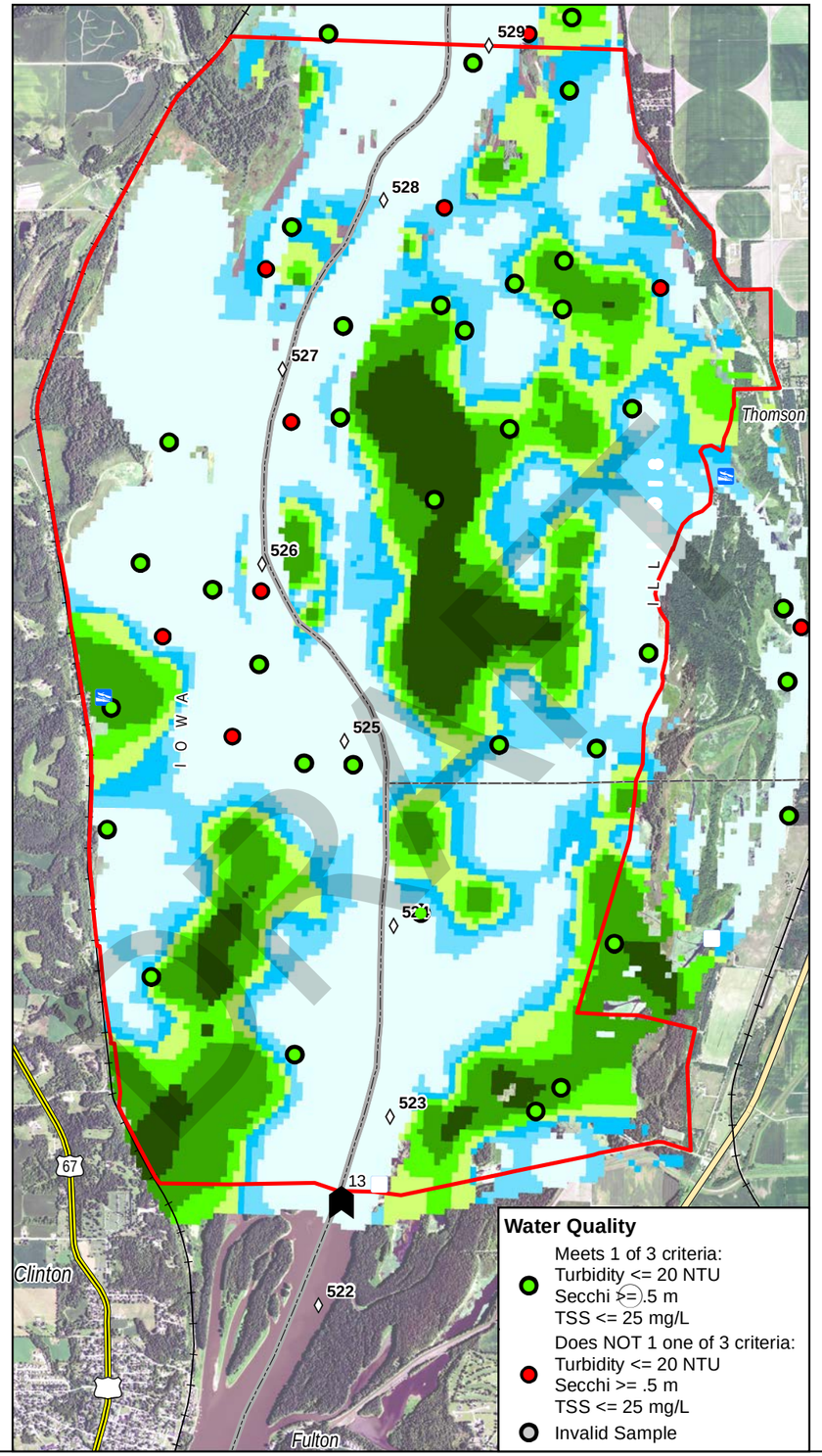

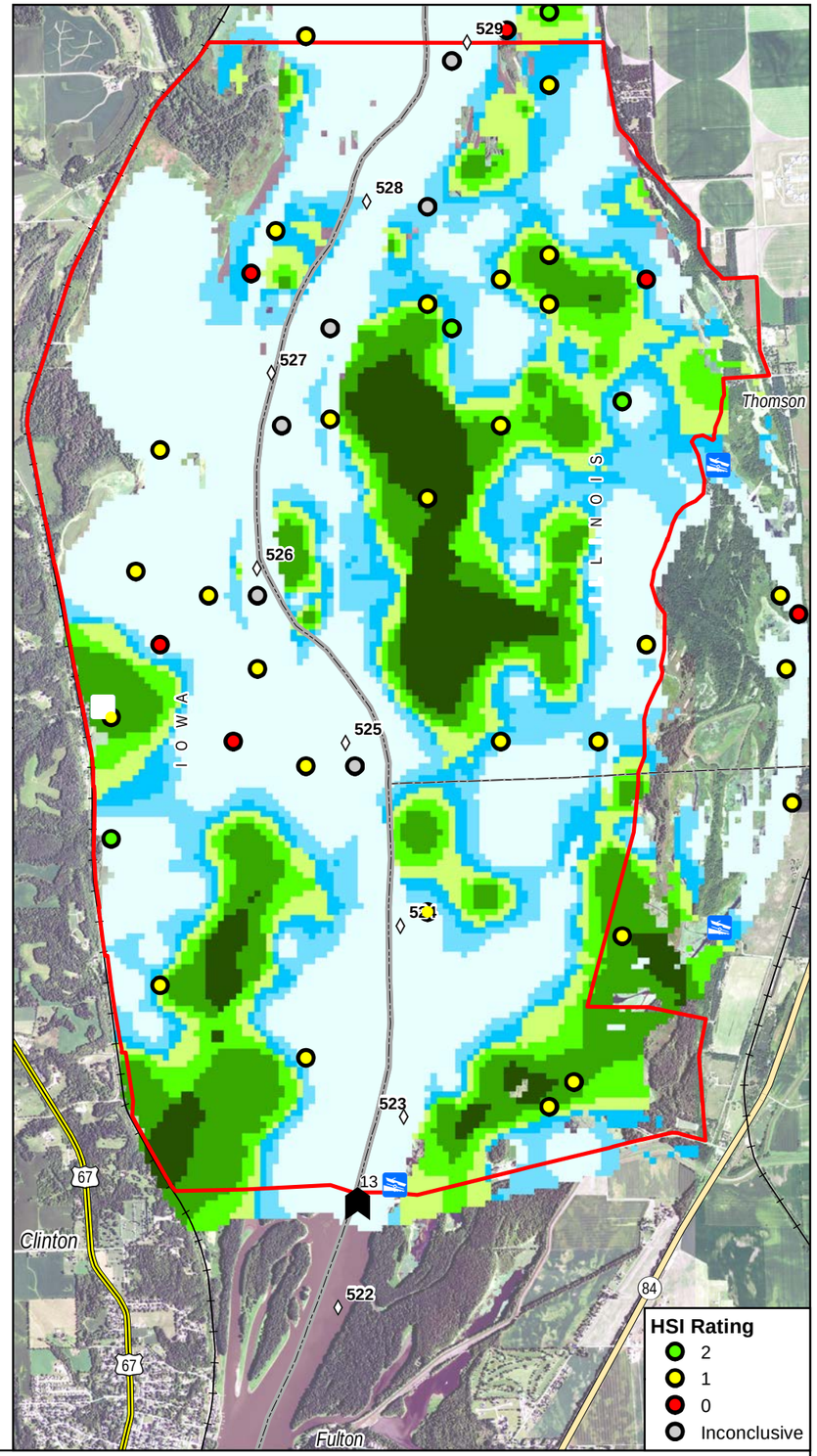

Lower Pool 13 HREP
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US Army Corps of Engineers
Rock Island District

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT C
GEOTECHNICAL

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1. GEOTECHNICAL

1.1 Study Area Geology

Surficial geology consists of Deforest Formation, Quaternary System silty clay loams and clay loams associated with the modern channel of the Mississippi River valley. Bedrock geology consists of Ordovician Age, Galena Group limestones and shales, and Maquoketa Formation shales, dolomites and limestones.

The Beaver Island and Potters Marsh HREPs are near the Study Area and the geotechnical appendices for the Feasibility reports were referenced to inform feasibility level design for this project.

> 1992. Upper Mississippi River Restoration Feasibility Report with Integrated Environmental Assessment – Potters Marsh Habitat Rehabilitation and Enhancement Project: Pool 13, Upper Mississippi River Miles 522.5 and 526, Carroll and Whiteside Counties, IL.
>
> 2018. Upper Mississippi River Restoration Feasibility Report with Integrated Environmental Assessment - Beaver Island Habitat Rehabilitation and Enhancement Project: Pool 14, Upper Mississippi River Miles 513.0 and 517.0, Clinton County, IA.

1.2 Geotechnical Evaluations

Geotechnical evaluations will be completed and the features refined during design.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
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APPENDIX E
ENGINEERING

ATTACHMENT D
WATER QUALITY

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APPENDIX E
ENGINEERING APPENDIX

ATTACHMENT D
WATER QUALITY

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1. PURPOSE

Several data sources are available to examine water quality in the study area. The purpose of this appendix is to evaluate the results from water quality monitoring performed by Rock Island District (District) personnel and others at potential environmental enhancement sites located within the *Lower Pool 13 Habitat Rehabilitation and Enhancement Project*. Water quality monitoring done by the District was performed with the primary objective of defining pre-Project baseline water quality conditions. Data gathered by others supports broader monitoring objectives, but the results provide additional insight into the existing water quality conditions in the study area.

2. INTRODUCTION

The UMRR Program's Long Term Resource Monitoring (LTRM) element monitors the status and trends of the UMRS's natural resources. Pool 13 is considered an LTRM "trend pool" for data acquisition and analysis. In support of LTRM efforts, the IADNR has collected discrete water quality data in Pool 13 through Fixed Site Sampling (FSS) since 1988 and in 1993 began Stratified Random Sampling (SRS). There is only 1 active FSS site in the study area, site W-M525.5L. Results of LTRM monitoring are discussed in chapter 2 of the main report.

Project-specific baseline water quality monitoring was initiated by the PDT in order to determine pre-Project conditions and assist with selecting and locating measures and/or alternatives for habitat rehabilitation and enhancement. This monitoring also supports future evaluation of the Project related to the goal of restoring and protecting off-channel aquatic and wetland habitat. Of particular importance is an increase in aquatic habitat diversity and providing the water quality characteristics critical for enhancing the diversity and population of desirable species within the project area.

The PDT initiated baseline water quality monitoring at the Project on December 12, 2018, at site W-M526.6D (Figure D-1). Monitoring at this site continued consistently each summer and winter season through 2021. Site W-M525.5L was added on May 29, 2019 and was monitored every summer season through 2021. Site W-M525.1G was added on June 2, 2021 and only had one full summer season of monitoring. Baseline monitoring continued through September 28, 2021, for all sites with eight samples collected during the summer months and three samples during the winter months.

Site W-M526.6D was initially chosen as a representative pre-Project monitoring location because the Project fact sheet identified the Gomers Lake backwaters and the area north of Bulgers Hollow boat ramp of Lower Pool 13 as likely areas to restore depth diversity and pursue seasonal water level variation. During the feasibility phase, site W-M525.5L was added to monitor conditions in the "shadow" areas downstream of the islands that provide flow diversity and protection for the large submerged aquatic vegetation (SAV) beds on the eastern side of the pool. In addition, W-M525.5L is a LTRM fixed site in which historical data is available. Lastly, site W-M525.1G was added in feasibility as the project became more focused on the Southwest corner of Lower Pool 13. This area of the project is a wide-open area with long wind fetch lengths and little flow diversity. Proposed features in this area include rock structures in open areas of the water to break up wind-wave action and reduce velocities that may be inhibiting SAV establishment and growth.

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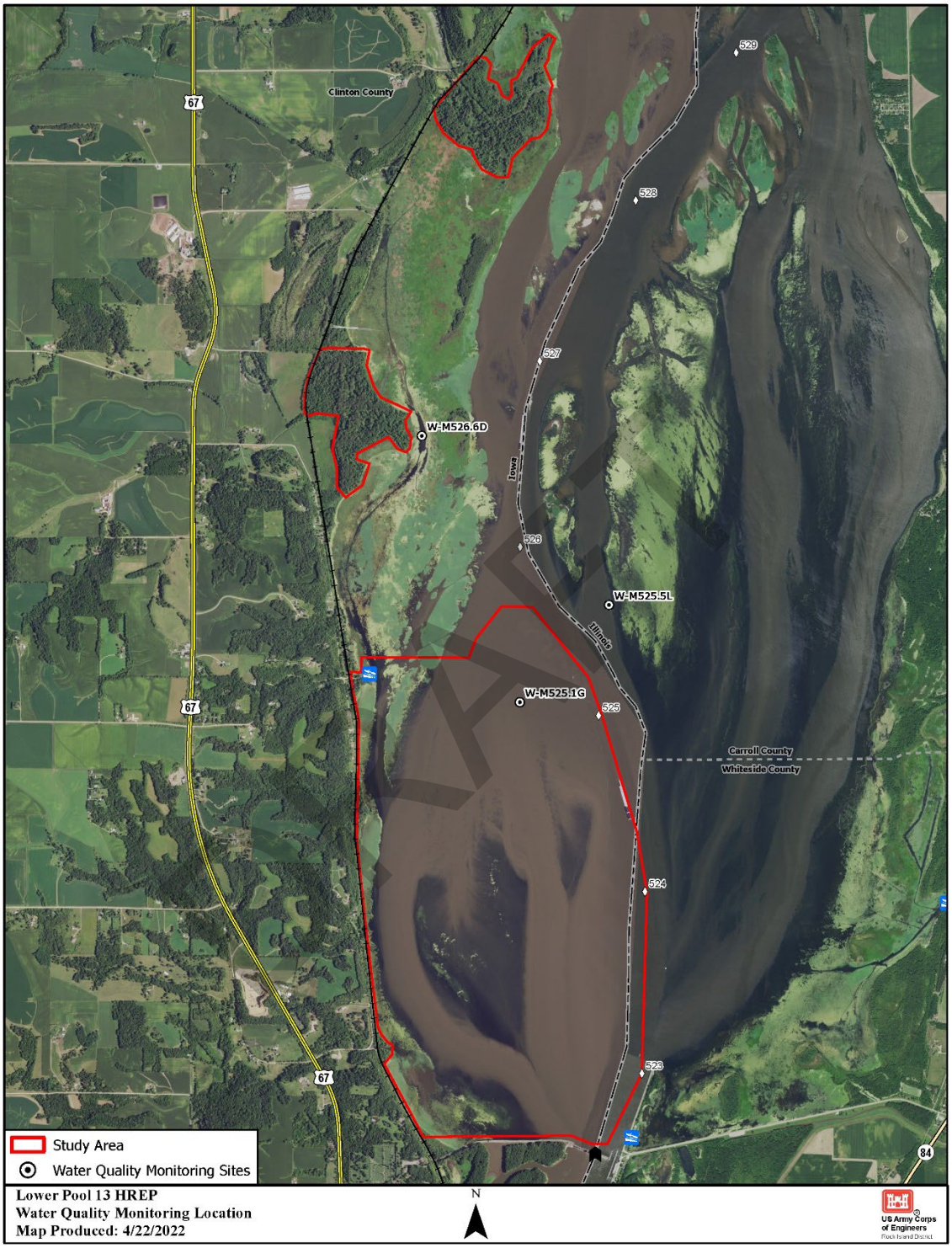

Figure D-1. Project Water Quality Monitoring Location

3. METHODS

Baseline water quality monitoring was accomplished by the PDT through a combination of collecting grab (discrete) water samples and deploying continuous monitors (sondes). Eight grab samples were collected during the summer months, and two or three grab samples were collected during the winter months at each site, each year. In general, sampling date, time, water depth, water transparency via Secchi disk depth, water velocity, wave height, air temperature, percent cloud cover, wind speed and direction, pH, water temperature, DO, and specific conductance were recorded in the field. During the summer months, a water sample was collected just below the surface at each sampling site. The sample was placed on ice and shipped to ARDL, Inc., Mt. Vernon, Illinois for total suspended solids (TSS) and chlorophyll analyses. Water grab samples were collected for turbidity as measured in Nephelometric Turbidity Units (NTU)[1] and alkalinity analyses, which were performed by the Rock Island District Water Quality Laboratory. Sample collection/preservation and field/laboratory analytical procedures were performed according to USEPA approved methods. In addition to the manually collected data, YSI EXO2 multi-parameter water quality sondes were deployed on numerous occasions. Typically, the sondes were suspended 1 to 2 feet from the river bottom and were programmed to record the following data every 2 hours: DO, pH, water temperature, depth, specific conductance, and turbidity as measured in Formazin Nephelometric Units (FNU)[1]. Beginning in the summer 2021 season, sampling frequency was increased to 15 minutes for summer deployments and to one hour for the winter deployments. Summer deployments typically lasted 2 to 4 weeks, while in the winter the sondes were deployed for approximately 6 to 14 weeks.

4. RESULTS AND DISCUSSION

In general, site W-M526.6D exhibits more lake-like (lentic) characteristics than the more riverine (lotic) sites W-M525.5L and W-M525.1G. The lentic site typically exhibits lower water velocity and has better water clarity as reflected in measurements of Secchi disk depth, turbidity, and total suspended solids. These differences, along with others, are described below in detail for each of the three project water quality monitoring sites. Minimum, maximum, average, and median statistics for several grab sample parameters at each site are displayed for the summer and winter seasons in Tables D-1, D-2, and D-3. Continuous monitoring data statistics can be found in Table D-4.

4.1. Site W-M526.6D

Table D-1 shows the results from surface grab sample monitoring at site W-M526.6D. The water quality monitoring data for this site spans the longest of all monitoring sites in Pool 13 covering consecutively three winter and three summer sampling seasons. In addition to grab samples each winter season, a sonde was also deployed to collect continuous monitoring data. Grab samples were taken at each site visit during the winter season (beginning, middle, and end) to confirm accurate data collection. For each summer season, no sondes were deployed at site W-M526.6D, but grab samples were collected approximately every other week.

1 Due to differences in sensor type, sonde turbidity readings are reported in FNU and turbidity grab samples analyzed with a turbidimeter are reported in NTU. For the purposes of this evaluation, it was assumed that 1FNU = 1 NTU.

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Generally, DO concentrations above the target level of 5 mg/L were observed during each winter season, including the entire winter 2019-2020 season (Figure D-3). However, it is to be noted that continuous monitoring observed a short period of time dropping below the target 5 mg/L in the winter 2018-2019 season (Figure D-2) and an additional extended drop below 5 mg/L in the 2020-2021 winter season (Figure D-4) lasting nearly the entire month of February. The 2020-2021 drop in DO lasted from January 31, 2021, until February 25, 2021 with the lowest DO concentration of 0.87 mg/L being observed on February 22, 2021. Looking closer at other parameters monitored during this timeframe, there was a similar drop recorded in pH and temperature values. In addition to this, the grab sample data for all parameters aligned with the sonde data which likely rules out any equipment malfunction (Figure D-4). Field conditions on February 3, 2021 were observed to have had approximately 4 cm of snow and 36 cm of ice covering the water. With thick ice and snow cover limiting the water surface's access to sunlight, this could impact the levels of DO as the process of photosynthesis of organisms within the water is limited. The average winter water temperature recorded was 1.6°C and the average depth measured was 1.25 m. Velocities ranged from 1.40 cm/sec to 47.60 cm/sec with an average of 10.76 cm/sec.

While winter monitoring is the main objective for site W-M526.6D, summer grab sample data was also collected for reference. Table D-1 shows these results from the 2019, 2020, and 2021 summer seasons. This site is the most isolated from the effects of the main channel and is the most heavily vegetated site. It was common to see DO concentrations fall below the target level concentration of 5 mg/L during the summer seasons, and this drop also seemed to correlate with when lower velocity values observed bringing in less oxygenated water. The maximum DO concentration was 8.61 mg/L on June 22, 2021, and the minimum DO concentration was 0.39 mg/L on September 8, 2021. When looking at all three summer seasons compiled, this produced an average DO of 3.22 mg/L. Velocity ranged from 0 cm/sec to 48.84 cm/sec with a mean value of 6.98 cm/sec. The isolated nature of this site was also shown in measurements reflective of water clarity—Secchi disk depth, turbidity and total suspended solids. The summer median value for Secchi disk depth (81.0 cm) was the highest of all five sites, while turbidity (4.25 NTU) and total suspended solids (9.60 mg/L) median values were the lowest. The maximum Secchi disk depth here was an exceptional 140.0 cm, which was equal to the water depth, on August 4, 2020.

4.2. Site W-M525.5L

Site W-M525.5L was monitored for three consecutive summer seasons starting in 2019. The 2019 and 2020 summer seasons had continuous monitoring sondes deployed and recorded data every 2 hours alongside grab samples taken every two weeks to confirm validity of the continuous monitoring data. The most recent 2021 summer season entailed just grab sample collection every two weeks for the summer season as sondes were needed in higher priority at other HREP projects. Table D-2 shows results from grab sample monitoring at site W-M525.5L throughout all seasons.

The lowest grab sample DO concentration was recorded to be 6.71 mg/L on September 8, 2021, and averaged 8.33 mg/L. Median velocities here were the highest of the three sites at 33.46 cm/sec, while the maximum summer velocity here was 48.00 cm/sec which was recorded on August 18, 2020. In addition to having the highest velocities among the three sites, W-M525.5L also had the lowest secchi disk depths and greatest TSS and turbidity readings. The median recorded secchi disk depth was 44.0 cm, the median recorded TSS value was 33.6 mg/L, and the median recorded turbidity value was 23.4 NTU. Of the three

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sites, W-M525.5L appears to have the poorest water clarity from the current monitoring data available.

Sondes were deployed at Site W-M525.5L during the summers of 2019 and 2020. The grab sample DO concentrations measured during the summer of 2019 were mirrored by the sonde monitoring results as shown in Figure D-5. It is to be noted that there was debris and sand found within the sonde enclosure which probably affected periods of monitoring and is likely the explanation for drops in both DO and pH during the season. Besides these noted drops, majority of DO values were recorded above 5 mg/L fairly consistently. It is also to be noted that the median turbidity value recorded on the sonde was 43.16 FNU and averaged to be 185.69 FNU with a minimum of 13.86 FNU and a maximum of 20144.20 FNU. When graphically represented, these extreme peaks appear to line up fairly well with periods of dropped off DO which likely means there was interference of debris having an influence on turbidity readings to some extent. The summer 2020 sonde deployment shows consistent values of DO, pH, and temperature with expected diurnal fluctuations (Figure D-6). Nearly all DO data recorded (99.6%) was above 5 mg/L with only 0.4% being recorded between 3 and 5 mg/L. In comparison to the 2019 summer monitoring period, the summer 2020 turbidity data recorded appeared to have much more reasonable values and likely much less interference while in the field. The median turbidity value recorded on the sonde was 27.92 FNU and averaged to be 39.04 FNU with a minimum of 11.09 FNU and a maximum of 6321.69 FNU.

4.3. Site W-M525.1G

The last site to exhibit lotic characteristics is W-M525.1G. This site had the shortest monitoring period, with only one season of data collection commencing on June 02, 2021. For the summer 2021 monitoring season, a sonde was deployed here and took readings every 15 minutes and grab samples were taken every 2 weeks throughout the season. Table D-3 displays the results from grab sample monitoring which occurred here. This site is located on the southeast corner of the project and visual observations from aerial imagery suggest fairly turbid waters and disappearing vegetation beds downstream of the site.

When comparing the three monitoring sites within Lower Pool 13, W-M525.1G and the previously discussed site, W-M525.5L, are most similar in terms of attributes and data recorded. Similar to W-M525.5L, W-M525.1G also experienced higher velocities and indications of poorer water clarity conditions, although not as low as W-M525.5L. The median velocity here recorded at 13.22 cm/sec, while the maximum summer velocity here was 28.60 cm/sec which was recorded on June 02, 2021. In addition to having the higher velocities among the three sites, W-M525.1G also experienced lower secchi disk depths and larger TSS and turbidity readings. The median recorded secchi disk depth was 59.0 cm, the median recorded TSS value was 22.6 mg/L, and the median recorded turbidity value was 17.7 NTU. Continuous monitoring indicated stable DO readings that were steadily recorded above 5 mg/L with expected diurnal fluctuations for the summer 2021 season (Figure D-7). The median turbidity value recorded on the sonde was 14.12 FNU and averaged to be 16.69 FNU with a minimum of 0.0 FNU and a peak maximum of 240.72 FNU.

4.4. Light-Related Criteria Necessary to Support Submersed Aquatic Vegetation

Light-related criteria necessary to support and sustain submersed aquatic vegetation (SAV) during the growing season in the UMR include a Secchi disk depth of 50 cm, a TSS concentration of 25 mg/L, and a turbidity of 20 NTU, as described in UMRCC (2003). Figures

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D-8, D-9, and D-10 are box plots of the Secchi disk depths, TSS concentrations, and turbidity measurements for all three sites during the summer months compared to the UMRCC criteria.

The percentage of water clarity measurements during the 2019 and 2020 growing seasons at site W-M525.5L that met the criteria were as follows: Secchi disk depth (29.6%), TSS (19.2%) and turbidity (25.9%). This site is impacted from the effects of the main channel and upstream eroding islands, and it was reflected in the water clarity results which showed lower percentages of readings meeting the water clarity criteria. The percentage of water clarity measurements during the 2021 growing seasons at site W-M525.1G that met the criteria were as follows: Secchi disk depth (66.7%), TSS (19.2%) and turbidity (62.5%). This site is also impacted from the effects of the main channel similar to W-M525.5L, but to a lesser degree which was reflected in the water clarity results which showed higher percentages of readings meeting the criteria. As expected, site with the highest velocities and greatest TSS and turbidity readings, W-M525.5L, had the most diminished water clarity. In addition to grab samples, Figure D-11 includes sonde-measured results for sites W-M525.5L and W-M525.1G. These results indicate the sondes were more effective at capturing high turbidity events, whereas, with grab samples only, these events would have been missed. It is to be noted, however that the units between the grab samples and continuous sonde readings are different. District water quality staff have found that FNU results are similar to NTU but do have a slight increase over years of data collection. In order to establish a definitive relationship more site specific studies would be necessary.

4.5. Water Quality Criteria Necessary to Support Over-Wintering Fish

According to Palesh and Anderson, optimum values for winter bluegill habitat on the UMRS include water depth greater than 4 ft, dissolved oxygen (DO) greater than 5 mg/L, water temperature of 4 °C, and current velocity of 0 cm/s (1990). Figures D-12, D-13, D-14, D-15, D-16, and D-17 are box plots of the DO, temperature, depth and velocity measurements for site W-M526.6D during the winter months compared to the bluegill model criteria.

The percentage of over-wintering grab sample measurements during the 2018-2019, 2019-2020 and 2020-2021 winter seasons at site W-M526.6D that met the criteria were as follows: Dissolved oxygen (94.4%), temperature (11.1%), depth (66.7%) and velocity (0.0%). Dissolved oxygen and temperature parameters also had continuous monitoring data which is included in Figures D-12 and D-14. This set of data met the criteria at the following percentages: Dissolved oxygen (91.0%) and temperature (6.03%). Taking a closer look at the temperature, a further breakdown of percentages within specific temperatures reveals that 18.54 % of all temperatures recorded were between 2 and 4 degrees Celsius and that 75.5%, the vast majority of all temperatures, were less than or equal to 2 degrees Celsius. Seeing that no values were at the criteria for velocity, a closer look reveals that 55.6% of all grab samples were less than or equal to 5 cm/sec and the remaining 44.4% were observed to be above 5 cm/sec.

5. CONCLUSION

Pre-Project baseline water quality monitoring was initiated at the first project site, W-M526.6D, on December 12, 2018, an additional site, W-M525.5L, on May 19, 2019, and a final third site, W-M525.1G, on June 2, 2021. Monitoring continued each year for site W-M526.6D and every summer for sites W-M525.5L and W-M525.1G. Monitoring was

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accomplished through the collection of discrete grab samples, as well as by utilization of continuous monitors.

Site W-M526.6D exhibited lentic water quality characteristics, while sites W-M525.5L and W-M525.1G exhibited lotic characteristics. The lentic site typically had lower water velocities and better water clarity as reflected in measurements of Secchi disk depth, turbidity, and total suspended solids. The lotic sites exhibited steady DO concentrations at or above the target level of 5 mg/L, while at the lentic site, DO concentrations were at the target DO reading for only winter seasons and dipped below for majority of the summer seasons.

Sonde-measured DO concentrations at sites W-M526.6D varied by year and season. It was rare to see a winter DO concentration below 5 mg/L, except for one recorded short dip during the winter of 2018-2019, and one extended dip during the winter of 2020-2021. This extended period below 5 mg/L in the 2020-2021 winter season was likely attributed high ice and snow cover depths seen during this winter season. Increasing water depth via dredging would help alleviate the low DO concentrations here by providing a larger volume of DO in the water column prior to ice-over. Introduction of flow would also help but at the expense of increasing the sediment load and velocities. Sonde-measured winter water temperatures were generally below 4 degrees Celsius and typically average just under 2 degrees Celsius. Dredging would create deep-water habitat that would likely stratify and have water temperatures close to 4°C near the bottom.

During the growing seasons monitored at sites W-M525.5L and W-M525.1G, both sites had a very low percentage of readings that met TSS criteria for SAV. In terms of turbidity and secchi disk depth readings, site W-M525.5L met the criteria for SAV less than 30% of the growing seasons monitored, and site W-M525.1G met the criteria closer to 65% of the growing seasons monitored. With the addition of rock structures within pool 13, site W-M525.1G would likely show improvements in lower velocities and greater light related water quality characteristics.

The Recommended Plan includes installing rock structures within Pool 13 to allow for reduced velocities and to break up wind-wave action to increase water clarity throughout the Project area. The decreased velocities, TSS, and turbidity values would allow for an increase in desirable plant, wildlife, and aquatic species diversity by enhancing and restoring habitat within Lower Pool 13.

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6. REFERENCES

Palesh, G. and D. Anderson. (1990). *Modification of the Habitat Suitability Index Model for the Bluegill (Lepomis macrochirus) for Winter Conditions for Upper Mississippi River Backwater Habitats.* St. Paul District Corps of Engineers.

Upper Mississippi River Conservation Committee (UMRCC). (2003). *Proposed Light-Related Water Quality Criteria Necessary to Sustain Submersed Aquatic Vegetation in the Upper Mississippi River.*

Table D-1. Water Quality Monitoring Results from Surface Samples Collected at Site W-M526.6D

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH(SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
12/12/201	1.260	3.110	1.4	10.30	7.37	-	48.50	-	-	-	-	-
2/14/2019	1.225	4.090	0.8	14.35	7.45	-	8.52	-	-	-	-	-
3/12/2019	1.250	11.490	1.0	11.72	7.63	-	213.00	-	-	-	-	-
5/29/2019	2.760	48.840	17.9	6.87	7.67	30.0	40.00	36.0	15.9	<1.0	<1.0	2.9
6/11/2019	2.530	48.100	21.5	7.82	7.88	39.0	22.80	23.2	34.9	<1.0	1.8	4.7
6/25/2019	1.380	13.880	21.6	6.87	7.89	25.5	45.80	46.0	24.0	<1.0	<1.0	5.4
7/9/2019	1.450	17.130	24.9	5.37	7.53	29.5	35.10	32.4	12.1	<1.0	<1.0	4.3
7/23/2019	1.480	6.630	23.4	4.57	7.54	32.0	19.40	18.8	8.5	<1.0	<1.0	<1.0
8/6/2019	1.325	1.030	24.0	1.58	7.27	64.0	6.80	11.2	5.8	<1.0	<1.0	<1.0
8/20/2019	1.270	1.070	22.7	0.83	7.34	77.5	4.23	6.0	2.8	<1.0	<1.0	<1.0
9/4/2019	1.270	2.140	20.5	3.35	7.39	81.0	5.09	6.8	5.5	<1.0	<1.0	<1.0
9/30/2019	1.450	11.320	18.1	2.31	7.35	60.0	13.30	8.0	2.2	<1.0	<1.0	<1.0
12/5/2019	1.300	47.600	1.4	14.99	8.06	73.0	9.00	-	-	-	-	-
1/23/2020	1.380	9.320	0.1	18.88	7.80	-	4.98	-	-	-	-	-
3/10/2020	1.320	13.070	5.7	10.65	7.58	23.0	50.00	-	-	-	-	-
6/9/2020	1.260	7.118	23.9	4.71	7.55	39.5	27.70	22.0	8.3	<1.00	<1.00	3.2
6/23/2020	1.155	3.001	19.7	1.75	7.21	70.0	9.53	<5.00	<1.00	<1.00	<1.00	<1.00
7/7/2020	1.300	0.747	27.3	1.15	7.16	117.5	3.37	<4.00	4.3	<1.00	<1.00	<1.00
7/21/2020	1.230	2.074	23.6	0.74	7.13	123.0	3.24	4.0	5.1	<1.00	<1.00	<1.00
8/4/2020	1.400	0.261	20.5	2.93	7.20	140.0	2.94	<4.00	4.4	<1.00	<1.00	<1.00
8/18/2020	1.255	0.163	22.0	2.93	7.26	91.0	2.09	<4.00	5.5	<1.00	<1.00	<1.00
9/1/2020	1.180	0.298	20.2	2.35	7.22	>118.0	5.64	14.3	24.9	<1.00	<1.00	10.0
9/15/2020	1.285	2.558	16.7	0.93	7.14	112.0	3.60	3.5	4.6	<1.00	<1.00	1.8
9/29/2020	1.160	10.601	14.6	2.71	7.10	69.0	4.25	3.25	4.7	<1.00	<1.00	1.8
12/3/2020	1.140	2.167	0.7	13.73	7.68	-	7.58	-	-	-	-	-
2/3/2021	1.200	1.400	0.1	7.55	7.46	-	5.17	-	-	-	-	-
3/17/2021	1.175	4.610	2.8	13.66	8.12	45.0	19.70	-	-	-	-	-
6/2/2021	1.130	1.758	21.0	8.61	7.75	112.0	3.70	<4.00	2.4	<1.00	<1.00	<1.00
6/15/2021	1.140	0.283	23.4	6.08	7.76	76.0	6.23	4.0	5.9	<1.00	<1.00	<1.00
6/29/2021	1.050	0.224	24.5	2.42	7.28	72.0	2.39	<4.00	2.7	<1.00	<1.00	1.4
7/13/2021	1.100	0.000	20.0	1.08	6.9	110.0	6.03	<4.00	4.0	<1.00	<1.00	<1.00
7/27/2021	1.160	0.022	25.0	1.79	7.32	91.0	2.52	<4.00	5.1	<1.00	<1.00	<1.00
8/10/2021	1.105	0.141	24.4	1.57	7.24	>110.5	1.97	<4.00	3.5	<1.00	<1.00	<1.00
8/24/2021	1.210	1.232	23.5	1.90	7.36	98.0	2.12	<4.00	2.8	<1.00	<1.00	<1.00
9/8/2021	1.065	0.838	19.3	0.39	7.12	>106.5	3.44	5.6	9.3	<1.00	<1.00	1.4
9/28/2021	1.140	1.105	17.2	5.41	7.73	114.0	1.43	-	-	-	-	-
MIN.	**1.050**	**0.000**	**0.1**	**0.390**	**6.90**	**23.0**	**1.43**	**3.3**	**<1.00**	**<1.00**	**<1.00**	**<1.00**
MAX.	**2.760**	**48.840**	**27.3**	**18.880**	**8.12**	**140.0**	**213.00**	**46.0**	**34.9**	**<1.00**	**1.8**	**10.0**
AVG.	**1.319**	**7.762**	**16.5**	**5.690**	**7.46**	**74.6**	**18.09**	**15.3**	**8.4**	**<1.00**	**1.8**	**3.7**
MEDIA	**1.253**	**2.154**	**20.4**	**3.960**	**7.38**	**73.0**	**5.84**	**9.6**	**5.1**	**<1.00**	**1.8**	**3.1**

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Table D-2. Water Quality Monitoring Results from Surface Samples Collected at Site W-M525.5L

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
5/29/2019	2.730	36.830	18.1	8.34	7.85	62.0	22.00	28.0	19.0	<1.0	1.1	3.4
6/11/2019	2.545	34.130	224	9.09	8.08	50.0	23.80	33.6	54.2	<1.0	4.2	8.7
6/25/2019	1.410	40.350	22.5	8.11	8.01	44.0	23.70	34.8	33.0	<1.0	1.7	6.2
7/9/2019	1.430	38.830	26.3	6.86	7.94	32.5	41.00	49.2	18.6	<1.0	<1.0	5.8
7/23/2019	1.520	47.010	26.5	7.14	8.05	36.0	22.10	27.6	16.6	<1.0	<1.0	1.1
8/6/2019	1.380	39.060	27.2	8.57	8.26	46.0	33.10	64.8	39.0	2.5	1.8	13.3
8/20/2019	1.310	29.860	24.5	7.97	8.16	55.0	20.80	34.0	34.9	<1.0	<1.0	7.8
9/4/2019	1.320	25.730	22	9.6	8.43	48.0	18.40	24.8	51.8	1.6	2.9	11.1
9/30/2019	1.520	47.740	18.7	7.54	7.62	27.0	33.50	36.4	10.9	<1.0	<1.0	2.4
6/9/2020	1.320	33.456	25.2	9.87	8.54	28.0	58.80	68.7	66.5	<1.00	5.4	10.4
6/23/2020	1.230	42.849	23.6	7.57	7.94	34.0	35.10	40.0	32.4	<1.00	1.6	8.1
7/7/2020	1.325	36.775	29.6	7.29	8.16	51.0	26.80	37.2	21.4	<1.00	<1.00	5.6
7/21/2020	1.250	35.422	26.3	7.93	8.24	48.0	26.90	32.0	34.1	<1.00	1.9	5.0
8/4/2020	1.390	35.822	25	8.03	8.36	31.0	36.10	34.8	34.4	1.5	<1.00	25.7
8/18/2020	1.290	48.000	25	10.06	8.55	25.0	23.40	33.6	60.2	3.5	3.5	11.2
9/1/2020	1.250	29.162	24.2	7.51	8.15	45.0	29.20	39.3	20.1	<1.00	<1.00	4.5
9/15/2020	1.295	33.386	16.9	8.52	7.92	36.0	37.40	47.2	9.3	<1.00	<1.00	1.4
9/29/2020	1.200	20.470	17.6	9.14	8.26	40.0	22.70	32.0	36.8	<1.00	1.8	4.8
6/2/2021	1.320	39.305	18.6	8.85	7.92	51.0	23.60	35.6	12.9	<1.00	<1.00	<1.00
6/15/2021	1.300	18.317	27.5	8.01	8.25	58.0	12.80	12.4	17.4	<1.00	<1.00	3.9
6/29/2021	1.240	13.463	24.5	7.03	8.16	66.0	13.00	19.6	16.2	<1.00	<1.00	5.1
7/13/2021	1.310	15.030	23.3	7.9	8.28	49.0	20.00	28.8	49.9	1.9	2.6	4.8
7/27/2021	1.340	5.922	27.1	11.28	8.68	38.0	22.60	30.8	95.2	2.9	3.0	11.3
8/10/2021	1.265	19.573	26	9.11	8.3	40.0	20.70	32.8	57.6	2.2	2.4	6.7
8/24/2021	1.280	7.845	25.9	7.9	7.95	43.0	15.30	21.6	35.6	1.6	<1.00	7.5
9/8/2021	1.215	31.378	21.8	6.71	7.69	40.0	18.80	24.0	15.1	<1.00	<1.00	1.6
9/28/2021	1.380	14.734	19.1	8.95	8.28	63.0	14.70	-	-	-	-	-
MIN.	**1.200**	**5.922**	**16.9**	**6.71**	**7.62**	**25.0**	**12.80**	**12.4**	**9.3**	**1.5**	**1.1**	**1.1**
MAX.	**2.730**	**48.000**	**224.0**	**11.28**	**8.68**	**66.0**	**58.80**	**68.7**	**95.2**	**3.5**	**5.4**	**25.7**
AVG.	**1.421**	**30.387**	**31.0**	**8.33**	**8.15**	**43.9**	**25.79**	**34.8**	**34.4**	**2.2**	**2.6**	**7.1**
MEDIA	**1.320**	**33.456**	**24.5**	**8.03**	**8.16**	**44.0**	**23.40**	**33.6**	**33.6**	**2.1**	**2.4**	**5.8**

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Table D-3. Water Quality Monitoring Results from Surface Samples Collected at Site W-M525.1G

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
6/2/2021	1.250	28.595	18.1	8.85	7.99	39.0	22.80	37.6	12.9	<1.00	<1.00	<1.00
6/15/2021	1.190	10.852	27.5	7.91	8.19	59.0	13.20	16.8	21.3	<1.00	<1.00	8.7
6/29/2021	1.155	18.089	24.5	7.01	8.18	65.5	18.30	22.0	19.3	1.3	1.4	5.5
7/13/2021	1.260	13.22	23.4	8.05	8.24	67.0	17.40	22.0	43.3	1.1	1.8	6.4
7/27/2021	1.320	9.795	27.5	12.48	8.76	46.0	20.90	30.0	102.0	2.8	4.0	15.0
8/10/2021	1.180	16.743	26.1	8.96	8.22	44.0	18.50	28.8	51.4	1.9	2.1	7.4
8/24/2021	1.300	9.323	26.0	7.84	7.98	57.0	12.10	17.2	34.4	1.5	<1.00	8.7
9/8/2021	1.170	20.343	21.6	6.79	7.79	65.0	16.80	23.2	14.0	<1.00	<1.00	1.3
9/28/2021	1.310	13.027	19.2	8.96	8.25	65.0	13.70					
MIN.	**1.155**	**9.323**	**18.1**	**6.79**	**7.79**	**39.00**	**12.10**	**16.80**	**12.9**	**1.1**	**1.4**	**1.3**
MAX.	**1.320**	**28.595**	**27.5**	**12.48**	**8.76**	**67.00**	**22.80**	**37.60**	**102.0**	**2.8**	**4.0**	**15.0**
AVG.	**1.237**	**15.554**	**23.8**	**8.54**	**8.18**	**56.39**	**17.08**	**24.70**	**37.3**	**1.7**	**2.3**	**7.6**
MEDIAN	**1.250**	**13.220**	**24.5**	**8.05**	**8.19**	**59.00**	**17.40**	**22.60**	**27.9**	**1.5**	**2.0**	**7.4**

Table D-4. Seasonal Summary Statistics for Continuous Monitoring Data at Three Monitoring Sites

Site	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Specific Conductance (cm)	Turbidity (FNU)
W-M526.6D Winter					
Min.	-0.09	0.87	7.26	140.3	1.70
Max.	11.77	27.00	8.46	810.2	4223.50
Avg.	1.56	13.06	-	586.4	67.04
Median	1.10	13.26	7.74	582.1	12.75
W-M525.5L Summer					
Min.	16.55	0.04	7.43	262.8	11.09
Max.	30.51	11.87	8.75	529.5	20144.20
Avg.	24.12	7.00	-	375.3	116.09
Median	24.63	7.81	8.17	362.9	32.64
W-M525.1G Summer					
Min.	18.31	5.49	7.62	226.6	-0.11
Max.	29.44	15.49	9.14	420.0	240.72
Avg.	25.24	8.93	-	348.0	16.69
Median	25.80	8.67	8.32	352.1	14.12

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FIGURE D-2. PRE-PROJECT DISSOLVED OXYGEN, PH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M526.6D DURING WINTER 2018-2019

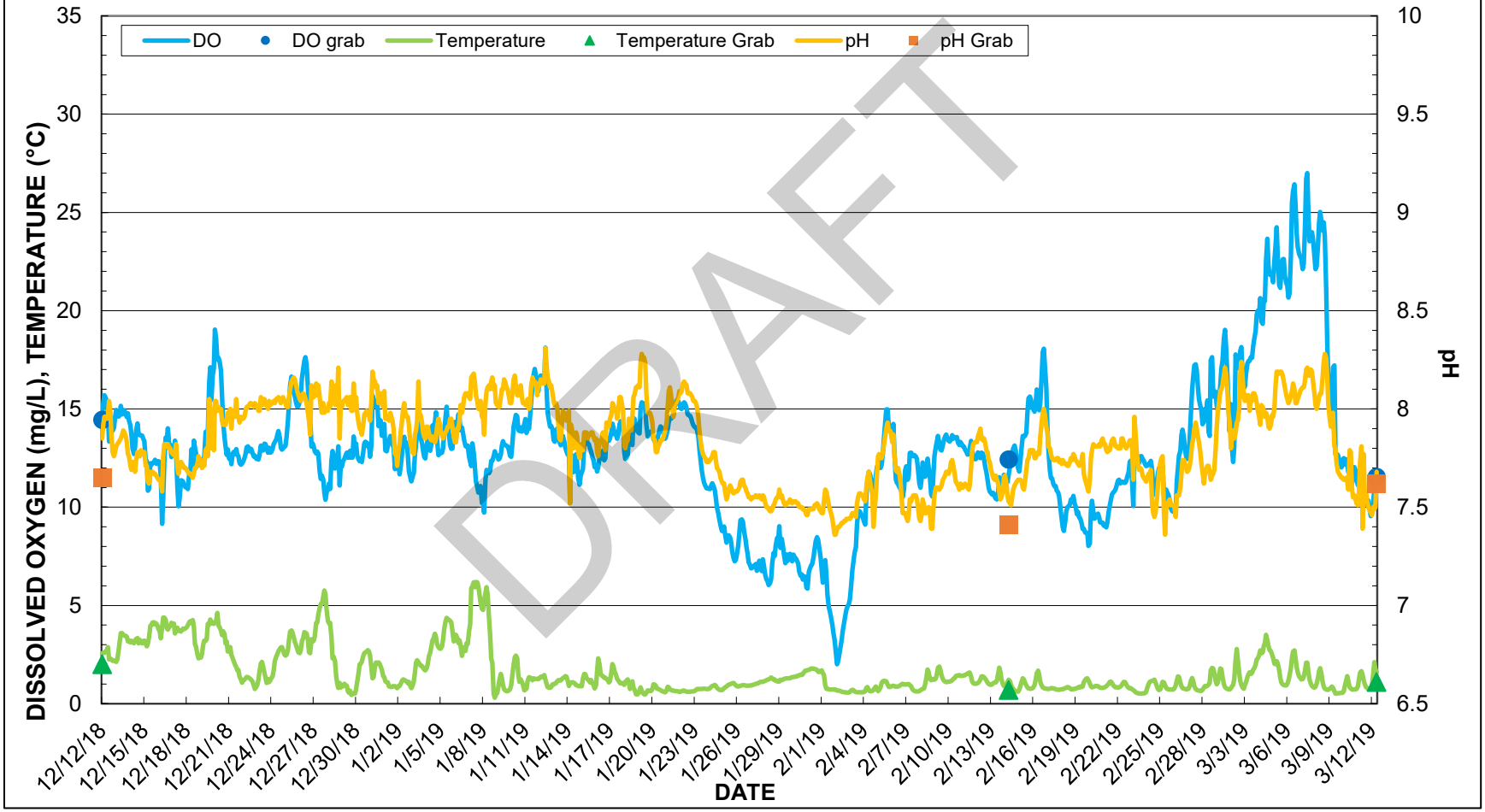

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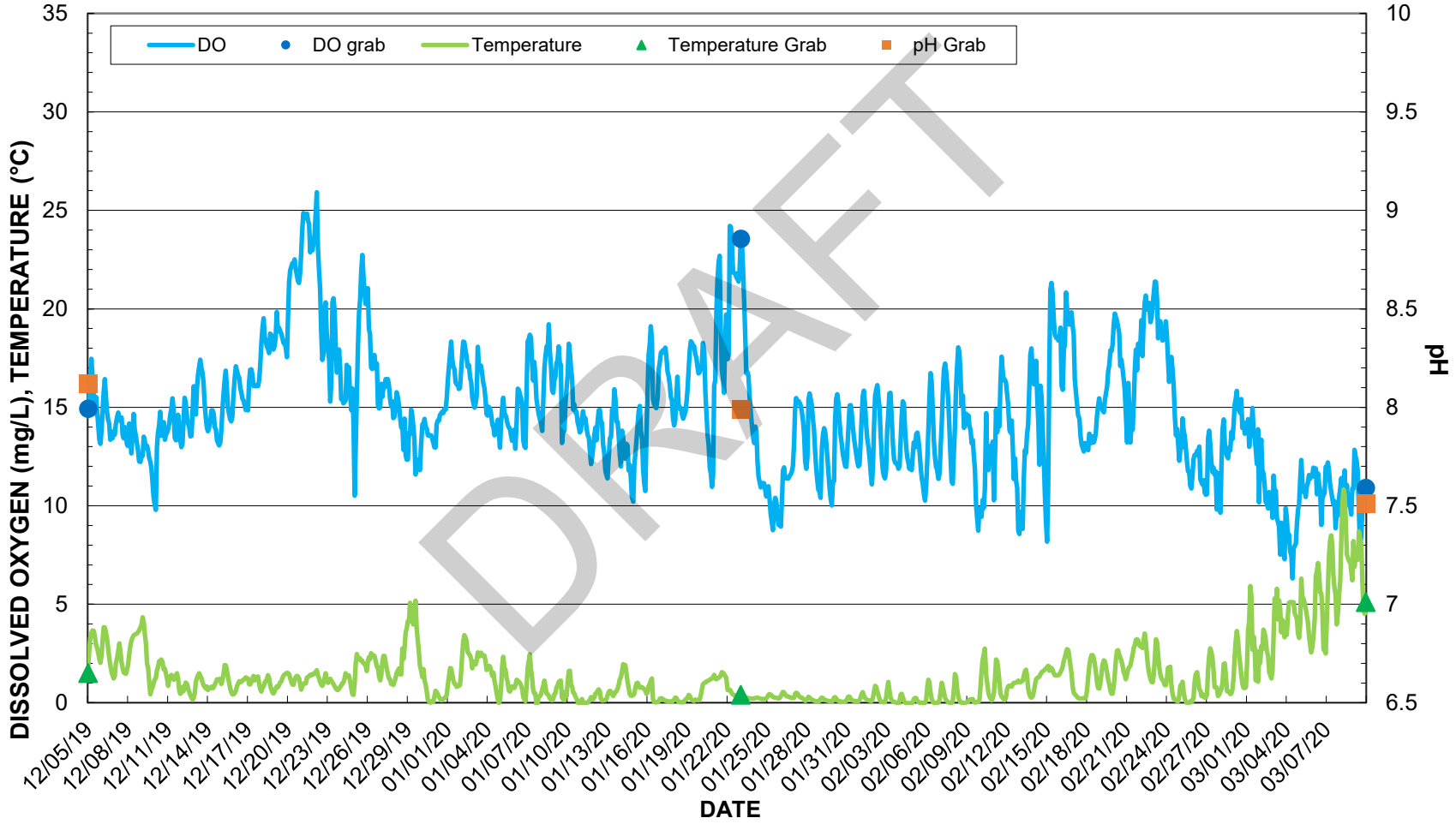
FIGURE D-3. PRE-PROJECT DISSOLVED OXYGEN, PH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M526.6D DURING WINTER 2019-2020



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Note: Continuous pH data omitted. Readings were erroneous due to sensor failure during the deployment.

FIGURE D-4. PRE-PROJECT DISSOLVED OXYGEN, PH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M526.6D DURING WINTER 2020-2021

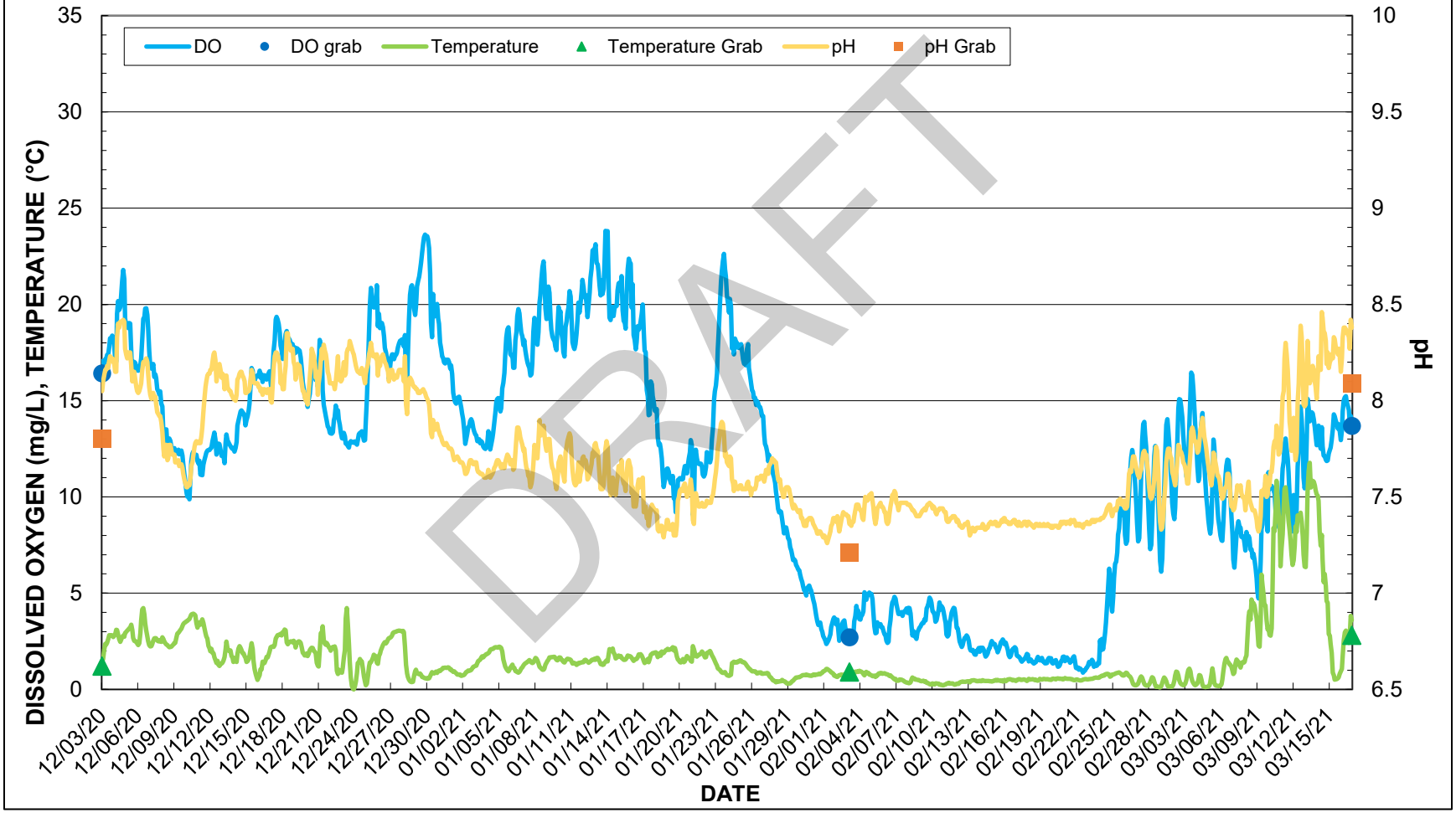

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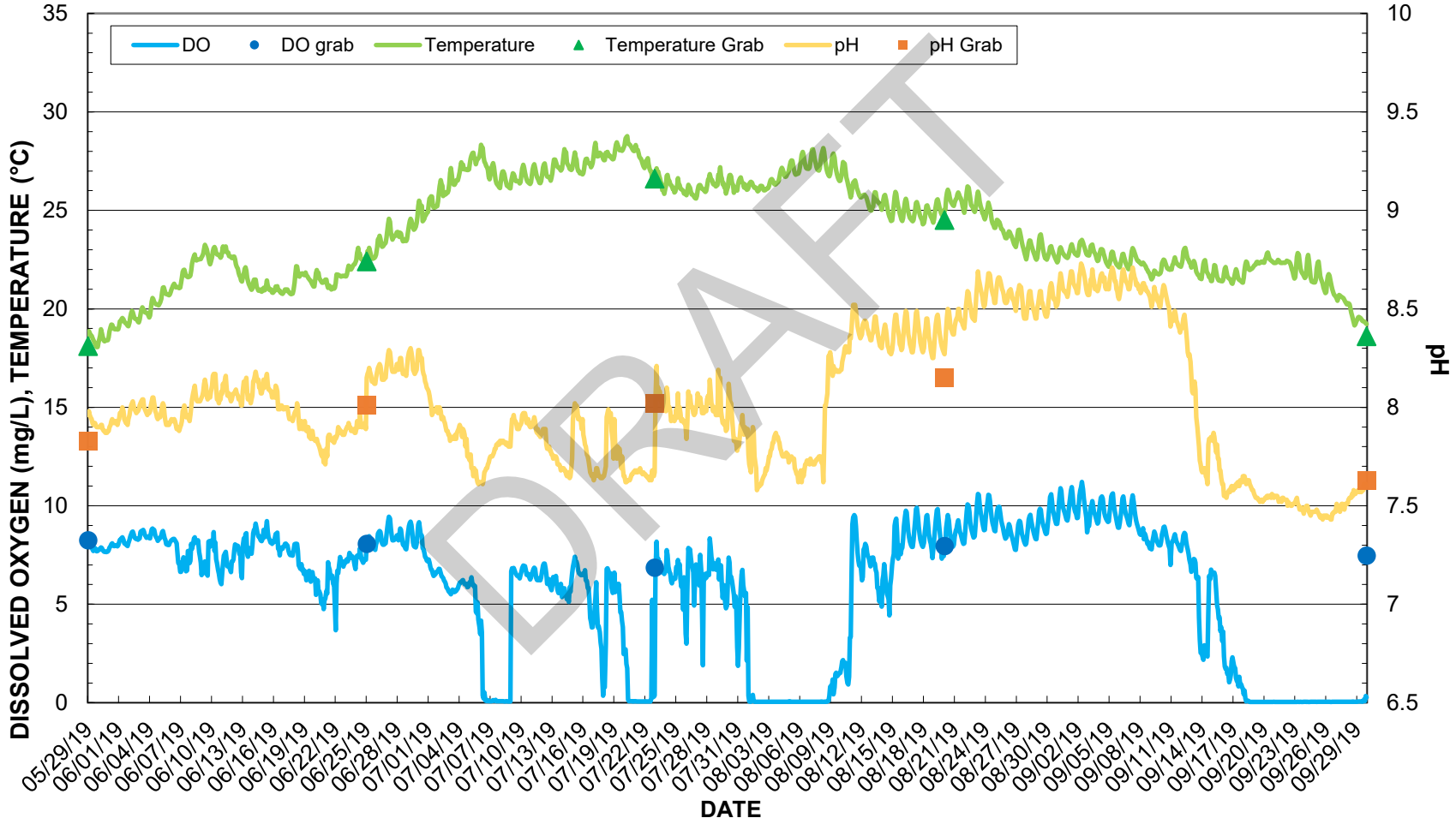
FIGURE D-5. PRE-PROJECT DISSOLVED OXYGEN, PH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M525.5L DURING SUMMER 2019



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Note: DO and pH data between 7/6/2019 and 8/11/2019 and after 9/12/2019 likely affected by debris collecting next to the sensor faces.

FIGURE D-6. PRE-PROJECT DISSOLVED OXYGEN, PH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M525.5L DURING SUMMER 2020

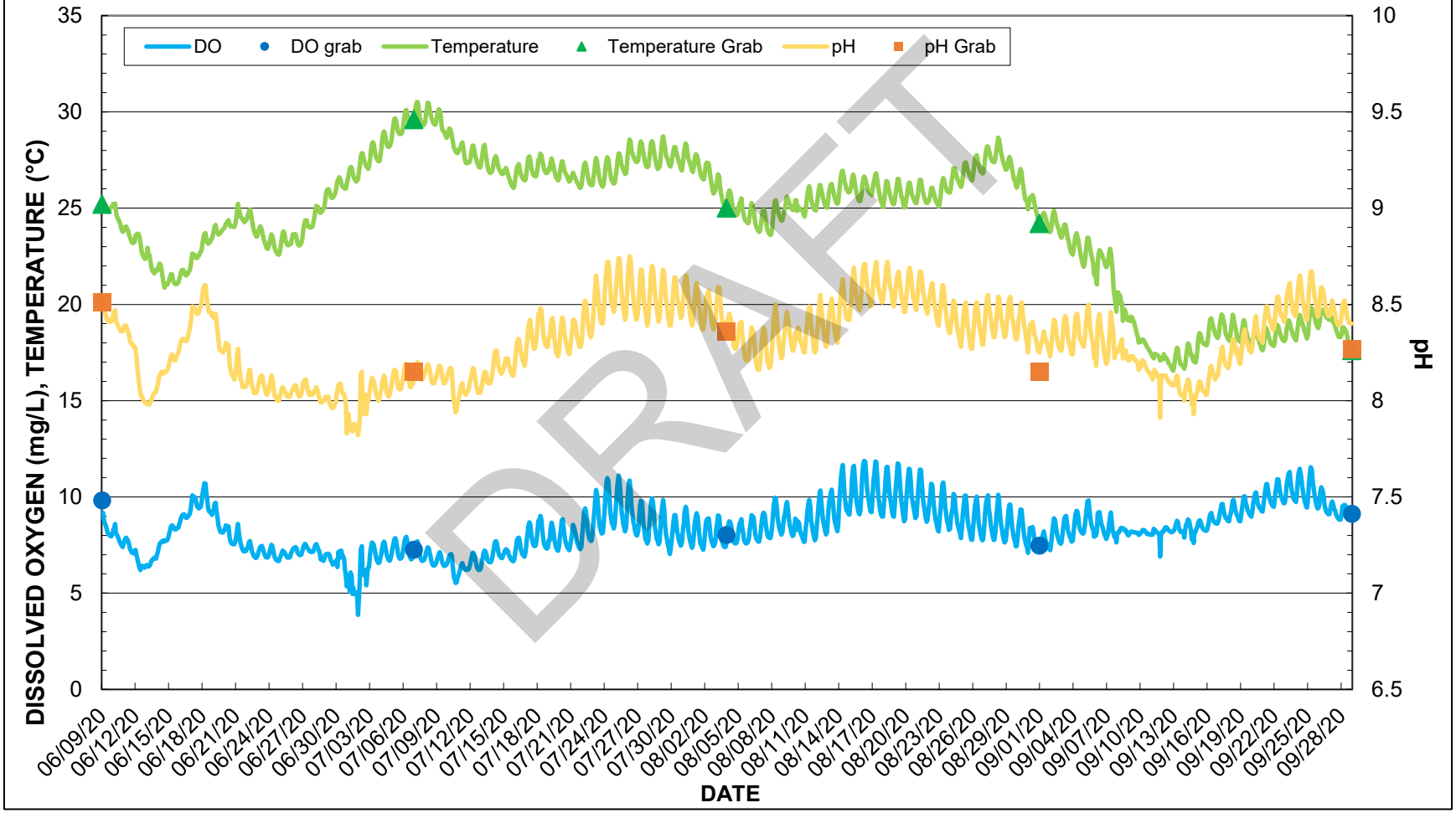

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FIGURE D-7. PRE-PROJECT DISSOLVED OXYGEN, PH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M525.1G DURING SUMMER 2021

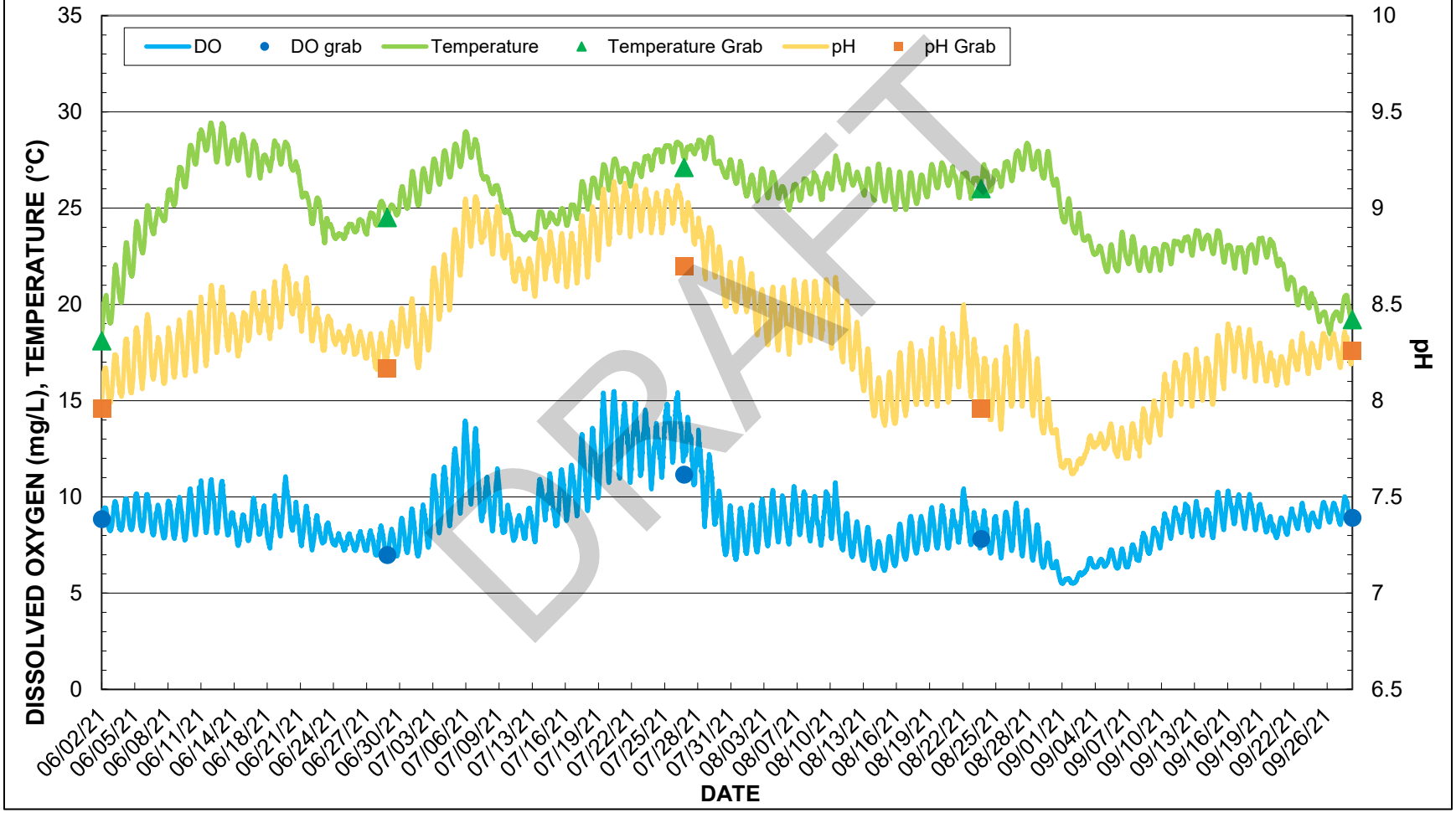

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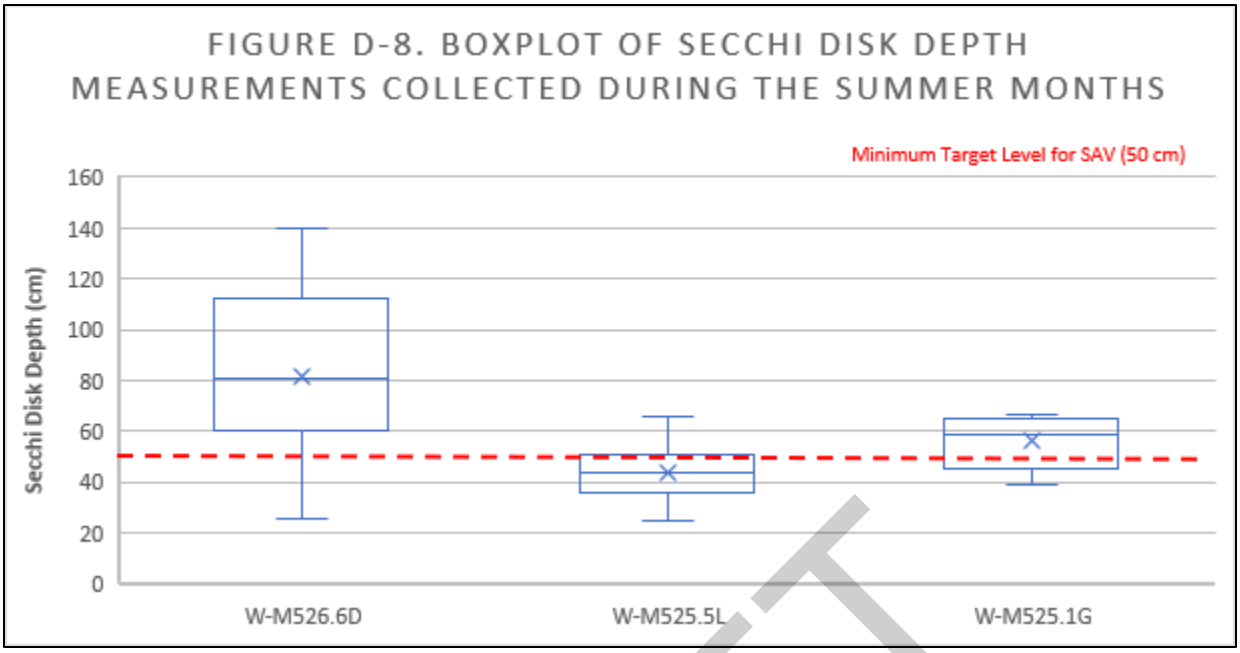
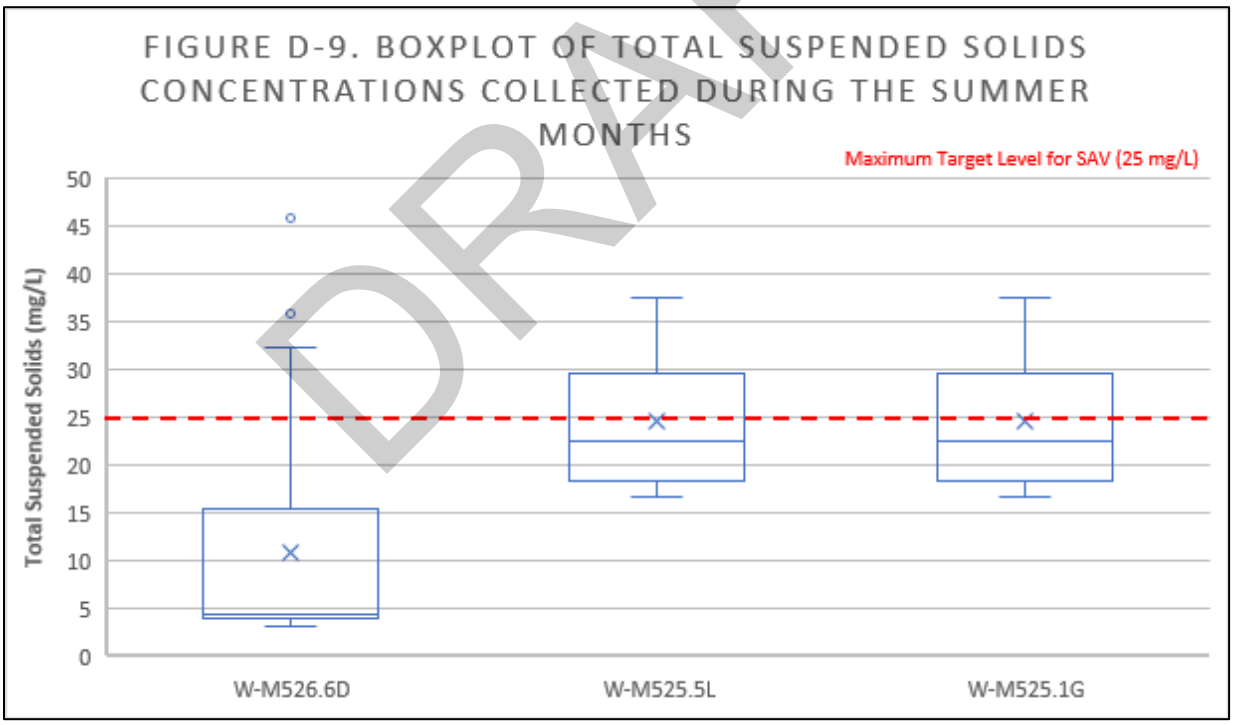
FIGURE D-8. BOXPLOT OF SECCHI DISK DEPTH MEASUREMENTS COLLECTED DURING THE SUMMER MONTHS



Note: Six secchi disk depth readings at site W-M526.6D were equivalent to the water depth and therefore greater than recorded. Water depth was used in the boxplot.

FIGURE D-9. BOXPLOT OF TOTAL SUSPENDED SOLIDS CONCENTRATIONS COLLECTED DURING THE SUMMER MONTHS



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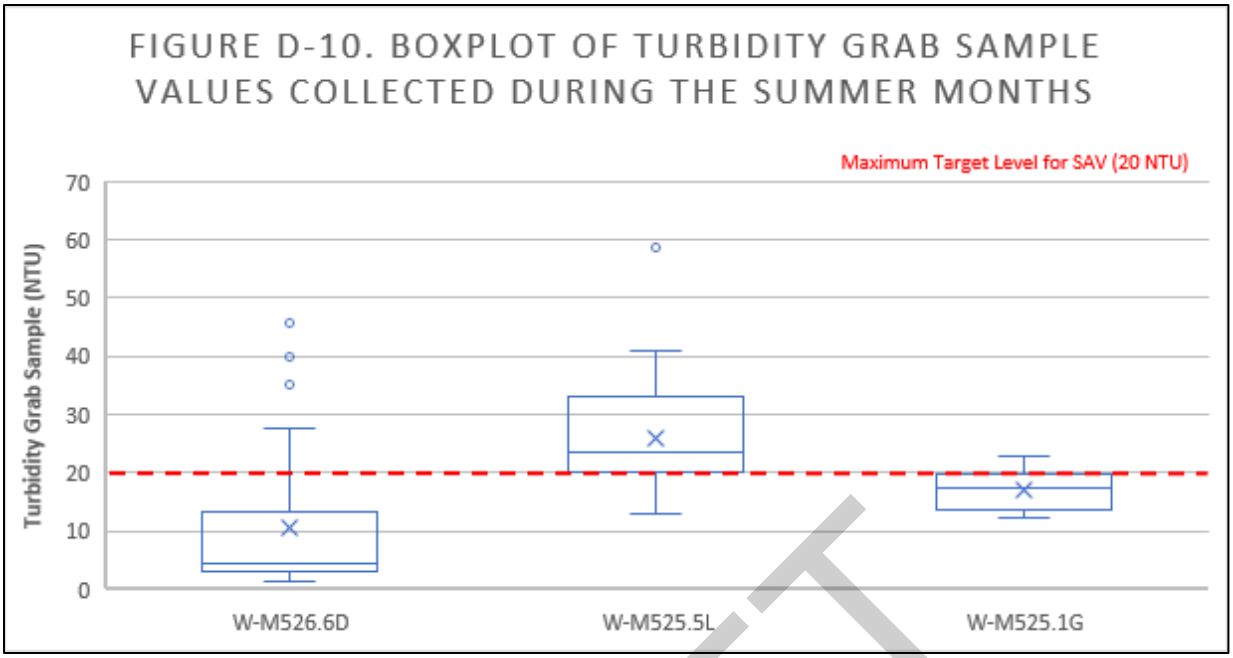

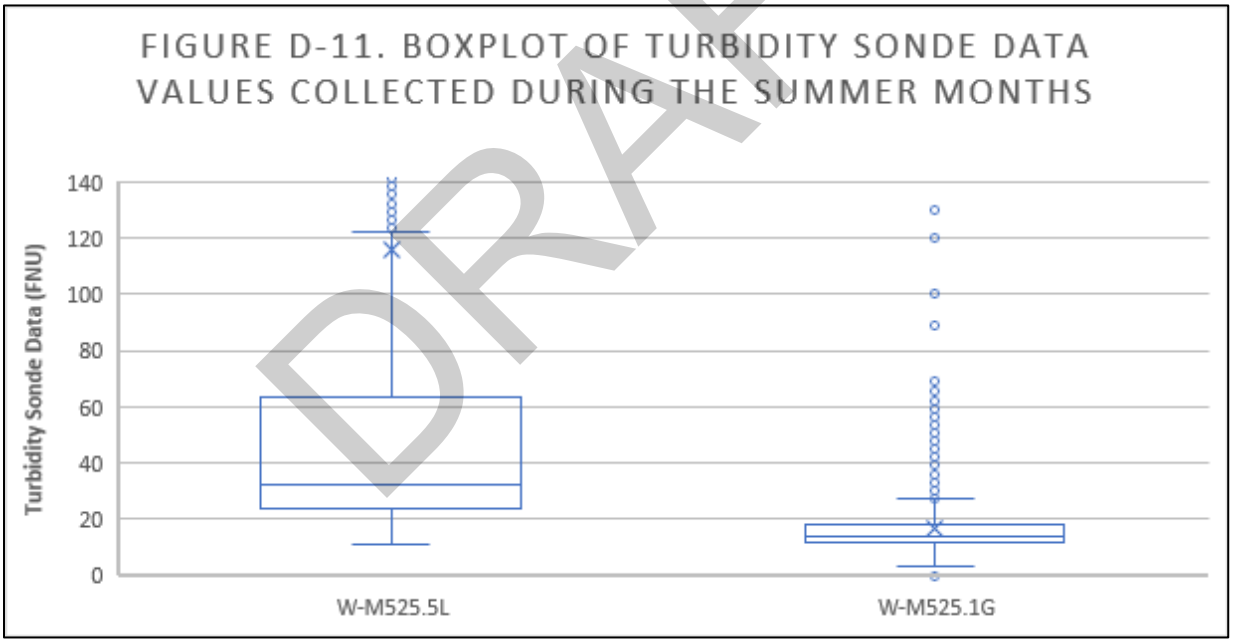

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Note: Outliers above the maximum value in the graph omitted for clarity. Summer 2019 data for site W-M525.5L not used due to erroneously high readings caused by debris near the sensors.

FIGURE F-17. BOXPLOT OF GRAB SAMPLE VELOCITY VALUES COLLECTED AT SITE W-M526.6D

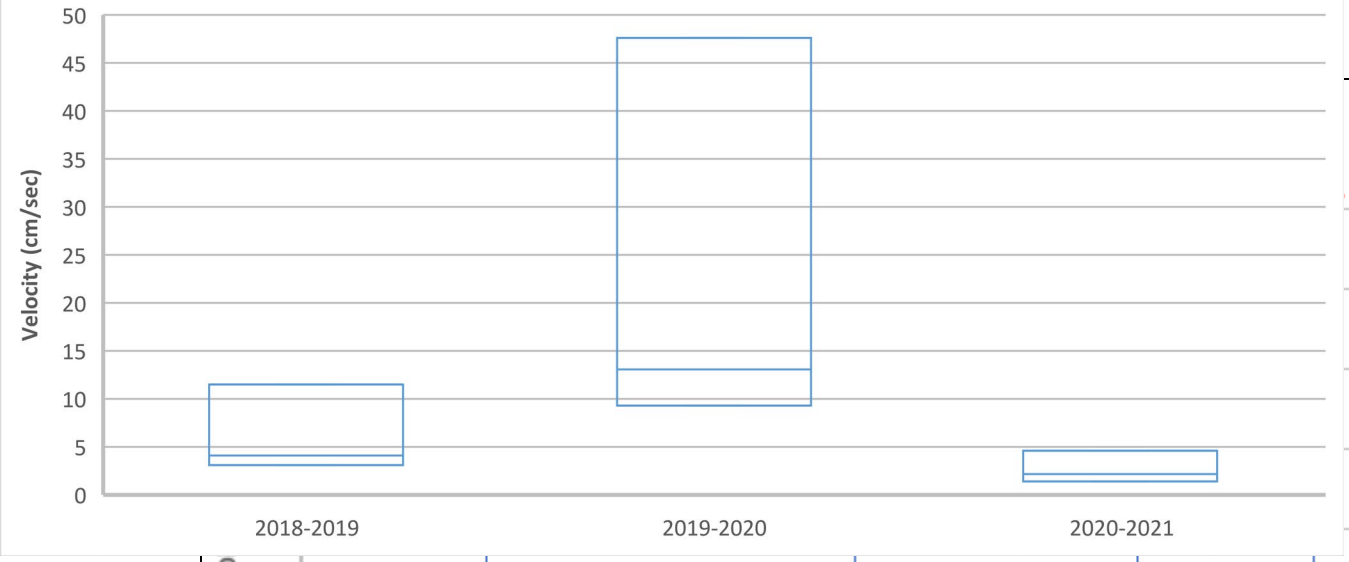
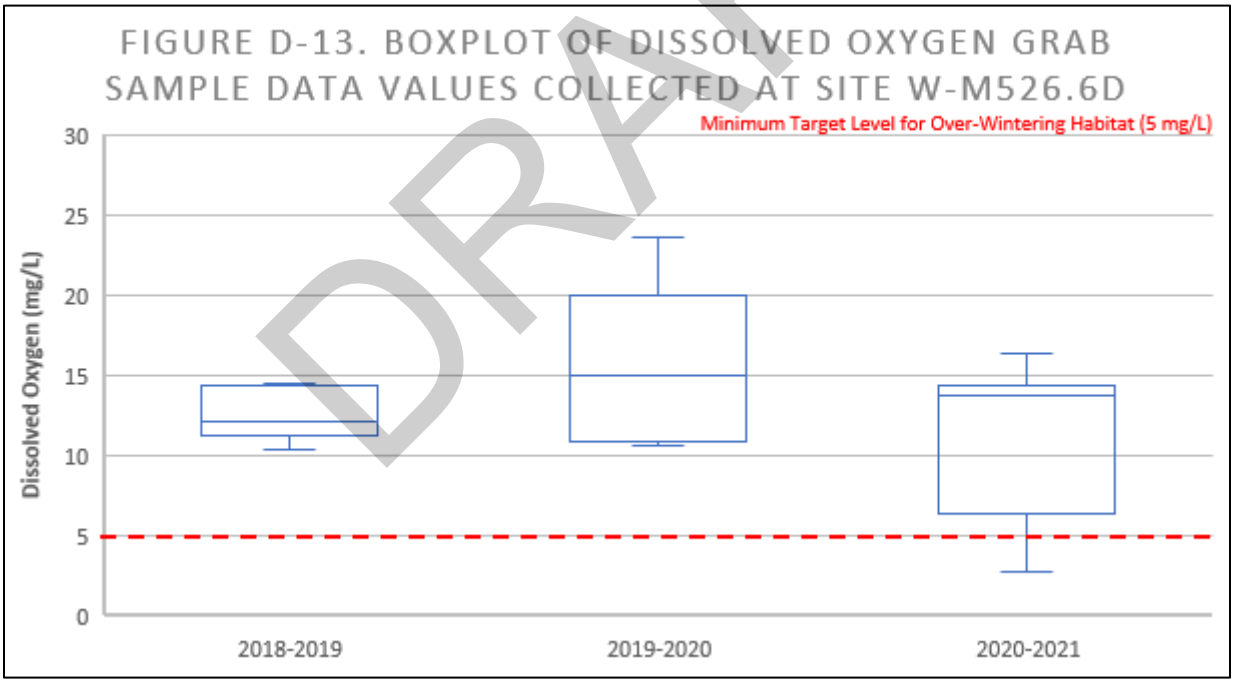


FIGURE D-13. BOXPLOT OF DISSOLVED OXYGEN GRAB SAMPLE DATA VALUES COLLECTED AT SITE W-M526.6D



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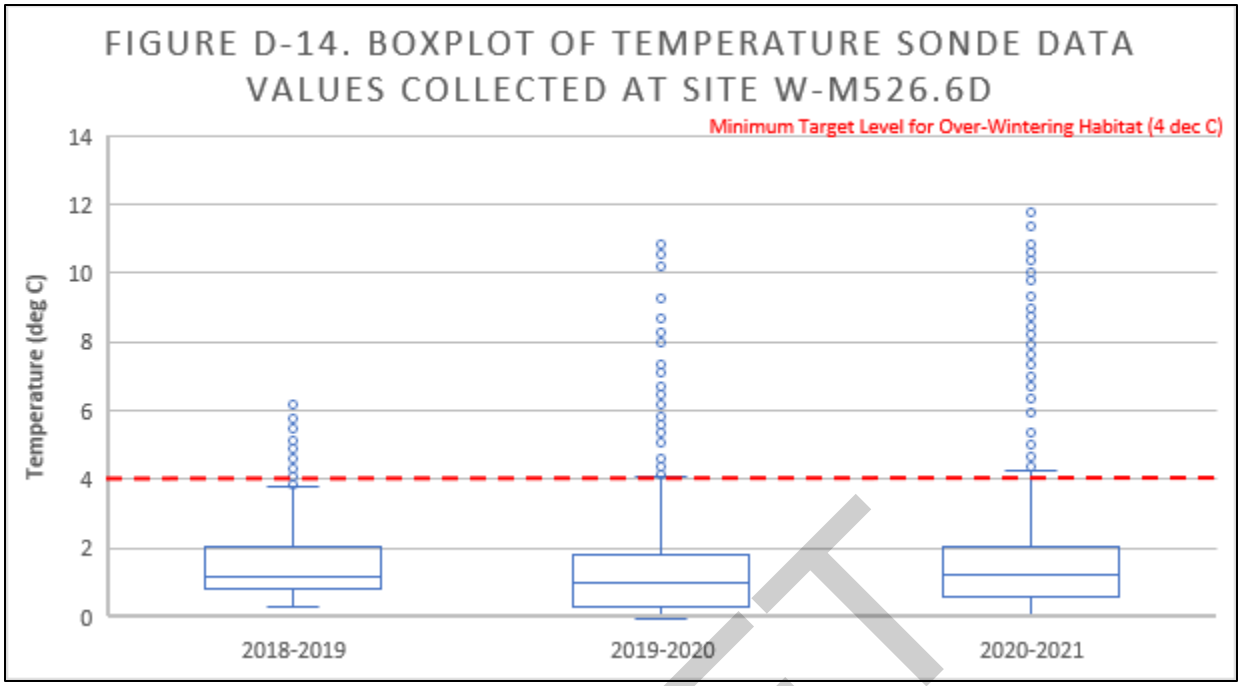
FIGURE D-14. BOXPLOT OF TEMPERATURE SONDE DATA VALUES COLLECTED AT SITE W-M526.6D
Minimum Target Level for Over-Wintering Habitat (4 dec C)
Temperature (deg C)
14
12
10
8
6
4
2
0
2018-2019
2019-2020
2020-2021

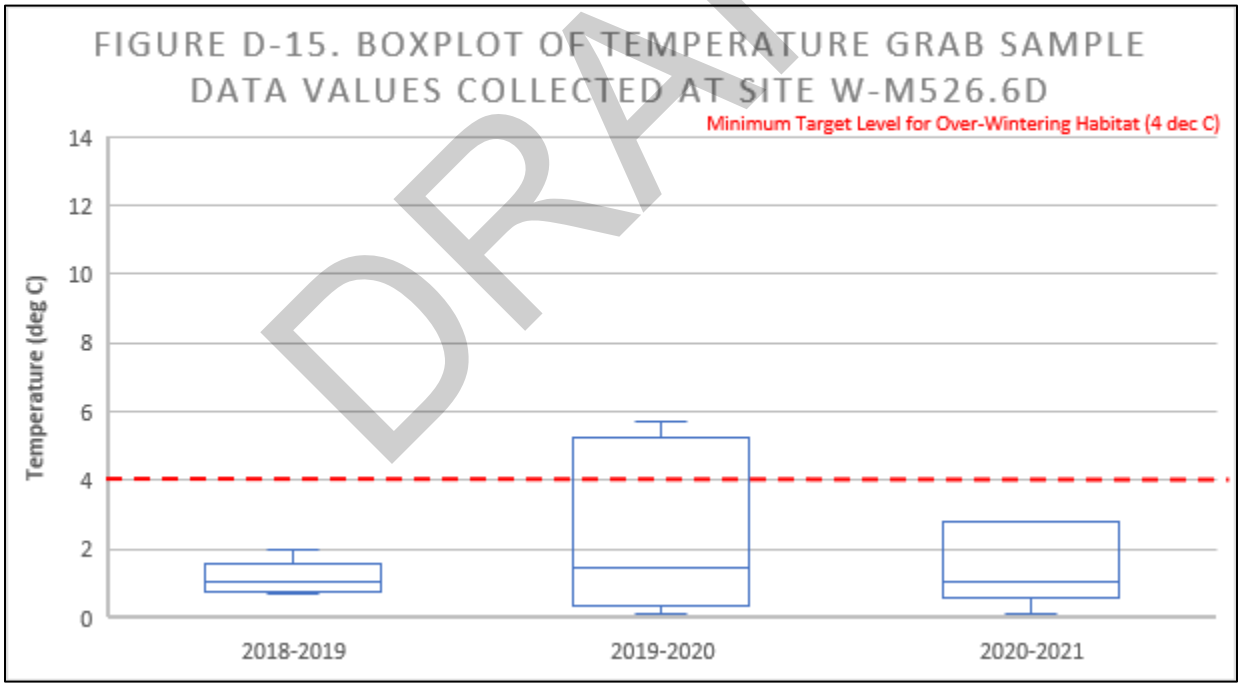
FIGURE D-15. BOXPLOT OF TEMPERATURE GRAB SAMPLE DATA VALUES COLLECTED AT SITE W-M526.6D
Minimum Target Level for Over-Wintering Habitat (4 dec C)
Temperature (deg C)
14
12
10
8
6
4
2
0
2018-2019
2019-2020
2020-2021

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FIGURE D-16. BOXPLOT OF GRAB SAMPLE DEPTH VALUES COLLECTED AT SITE W-M526.6D

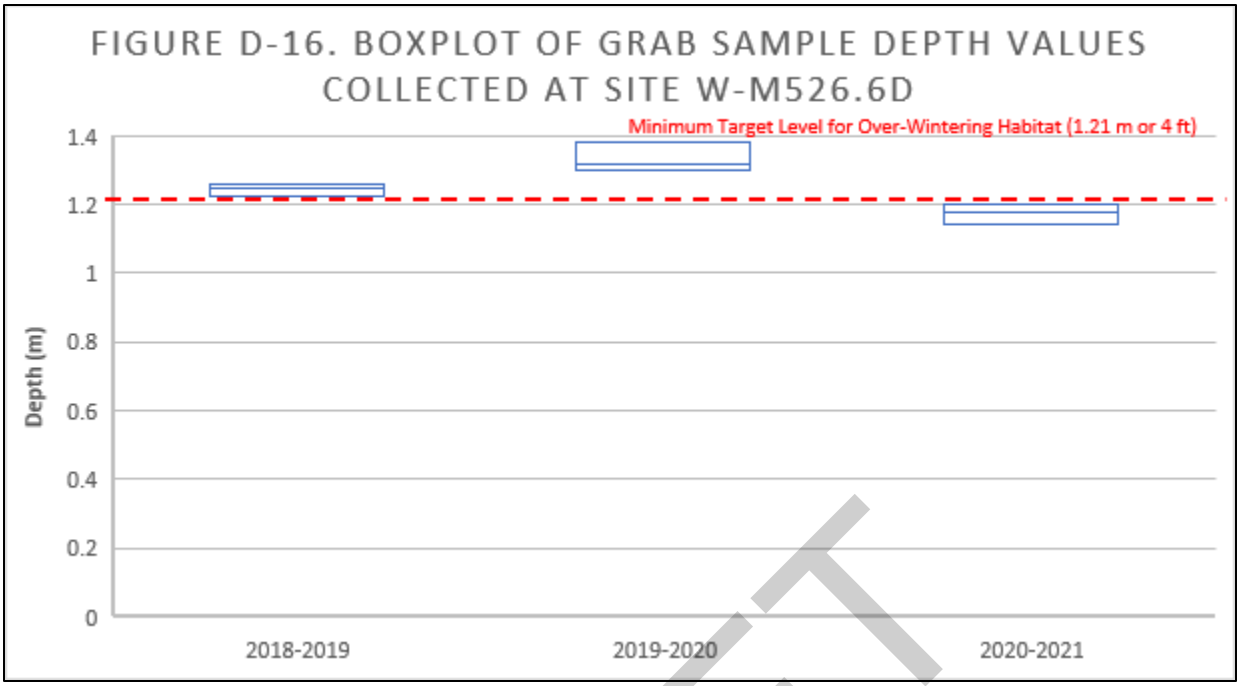
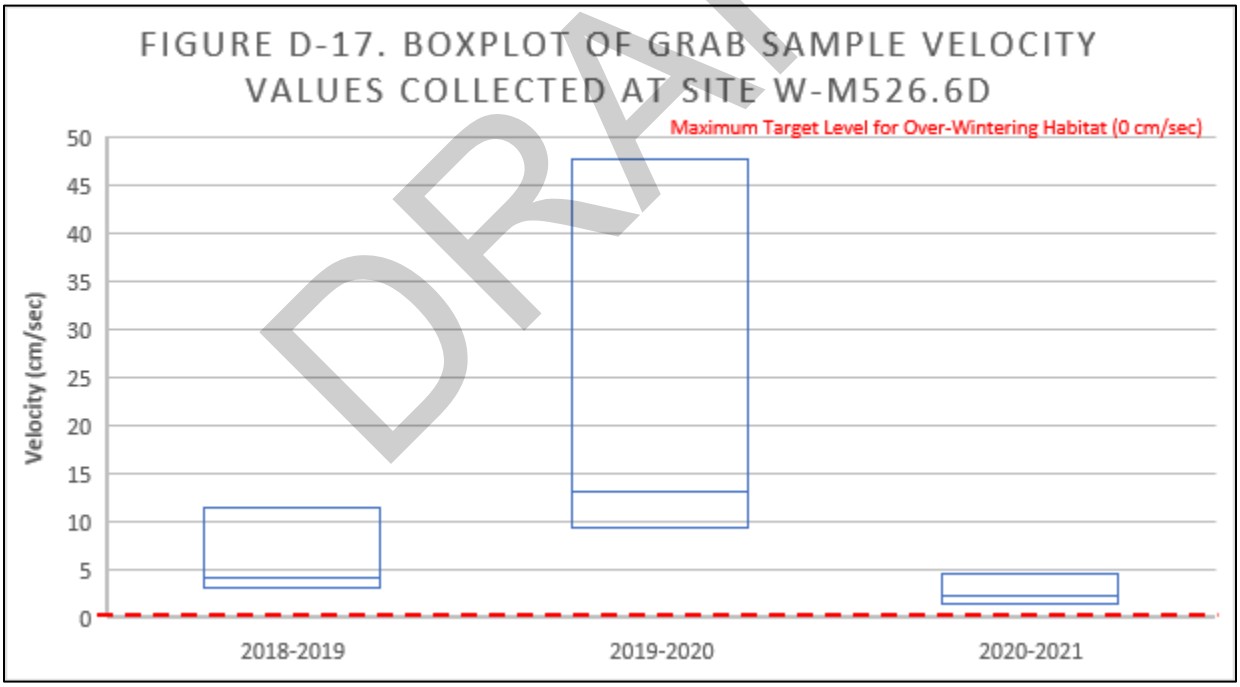


FIGURE D-17. BOXPLOT OF GRAB SAMPLE VELOCITY VALUES COLLECTED AT SITE W-M526.6D



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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT E
SURVEY, MAPPING, AND GEOSPATIAL DATA

DRAFT

APPENDIX E
ENGINEERING APPENDIX

ATTACHMENT E
SURVEY, MAPPING, AND GEOSPATIAL DATA

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Appendix E-A Project Survey Datums
Appendix E-B Surface Decision Document

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1. SURVEY, MAPPING, AND OTHER GEOSPATIAL REQUIREMENTS

Survey and other geospatial data requirements for the study area are summarized below.

1.1. Horizontal Datum

NAD 1983 State Plane Illinois West FIPS 1202 (US Feet) (WKID: 3436 Authority: EPSG)

1.2. Vertical Datum

NAVD88

1.3. Geoid

Pool 13 was Geoid 12B

1.4. Units

US survey feet

1.5. Conversion

Historic datum conversions were used for the Lower Pool 13 HREP Study. A single study-wide vertical datum conversion of “MSL12 – 0.64 feet = NAVD88” will be used within the study area for surface data processing, plans, and specifications. For hydraulic modeling, the conversions listed in Table 1 (extending from L&D 13 to L&D 12) will be used.

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Table E-1. Historic Vertical Datum Conversions for Mississippi River Pool 13,
To Be Used for Hydraulic Modeling

Mississippi River Mile	To Convert Elevations in MSL1912 to NAVD1988, Subtract (Feet)	Mississippi River Mile	To Convert Elevations In MSL1912 to NAVD1988, Subtract (Feet)
522.50 (L&D 13, Study downstream	0.625	539.10	0.662
522.60	0.625	539.90	0.662
522.80	0.629	540.60	0.668
523.10	0.629	541.20	0.672
523.60	0.632	541.80	0.672
524.00	0.635	542.60	0.675
524.50	0.635	543.30	0.675
525.00	0.638	543.70	0.675
526.00 (Study Area midpoint)	0.635	544.30	0.675
526.60	0.638	544.80	0.678
527.00	0.638	545.40	0.678
528.00	0.645	546.00	0.678
528.50	0.645	546.40	0.678
529.00 (Study upstream boundary)	0.645	547.00	0.681
529.70	0.655	547.50	0.681
530.00	0.655	548.10	0.675
530.90	0.658	549.10	0.675
531.70	0.662	549.70	0.675
532.30	0.662	550.40	0.675
532.80	0.662	551.00	0.675
533.50	0.658	552.00	0.675
534.10	0.658	552.80	0.675
535.10	0.658	553.30	0.675
535.50	0.655	554.00	0.678
535.70	0.655	554.50	0.681
535.90	0.655	555.20	0.685
536.40	0.655	555.70	0.685
537.10	0.665	556.20	0.675
537.70	0.665	556.60	0.675
538.10	0.662	556.70 (L&D 12)	0.675
538.50	0.662		

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1.6. Surface

Several datasets were used to develop the surface.

Engineering Survey Transects.

- Agency: MVR
- Dates: Oct 2019 – Jan 2020
- Collection method: Soundings
- In April 2021 it was determined that, due to the wide spacing between transects, for purposes of hydraulic modeling the transects did not provide significant benefit over the denser coverage provided by the OD-T hydrosurvey and the LTRM bathymetry. Additionally, the transects were highly "visible" in the completed surface model and although they provided the most recent coverage they prevented the surface from appearing cohesive. For these reasons they were removed from the surface and were not used in modeling efforts after April 2021.

Operations Survey.

- Agency: MVR, SEAS
- Hydrosurvey (MVR, 1999 – 2019, multibeam/singlebeam)
- Wingdam survey (MVR, 1999 – 2012, multibeam/singlebeam)
- Depth soundings (SEAS, 2014)
- Data type: Point
- Average accuracy: +/- 10-15cm (depending on survey age)
- Comparisons between this dataset and the EC-T transects indicate there is a minor vertical difference (0.009') and no shift is required
- Provides thorough coverage in the channel but does not extend into backwater areas

LTRM Bathymetric Survey.

- Agency: USGS Upper Midwest Environmental Sciences Center (UMESC)
- Date collected: 1990, 1991, and 1997
- Collection method: Depth sounding
- Data type: Point
- Average accuracy: < 1 meter
- On average, points in the side-channel and backwater are 0.7' higher in elevation than EC-T transects in the same areas. These points will have a 0.7' adjustment applied before being used for analysis
- Does not cover backwater areas in the far northwest and southeast, limited coverage in the northern part of the pool

LTRM LiDAR-derived DEM

- Agency: USACE, IA DNR, UMESC
- Date collected: 2007
- Collection method: LiDAR
- Data type: DEM (raster)
- Average accuracy: 0.6'
- Average point spacing: o of values extracted from DEM (used here) – 1m of original LiDAR collect – 1.4m

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- Hydroflattened LiDAR-derived DEM o LiDAR collected by the IA DNR and USACE
- Post-processed by UMESC, DEM produced by UMESC
- Elevation value converted from meters to feet by multiplying by 3.281
- On average, the LTRM LiDAR was 2.17’ higher than the EC-T survey in the same areas. An adjustment of -2.17’ was applied to the LiDAR to compensate.
- LiDAR collects from the states of IA and IL were also considered (from 2007 and 2009, respectively) but both states did not post-process their data in the same ways. Because the LTRM program LiDAR is one cohesive product across the full project area, here it will be considered the most reliable available elevation model
- The LTRM topobathy elevation model (3-meter resolution) was also considered but will not be used because 1) the points used to create that model are already included in this elevation model and 2) interpolated values from that surface are not likely to be more accurate than interpolated values derived from the newer data used here

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Figure E-1. Surface Development

1.7. Surface Files

The surface files used for computations are titled B5UMRR131801-CAD_MODEL-2022-02-02-V-ORDT01.dgn and B5UMRR131801-CAD_MODEL-2022-02-02-V-ORDT01.dtm

1.8. References

USACE, ***Surface Decision Document:*** Draft Report.
Prepared by the Rock Island District, U.S. Army Corps of Engineers. May 2020

USACE, ***Survey Needs:*** Notes.

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Prepared by the Rock Island District, U.S. Army Corps of Engineers. September 2019

USACE, ***Vertical Datum Conversion:*** Memorandum for Record.
Prepared by the Rock Island District, U.S. Army Corps of Engineers. November 2020

1.9. Attachments

Attachment E-A: Project Survey Datums MFR (2021)
Attachment E-B: Surface Decision Document (2022)

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APPENDIX E
ENGINEERING

ATTACHMENT E
SURVEY, MAPPING, AND GEOSPATIAL DATA

APPENDIX E-A
PROJECT SURVEY DATUMS

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CEMVR-EC-DN(KNM) 2021-08-23 (updated 2/25/22)

Memorandum for Record

Subject: Lower Pool 13 HREP Project Survey Datums

1. **References:**

B5UMRR131801-DOC-2020-05-14-Surface Decision Document.pdf
B5UMRR131801-MEMO-2022-02-07-SURFACE-DECISIONS-DOCUMENT.pdf
B5UMRR131801-MEMO-2020-11-18-Vertical Datum Conversion.pdf

2. **Horizontal Datum** NAD 1983 State Plane Illinois West FIPS 1202 (US Feet) (WKID: 3436 Authority: EPSG)

3. **Vertical Datum** NAD88
4. Geoid Pool 13 was Geoid 12B
5. **Units** US survey feet
6. **NAVD88 to MSL 1912 (if needed)**

In the interest of limiting delay to the project and computational issues in hydraulic modeling, it was agreed that the historic datum conversions will be used for Lower Pool 13 HREP. **A project vertical datum conversion of "MSL12 - 0.64 feet = NAVD88" will be used for plans and specs. For hydraulic modeling, the conversions listed in Table 2 will be used.**

Table 2: Historic vertical datum conversions for Mississippi River Pool 13, to be used for hydraulic modeling, Lower Pool 13 HREP

Mississippi RiverMile	To convert elevations in MSL1912 to NAVD1988, subtract (feet)	Mississippi RiverMile	To convert elevations inMSL1912 to NAVD1988, subtract (feet)
522.50 (L&D 13, project downstream boundary)	0.625	539.10	0.662

7. **NAVD88 to NGVD 1929 (if needed): N/A**

8. **Surface Names:**

B5UMRR131801-CAD_MODEL-2022-02-02-V-ORDT01.dgn
B5UMRR131801-CAD_MODEL-2022-02-02-V-ORDT01.dtm
B5UMRR131801-CAD_MODEL-2021-01-21-C-ORDT01.dgn
Pool_13_Surface.dtm
B5UMRR131801-IMG_PHOTO-2021-04-21-1M-RASTER-IL-WEST.zip
B5UMRR131801-IMG_PHOTO-2021-04-21-1M-RASTER-ALBERS.zip

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APPENDIX E
ENGINEERING

APPENDIX E-B
SURFACE DECISION DOCUMENT

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Lower Pool 13 HREP: Surface Development Decisions

Figure 1 shows a comparison between the existing LTRM topobathy elevation model (c. 1997) and recent (2019-2020) survey transects in lower Pool 13. This comparison shows large discrepancies (plus and minus 4 feet or more) between current conditions and the historic conditions represented in the elevation model. Most of these discrepancies (both high and low) are concentrated around the channel and would be remedied by the inclusion of more recently collected datasets, as outlined below in Figure 2.

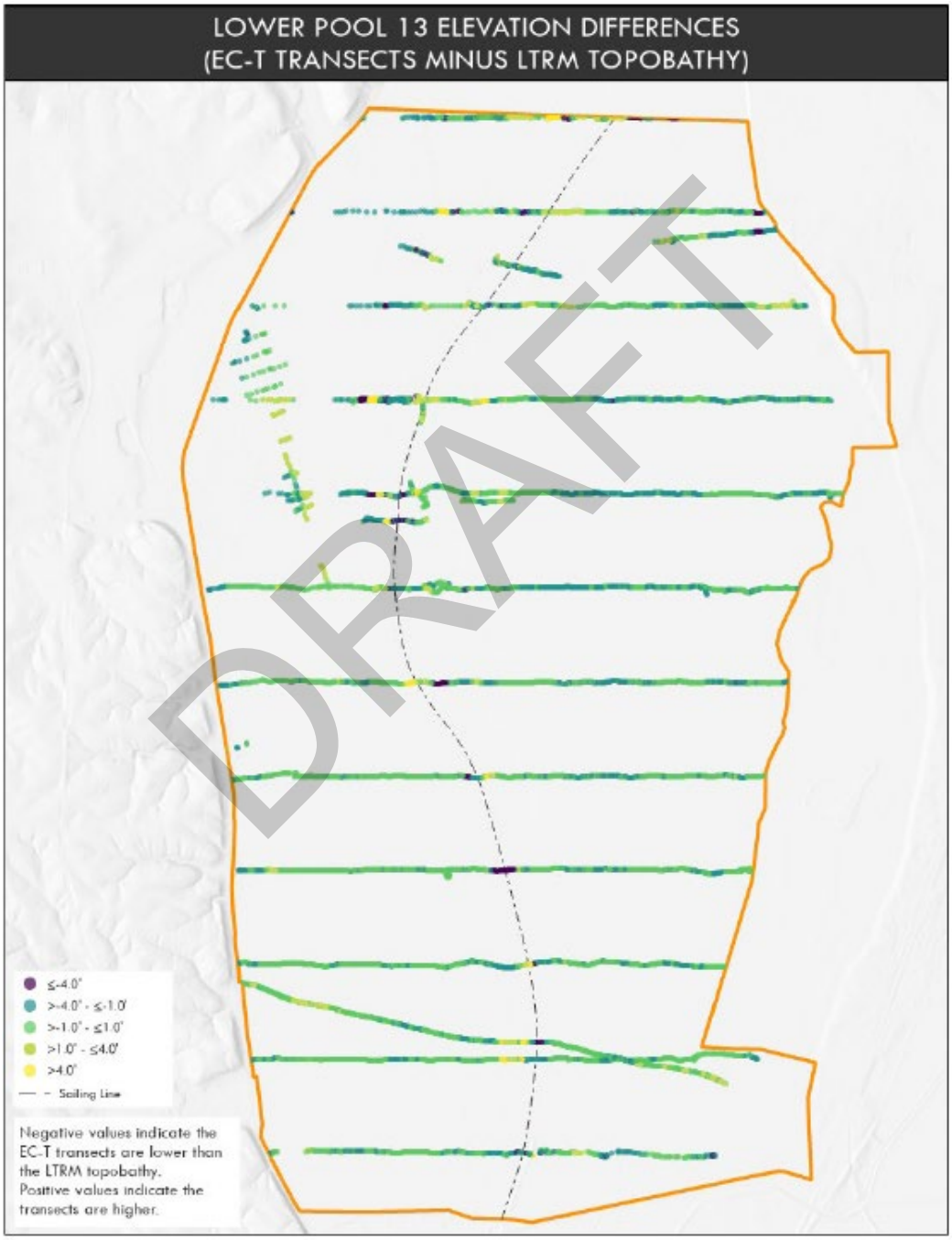


Figure 1. Lower Pool 13 Elevation Differences (EC-T Transects Minus LTRM Topobathy)

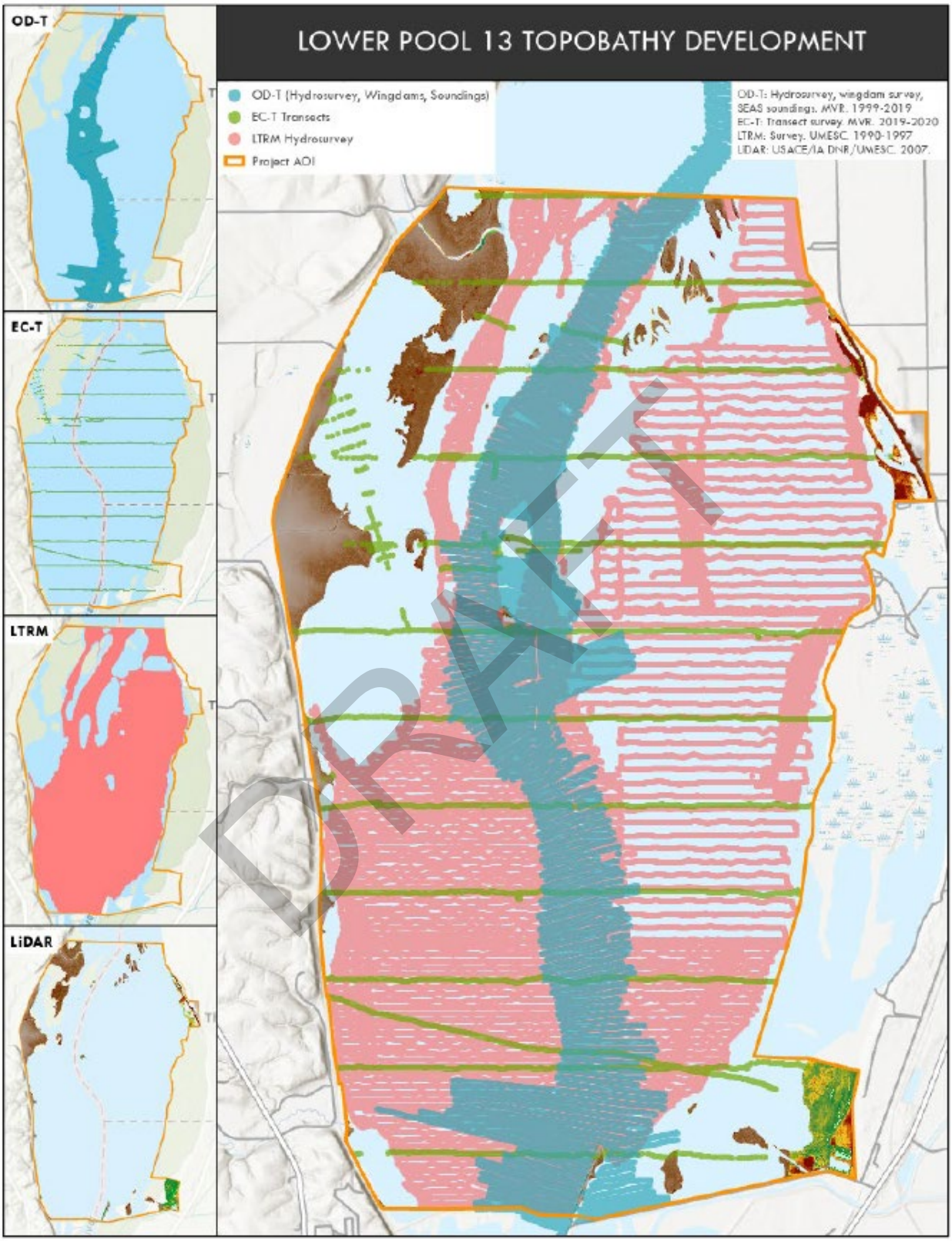
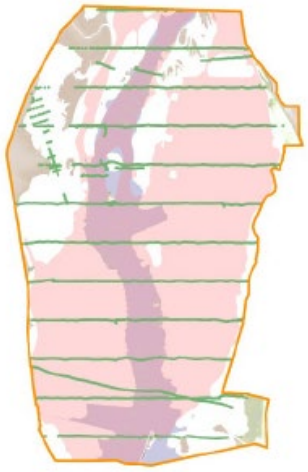


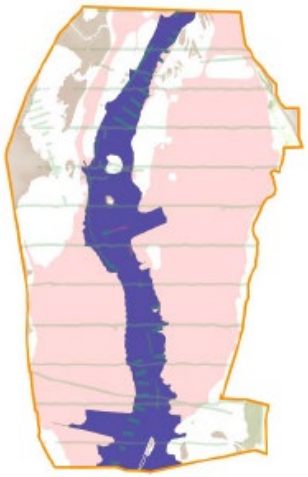
Figure 2. Lower Pool 13 Topobathy Development

Datasets for Constructing a New Surface



EC-T Survey Transects

- Agency: MVR
- Dates: Oct 2019 – Jan 2020
- Collection method: Soundings
- *In April 2021 it was determined that, due to the wide spacing between transects, for purposes of hydraulic modeling the transects did not provide significant benefit over the denser coverage provided by the OD-T hydrosurvey and the LTRM bathymetry. Additionally, the transects were highly "visible" in the completed surface model and although they provided the most recent coverage they prevented the surface from appearing cohesive. For these reasons they were removed from the surface*
- *and were not used in modeling efforts after April 2021.*



OD-T survey

- Agency: MVR, SEAS
- Hydrosurvey (MVR, 1999 – 2019, multibeam/singlebeam)
- Wingdam survey (MVR, 1999 – 2012, multibeam/singlebeam)
- Depth soundings (SEAS, 2014)
- Data type: Point
- Average accuracy: +/- 10-15cm (depending on survey age)
- Comparisons between this dataset and the EC-T transects indicate there is a minor vertical difference (0.009') and no shift is required
- Provides thorough coverage in the channel but does not extend into backwater areas



LTRM Bathymetric Survey

- Agency: USGS Upper Midwest Environmental Sciences Center (UMESC)
- Date collected: 1990, 1991, and 1997
- Collection method: Depth sounding
- Data type: Point
- Average accuracy: < 1 meter
- On average, points in the side-channel and backwater are 0.7' higher in elevation than EC-T transects in the same areas. These points will have a -0.7' adjustment applied before being used for analysis
- Does not cover backwater areas in the far northwest and southeast, limited coverage in the northern part of the pool

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LTRM LiDAR-derived DEM



- Agency: USACE, IA DNR, UMESC
- Date collected: 2007
- Collection method: LiDAR
- Data type: DEM (raster)
- Average accuracy: 0.6'
- Average point spacing:
  - o of values extracted from DEM (used here) – 1m
  - o of original LiDAR collect – 1.4m
- Hydroflattened LiDAR-derived DEM
  - o LiDAR collected by the IA DNR and USACE
  - o Post-processed by UMESC, DEM produced by UMESC
- Elevation value converted from meters to feet by multiplying by 3.281
- On average, the LTRM LiDAR was 2.17' higher than the EC-T survey in the same areas. An adjustment of -2.17' was applied to the LiDAR to compensate.
- LiDAR collects from the states of IA and IL were also considered (from 2007 and 2009, respectively) but both states did not post-process their data in the same ways. Because the LTRM program LiDAR is one cohesive product across the full project area, here it will be considered the most reliable available elevation model
- The LTRM topobathy elevation model (3-meter resolution) was also considered but will not be used because 1) the points used to create that model are already included in this elevation model and 2) interpolated values from that surface are not likely to be more accurate than interpolated values derived from the newer data used here

Final Surface Assembly

The final surface will be built from these datasets, ordered by accuracy and age. Older or less accurate data will be removed from within the footprint of more recent or more accurate data.

In order:

OD-T Survey

- This data represents continual survey-grade collection efforts within the channel and has already been processed by OD-T for inclusion in a surface model (i.e., older data has been removed from the footprint of more recent data)
- These surveys will be used in full alongside the EC-T survey transects. In the case of overlapping points (within 1 meter), whichever point was collected most recently will be preserved
- LTRM data that falls within the footprint of this dataset will not be used for surface creation

LTRM Bathymetric Survey

- Due to the age of this data, points that fall within the footprint (within 5 meters) of either OD-T or EC-T surveys (primarily within the channel) will be discarded, all other areas will be retained

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LTRM LiDAR-derived DEM

- Because this DEM has been hydroflattened it will not be used for bathymetry, only topography (i.e., islands and land surrounding the pool)
- Areas of the DEM that are 1) not hydroflattened and 2) not covered by any of the above datasets will be included in surface creation by converting the elevation value of each 1m cell to one vector point at the cell center

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT F
OPERATION AND MAINTENANCE

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1. OPERATION AND MAINTENANCE

Operation and maintenance of UMRR HREPs is similar to that undertaken by the partner agencies in day-to-day management of parks, boat ramps, wildlife management areas and other such public use areas. The purpose of assigning O&M costs to the federal or non-federal partner is to ensure commitment and accountability by the Project Sponsors. HREPs are designed and constructed to operate for 50 years with proper maintenance. This Project was designed to reduce overall operation costs. In general, operation is limited to routine inspections every 5 years to ensure that the measures are performing as designed (Table 1). Total estimates of operation costs every 5 years are shown in Appendix F, *Cost*. A complete list of operation needs would be provided in an O&M manual following construction completion.

Table 1. Operation and Maintenance Costs

	Quantity	Unit	Unit Price	Total Costs
Site inspections every 5 years				
Agency Site Inspections (all constructed measures)	32	Hours	$100.00	$3,200.00
USACE Site Inspections (all constructed measures)	60	Hours	$100.00	$6,000.00
				$9,200.00

2. REPAIR, REHABILITATION, AND REPLACEMENT CONSIDERATIONS

For analysis purposes, the costs presented for operation and maintenance used the 50-year period of analysis. The USFWS is expected to operate and maintain the Project per the agreed-to terms in the Memorandum of Agreement (Appendix A, *Environmental*) and should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. Table 2 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 2. Repair, Rehabilitation, and Replacement Considerations

Component	Frequency
Replace Rock Structures	Every 75 years

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT G
DATA MANAGEMENT

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1. DATA MANAGEMENT PLAN

The various documents generated throughout the life of this project represent a considerable investment that may have secondary and tertiary uses beyond the original intent for which they were developed and funded. Accordingly, this Data Management Plan has been developed with the goal of maximizing the long-term value of the information contained in these documents.

1.1. Decision Document and Appendices

Decision Document, Appendices, and related information will be properly archived electronically on the Upper Mississippi River Restoration (UMRR) website and ProjectWise (PW). Hardcopies are to be given to the Rock Island District (MVR) library, engineering, and planning branches. All of the assembled field data, engineering products and contract administration related information created in association with this project may be required to support Design Changes and or Construction Changes throughout the life of this project. Moreover, all of the documentation generated may be required to resolve issues or support the Federal Government's position should conflicts arise associated with the Architect, Engineer, or Construction Contractor responsibility.

1.2. As-Builts and Operation and Maintenance (O&M) Manuals

The completed As-Built Drawing files, Final Design, and the O&M Manuals generated throughout the execution of this project are necessary for the Sponsor's future use in the upkeep and alteration of the completed project features and therefore must be properly archived electronically on the UMRR website, and PW. Hardcopies are to be given to the MVR library, engineering, and planning branches. Hardcopies will also be provided to the sponsors and the states.

1.3. Hazardous, Toxic, Radioactive Waste (HTRW) and Geotech Data

The HTRW and Geotech Investigation Data may have future application in Master Planning, NEPA Compliance efforts, and design activities associated with land adjoining the Project site and therefore must be properly archived for transfer to the Sponsor and incorporated in the appropriate data library.

1.4. Geographic Information Systems Data

The collected survey data and geospatial products may have applications for other nearby projects and/or upgrade to GIS maintained by MVR or others, and therefore the data must be compiled and properly archived for transfer to the Client and incorporated into the appropriate data library. See Appendix E, *Engineering*, Attachment E, *Survey Mapping and Geospatial Data,* for more information.

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX E
ENGINEERING

ATTACHMENT H
HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

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APPENDIX E
ENGINEERING APPENDIX

ATTACHMENT H
HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE
DOCUMENTATION REPORT

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ATTACHMENT H-A Study Area
ATTACHMENT H-B Historical Aerial Photographs

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1. GENERAL

1.1. Authority

The Lower Pool 13 Habitat Rehabilitation and Enhancement Project (HREP; Project) is an ecosystem restoration project being developed through the Upper Mississippi River Restoration (UMRR) Program. The UMRR Program, authorized by the Water Resources Development Act (WRDA) of 1986 under Section 1103 and extended indefinitely by the WRDA of 1999, is a Federal/State partnership program for planning, construction and evaluation of fish and wildlife habitat rehabilitation projects and for monitoring the natural resources of the river system. It is a regional program that includes the U. S. Army Corps of Engineers' (USACE) St. Paul, Rock Island, and St. Louis Districts. The purpose of the HREPs is to preserve and restore habitat on the Mississippi and Illinois floodplain river systems.

1.2. Guidance and Policy

The Corps' Engineering Regulation (ER) 1105-2-100, *Planning Guidance Notebook,* provides guidance for the conduct of Civil Works Planning. 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. Division Regulation 1165-2-132 provides divisional guidance for HTRW assessment for Civil Works projects. American Society for Testing and Materials (ASTM) Standards E1527-13 and E1528-06 provide a comprehensive guide for conducting Phase I Environmental Site Assessments (ESA). ASTM Standard E1903-97(2002) provides guidance for Phase II ESAs. These references provide information on what considerations are to be factored into project planning and implementation. The USACE policy 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

2.1. Purpose and Scope

The specific purpose of an HTRW Documentation Report 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 Lower Pool 13 HREP Feasibility Study.

This HTRW inquiry is required in order to minimize and prevent Federal liability under the Comprehensive Environmental Response, Compensation and Liability Act and to reduce any threats to Project workers and avoid costly delays associated with environmental abatement activities.

A Phase I ESA for the Feasibility Study area was conducted by personnel from the USACE Rock Island District (District) Environmental Engineering Section. Copies of the Phase I ESA are available from CEMVR-EC-DN.

2.2. Limiting Conditions and Methodologies Used

The techniques used to assess HTRW contamination within and adjacent to the study area consisted of review of historical documents, Federal and state environmental databases, aerial

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photographs, topographic maps, and conducting interviews and site visits. The scope of inquiry was limited to investigating onsite HTRW potential within the study boundaries as well as offsite HTRW potential within a reasonable distance (according to ASTM standards) from the Project.

3. STUDY AREA

3.1. Description

The study area is located on the Mississippi River between river miles 522.5 and 535.0 and is within Carroll and Whiteside Counties in Illinois, and Clinton County in Iowa. The study area is approximately 4,900 acres in size, comprised primarily of open water, with many islands ranging from less than an acre to more than ten acres in area. The US Fish and Wildlife Upper Mississippi River National Wildlife Refuge is present in and around the study area. Wetlands and backwater habitat are present on the borders of the study area on both shorelines.

To the east of the study area are relatively undeveloped woodlands, rural residential and agricultural properties. The village of Thomson, Illinois is located approximately ½ mile east of the eastern boundary of the study area. Lock and Dam 13 is located on the immediate southern boundary of the study area. To the west of the study area is Clinton County, and land use is predominately rural residential and agricultural properties. Approximately 1/2 mile southwest of the study area is the extreme northern boundary of the City of Clinton, IA. To the north of the study area is the Mississippi River and the remainder of Pool 13, with similar landscapes and land uses on both shorelines as exist to the east and west of the study area. Wetlands and backwater habitat are present on the borders of the study area on both shorelines.

The study area is located within portions of Sections 5, 6, 7, 8, 9, 16, 17 and 21 in Township 82 North, Range 7 East, and Sections 20, 21, 29, 30, 31 and 32 in Township 83 North, Range 7 East, in Clinton County, Iowa.

Attachment H-A includes a site plan of the study area.

3.2. Physical Setting

The USGS topographical maps from 1967, 1985 and 2018 were used for records review. Surface elevation for the study area ranges from approximately 590 feet on the banks of the study area to 750 feet above mean sea level (NAVD 1988) on the bluffs overlooking Pool 13. The study area is comprised of open water and islands in Pool 13 of the Mississippi River as well as floodplain forests on the shorelines of the Pool. Floodplain is present predominately on the Illinois side of the study area, where the floodplain is approximately 2 miles wide before encountering 100-to-150-foot bluffs. Floodplain landforms are minimal on the Iowa site of the study area, with bluffs fairly near the study area. Smaller floodplains are located at the mouths of Silver Creek and the Elk River in Clinton County, Iowa.
Surficial geology consists of Deforest Formation, Quaternary System silty clay loam and clay loams associated with the modern channel of the Mississippi River valley. Bedrock geology consists of Ordovician Age, Galena Group limestones and shales, and Maquoketa Formation dolomites and limestones.

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4. ENVIRONMENTAL SITE ASSESSMENT

A Phase I ESA was completed in the spring of 2022 for the study area and adjacent area. The Phase I ESA documented the study area history, reviewed state and Federal environmental databases, and identified potential Recognized Environmental Conditions (RECs).

4.1. Historical Use Information

The study area has been a forested island and floodplain complex since at least the 1890s. This determination is based on aerial photos (1927, 1938, 2004, 2011, 2018), topographic and chart maps (1890, 1915, 1967, 1985, 2018), as well as interviews. Population centers of Clinton, Iowa, Fulton, IL and Thomson, IL have been present since the mid-19th Century. The US Government purchased the properties of the study area in the 1930's in support of the Nine Foot Navigation Project on the adjacent Mississippi River for Pool 13/Lock and Dam 13. In 1945, the University of Iowa and the US Army conducted testing near the extreme southwest corner of the study area. This testing area included a north-south running strip of water in the pool on the southwestern corner of the study area and was closed in August 1945. Prior to the development of the Lock and Dam System, the study area was a typical section of the Mississippi River, with forested floodplain, meanders, oxbows and island complexes. After the development of Pool 13, the study area converted to a large, inundated area, resembling a large lake. Currently, the US Fish and Wildlife Service manages the study area lands.

Attachment H-B includes historic aerial photos of the study area.

4.2. Site Reconnaissance

Site visits were conducted by USACE representatives Steve Gustafson and Kara Mitvalsky on August 19, 2019, August 18, 2020, September 15, 2020 and October 30, 2020. A reconnaissance was performed with visual inspection of surrounding properties. The following observations were made:

- No indications of spills or staining were observed on the natural or manmade surfaces.
- No indications of hazardous materials storage areas.
- No indications of refuse or illegal dumping.

4.3. Findings

The Phase I ESA identified one Historic REC in or near the study area:

The potential for testing pollutants in sediments in the extreme southwest corner of the project area based on US Army Ordnance Department activities conducted during World War II.

5. CONCLUSIONS

There is one Historic REC present near the study area. This area of the Historic REC has been designated as a No Work Zone in regard to HREP measures, and therefore no construction activities will occur there. No other REC's, real or potential HTRW issues are present in the study area.

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6. RECOMMENDATIONS

No further HTRW assessment is recommended.

7. LIMITATIONS

No ESA can wholly eliminate uncertainty regarding the existence for recognized environmental conditions concerning a property. This assessment is intended to reduce, but not eliminate, uncertainty regarding the existence of recognized environmental conditions in connection with a property with reasonable limits of time and cost. If any previously unaddressed recognized environmental condition should arise, this HTRW Documentation Report will be revisited. Title searches and research into environmental liens were not conducted for this report, but will be required prior to construction phase of the preferred alternative.

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APPENDIX E
ENGINEERING

ATTACHMENT H-A
SURVEY, MAPPING, AND GEOSPATIAL DATA

STUDY AREA

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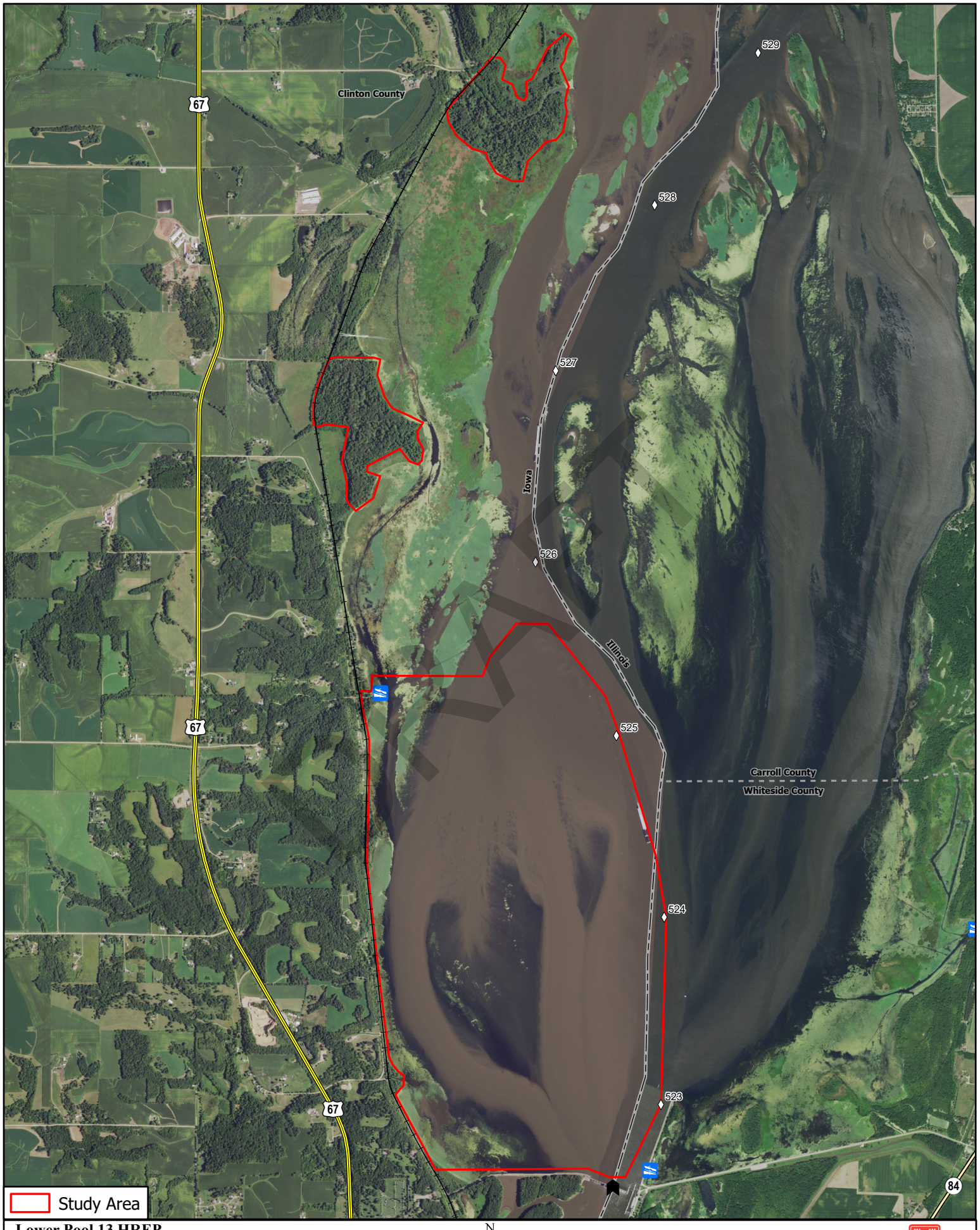

Lower Pool 13 HREP
Study Area
Map Produced: 4/22/2022

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US Army Corps of Engineers
Rock Island District

APPENDIX E
ENGINEERING

ATTACHMENT H-B
HISTORICAL AERIAL PHOTOGRAPHS

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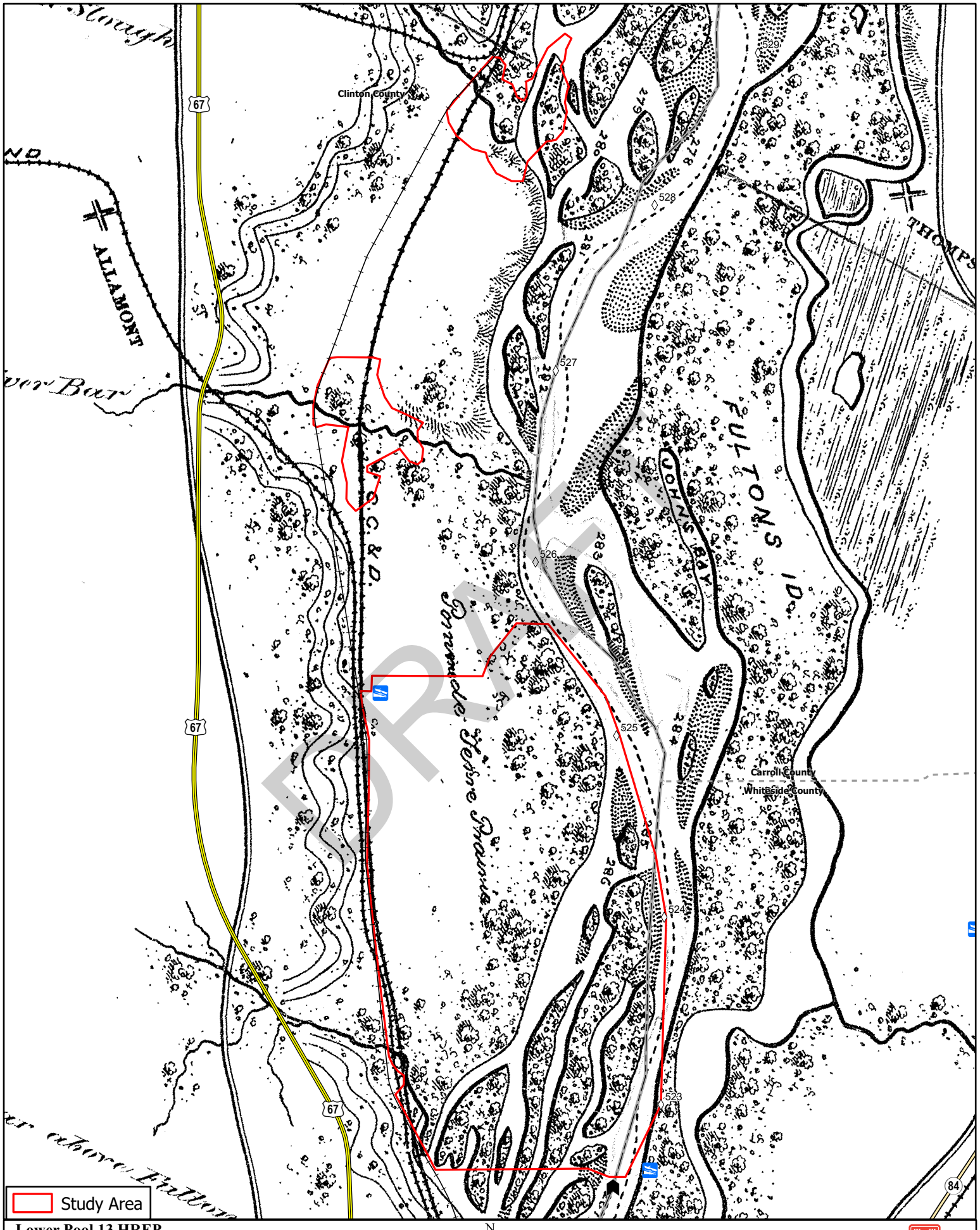
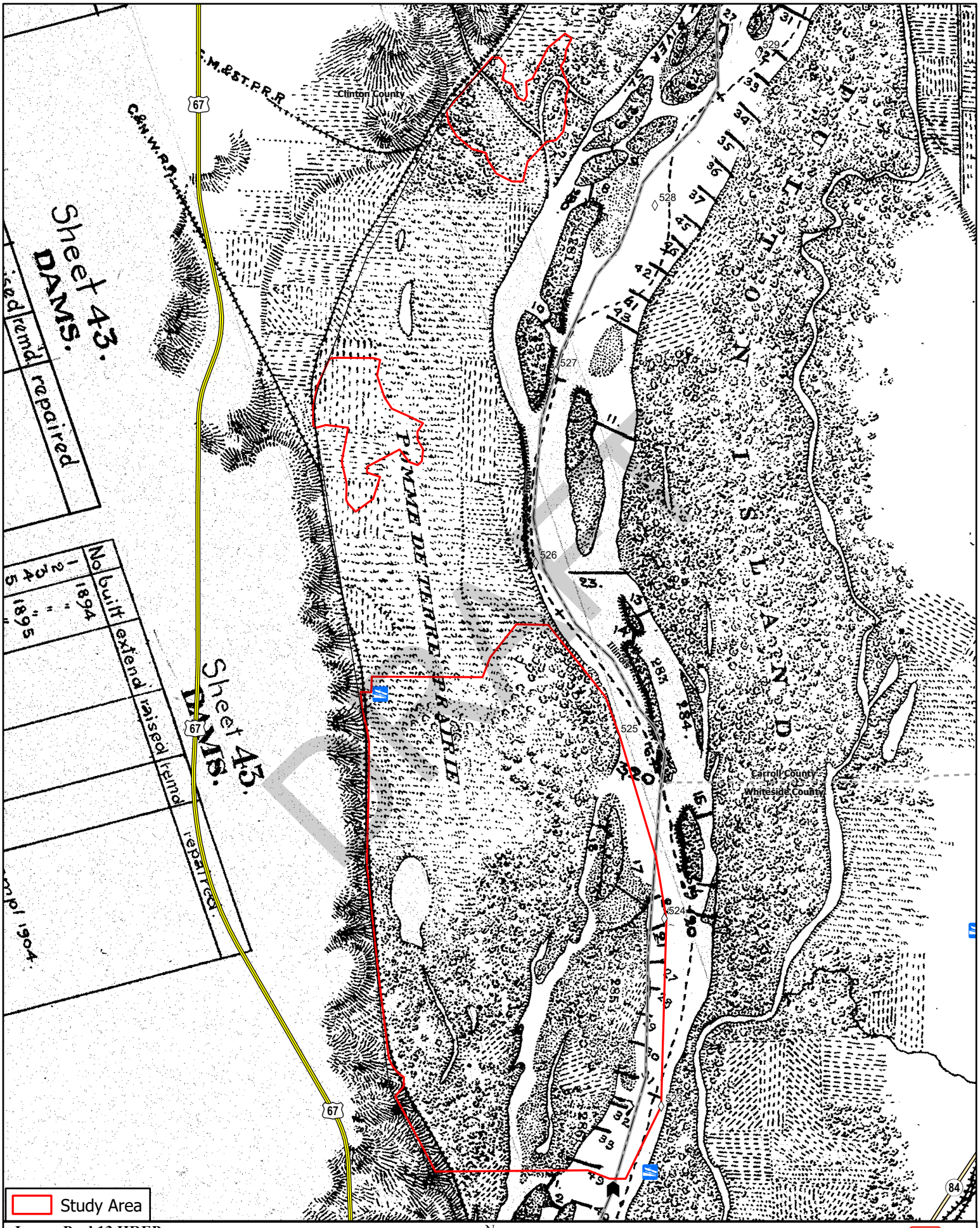


Lower Pool 13 HREP
Study Area over 1878 Farquhar Map
Map Produced: 4/22/2022

US Army Corps of Engineers
Rock Island District



Lower Pool 13 HREP
Study Area over 1915 Hoffman Chart
Map Produced: 4/22/2022

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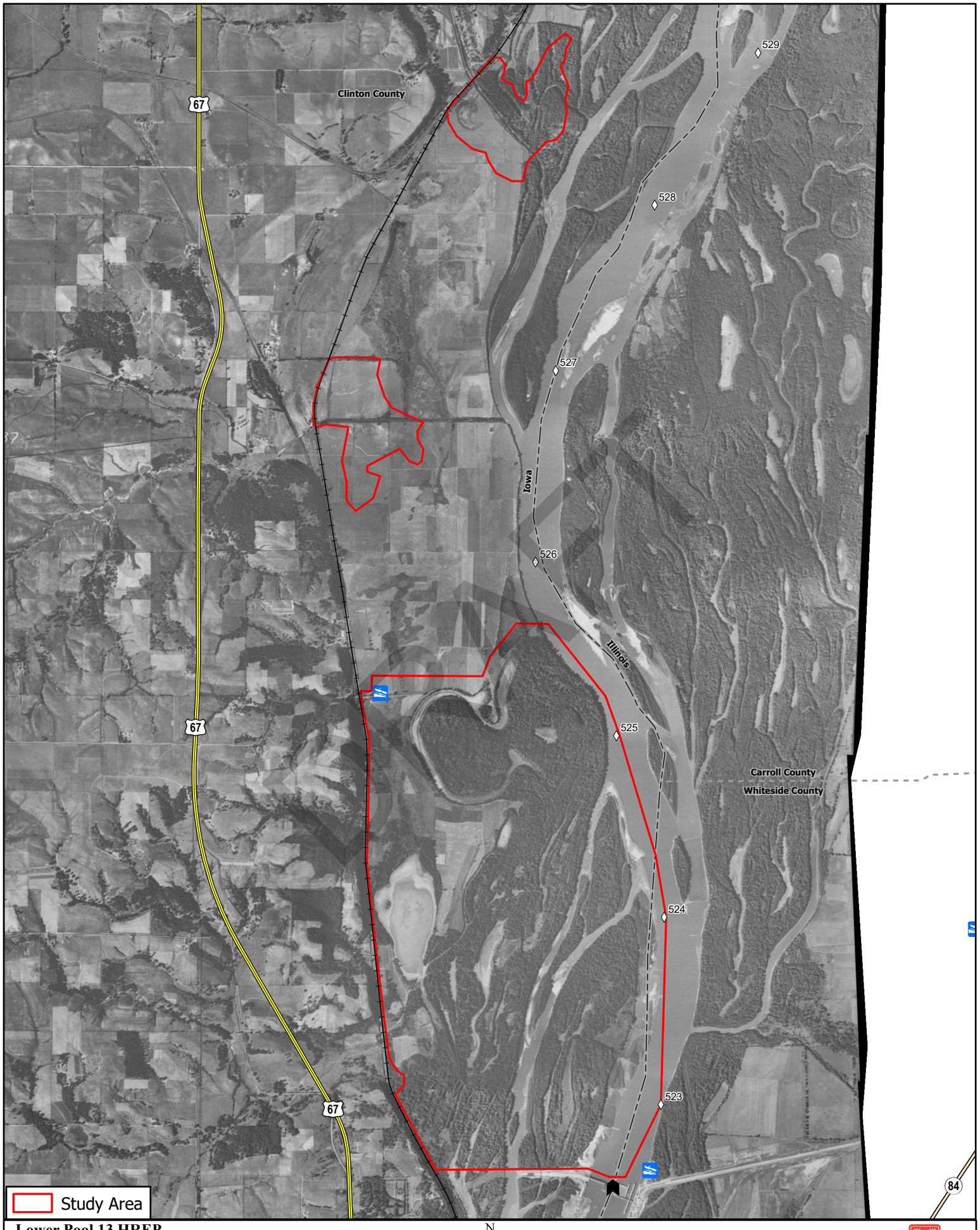

Lower Pool 13 HREP
Study Area over 1930 Iowa Ortho Imagery
Map Produced: 4/22/2022

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Lower Pool 13 HREP
Study Area over 2004 NAIP NC Imagery
Map Produced: 4/22/2022

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Lower Pool 13 HREP
Study Area over 2010 NAIP CIR Imagery
Map Produced: 4/22/2022

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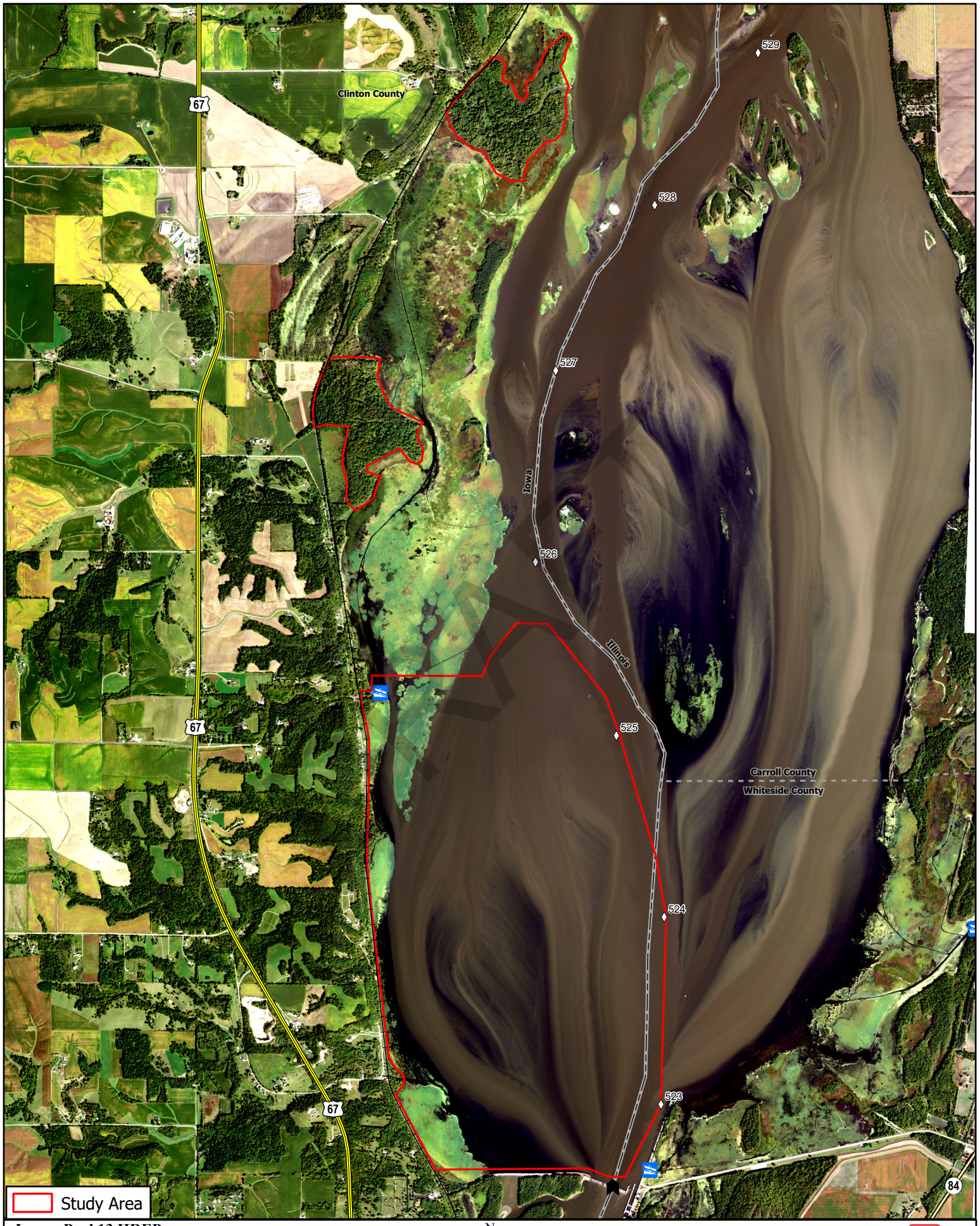
Rock Island District



Lower Pool 13 HREP
Study Area over 2017 NAIP NC Imagery
Map Produced: 4/22/2022

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Rock Island District

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX F
COST ENGINEERING

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX F
COST ENGINEERING

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1.5 Abbreviated Risk Analysis on the Maximum Alternative F-3
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1 COSTS FOR ALTERNATIVE EVALUATION

1.1 Basis of Estimate

The cost estimates for the Alternatives based on features developed by the PDT and quantity computations developed by EC-DN.

The quantities for the design were developed and checked by EC-DN. Quantities for the alternatives are computed in the spreadsheet and summarized below for the Maximum Alternative (Alternative 2), Efficient Alternative (Alternative 3), and the Submerged Aquatic Vegetation (SAV) Alternative (Alternative 4). Alternative 1 is the “No Action” alternative, and all quantities and costs are zero for Alternative 1.

1.2 Project Schedule

The project is currently in the feasibility phase. The planned start of pre-construction engineering and design is FY23 with construction starting in FY26.

1.3 Acquisition Strategy

The acquisition strategy is not yet determined. Based on previous HREP, the project would be separated into multiple independent stages with a total contract price in the $5M range. The first contract would be for the Forest Management features (for the alternatives that include Forest Management). The subsequent construction contracts would be the in-water features with contract awards every two years until the project is complete.

The solicitation is assumed to be a Small Business invitation for bids. The cost estimate assumes that the prime contractor would perform the majority of the work. The risks of awarding to a Small Business not capable of self-performing or not familiar with USACE processes are captured in the Abbreviated Risk Analysis.

1.4 Estimated Costs

The costs for each alternative were developed for the construction, the Planning Engineering and Design (PED), Construction Management (CM). The real estate costs are assumed to be zero as the project is 100% on Federal land.

1.4.1 Construction Cost Estimate

The estimated construction costs for the alternatives were developed using MCACES Second Generation (MII).

1.4.1.1 Labor

Labor rates are from the Davis Bacon Report for Clinton County, IA for Heavy and Highway Construction - IA20220002 dated 06/03/2022.

1.4.1.2 Equipment

The rates for equipment use the 2020 Equipment Manual for Region 5 along with current fuel rates from eia.gov and the cost of money as of July 2022.

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1.4.1.3 Material

Material costs are at the 2022 price level.

1.4.1.4 Markups

Contractor Markups
- Prime Contractor
  - Job Office Overhead (JOOH): 13%
  - Home Office Overhead (HOOH): 10%
  - Profit: 9.46% using profit weighted guidelines
  - Bond: Type B Bond Table
  - Insurance: 3%
- Survey Subcontractor and Quality Control Subcontractor
  - JOOH: 13%
  - HOOH: 10%
  - Profit: 8%
- Direct Cost Markups
  - Productivity: 95%
  - Overtime: Assumes 10-hour days at 5 days per week

Contractor Markups and Direct Cost Markups have not been applied to the Forest Management. The costs for Forest Management are derived from contract unit prices from recent construction contracts for similar work. In MII, a “dummy” contractor was created without any markups, and the Forest Management work was assigned to that “dummy” contractor. The Forest Management is assumed to be completed by a competent contractor experienced in forest manage.

Project Markups for escalation and contingency were not applied in the MII cost estimate. Escalation and contingency are included on the Total Project Cost Summary (TPCS) for each alternative.

Reports on the estimated construction cost were created for each of the alternatives.

1.4.2 Planning, Engineering and Design

The costs for PED are assumed to be proportional to the costs of construction. The percentages are detailed in the TPCS.

1.4.3 Construction Management

The costs for CM are assumed to be proportional to the costs of construction. The percentages are detailed in the TPCS.

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1.4.4 Real Estate

The project is located on Federal land. No real estate acquisition or costs associated with Lands Damages are expected.

1.5 Abbreviated Risk Analysis on the Maximum Alternative

An Abbreviate Risk Assessment Meeting was held on 28 Jan 2022 on Alternative 2, the MAX Alternative. The PDT assessed the risks associated with the MAX Alternative and developed a composite contingency of 48% (Table F-1). The contingency determination from the MAX Alternative is being applied to the other two alternatives because the features in all the alternatives are similar. The risks and the resulting contingency are assumed to be the same for all three alternatives.

Table F-1. Abbreviated Risk Analysis Summary

Abbreviated Risk Analysis

Project (less than $40M): **Alternatives for Lower Pool 13 HREP** — **Alternative:** **Alt 2 (MAX)**
Project Development Stage/Alternative: **Feasibility (Alternatives)**
Risk Category: **Low Risk: Typical Construction, Simple** — **Meeting Date:** **1/28/2022**

Total Estimated Construction Contract Cost = $ 26,123,000

	CWWBS	Feature of Work	Estimated Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ -		0%	$ -	$ -
1	06 FISH AND WILDLIFE FACILITIES	Forest Management	$ 1,678,000		33%	$ 551,272	$ 2,229,272
2	09 01 CHANNELS	Access Dredging	$ 7,119,000		73%	$ 5,165,678	$ 12,284,678
3	09 01 CHANNELS	Dredge Disposal	$ 3,471,000		63%	$ 2,171,630	$ 5,642,630
4	16 BANK STABILIZATION	Chevrons, Rock Mounds, Island	$ 13,855,000		47%	$ 6,550,307	$ 20,405,307
12	All Other	Remaining Construction Items	$ -	*0.0%*	0%	$ -	$ -
13	30 PLANNING, ENGINEERING, AND DESIGN	Planning, Engineering, & Design	$ 9,143,050		37%	$ 3,350,081	$ 12,493,131
14	31 CONSTRUCTION MANAGEMENT	Construction Management	$ 3,395,990		18%	$ 598,734	$ 3,994,724

Totals					
Real Estate	$ -		0%	$ -	$ -
Total Construction Estimate	$ 26,123,000		55%	$ 14,438,888	$ 40,561,888
Total Planning, Engineering & Design	$ 9,143,050		37%	$ 3,350,081	$ 12,493,131
Total Construction Management	$ 3,395,990		18%	$ 598,734	$ 3,994,724
Total Excluding Real Estate	**$ 38,662,040**		**48%**	**$ 18,387,702**	**$ 57,049,742**
			Base	**50%**	**80%**
Confidence Level Range Estimate ($000's)			$38,662k	$49,695k	$57,050k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	Real Estate Risk: If there are changes to access or staging that could be situated on non-USACE land, we would have to calculate a potential risk/value for Temporary Road or Temporary Work Area Easements.

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1.6 Other Costs

Management and Adaptive Monitoring (M&AM) was applied as a percentage of the estimated construction cost for each of the alternatives. Subject Matter Expert (SME) input determined 7.5% was appropriated based on similar previous projects. M&AM costs are captured within the PED costs in the TPCS. M&AM will be reassessed as the Tentatively Selected Plan (TSP) is developed in more detail.

Operations and Maintenance (O&M) costs were developed by SMEs based on similar past projects (Table F-2).

Table F-2. Operations and Maintenance Costs by Alternatives

Max Alternative	Quantity	Unit	Unit Price	Total Costs
Annual every year for 50 years				
Agency Site Inspections (all constructed measures)	120	Hours	$100.00	$12,000.00
Corps Site Inspections (all constructed measures)	60	Hours	$100.00	$6,000.00
First 5 years for forest (annual)				
Agency Site Inspection (Forestry)	40	Hours	$100.00	$4,000.00
Corps Site Inspections (Forestry)	80	Hours	$100.00	$8,000.00
Forestry effort (Corps)	2	(at 25 years at 50 years)	$100,000.00	$200,000.00
Efficient Alternative	**Quantity**	**Unit**	**Unit Price**	**Total Costs**
Annual every year for 50 years				
Agency Site Inspections (all constructed measures)	120	Hours	$100.00	$12,000.00
Corps Site Inspections (all constructed measures)	60	Hours	$100.00	$6,000.00
First 5 years for forest (annual)				
Agency Site Inspection (Forestry)	40	Hours	$100.00	$4,000.00
Corps Site Inspections (Forestry)	80	Hours	$100.00	$8,000.00
Forestry effort (Corps)	2	(at 25 years at 50 years)	$100,000.00	$200,000.00
SAV Alternative	**Quantity**	**Unit**	**Unit Price**	**Total Costs**
Annual every year for 50 years				
Agency Site Inspections (all constructed measures)	120	Hours	$100.00	$12,000.00
Corps Site Inspections (all constructed measures)	60	Hours	$100.00	$6,000.00

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1.7 Construction Schedule for Alternatives

The construction schedule for each alternative was developed using inputs from the detailed construction cost estimate and the assumed workday of 10 hours (Table F-3).

Table F-3. Constructions Schedule for Alternatives

Max Alternative	**Start**	**Finish**
Construction Phase	Wed 10/1/25	Wed 2/28/35
Stage I - Forest Management	Wed 10/1/25	Fri 11/10/28
Stage II - Chevrons and Island	Fri 1/1/27	Thu 3/29/29
Stage III - Upper Rock Mounds	Mon 1/1/29	Wed 11/13/30
Stage IV - Middle Rock Mounds	Wed 1/1/31	Thu 1/27/33
Stage V - Lower Rock Mound	Sat 1/1/33	Wed 2/28/35
Efficient Alternative	**Start**	**Finish**
Construction Phase	10/1/25	1/27/33
Stage I - Forest Management	10/1/25	11/10/28
Stage II - Chevrons and Island	1/1/27	3/29/29
Stage III - Upper Rock Mounds	1/1/29	11/12/30
Stage IV - Middle Rock Mounds	1/1/31	1/27/33
SAV Alternative	**Start**	**Finish**
Construction Phase	Fri 1/1/27	Wed 2/28/35
Stage I - Chevrons and Island	Fri 1/1/27	Thu 3/29/29
Stage II - Upper Rock Mounds	Mon 1/1/29	Tue 11/12/30
Stage III - Middle Rock Mounds	Wed 1/1/31	Thu 1/27/33
Stage IV - Lower Rock Mound	Sat 1/1/33	Wed 2/28/35

1.8 Total Project Cost for Alternatives

Total Project Costs Summary sheets were developed for each alternative (Figure F-1).

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**** TOTAL PROJECT COST SUMMARY ****

Printed:8/23/2022
Page 1 of 11

PROJECT: Lower Pool 13 HREP, Maximum Plan (Alt 2)
PROJECT NO: P2 469162
LOCATION: Clinton County, Iowa and Whiteside County, Illinois

DISTRICT: Rock Island District (MVR)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 8/1/2022

This Estimate reflects the scope and schedule in report; UMRR Feasibility Report Lower Pool 13 HREP

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2023									
						Effective Price Level Date: 1 OCT 22									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1-Oct-21 ($K)	TOTAL FIRST COST ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J		K	L	M	N	O
06	FISH & WILDLIFE FACILITIES	$1,678	$805	48.0%	$2,483	4.2%	$1,749	$839	$2,588	$0	$2,588	11.0%	$1,941	$931	$2,872
09	CHANNELS & CANALS	$12,293	$5,901	48.0%	$18,194	4.2%	$12,812	$6,150	$18,962	$0	$18,962	21.6%	$15,579	$7,478	$23,057
16	BANK STABILIZATION	$17,486	$8,393	48.0%	$25,879	4.2%	$18,225	$8,748	$26,972	$0	$26,972	25.3%	$22,826	$10,957	$33,783
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0 -		$0	-	$0	$0	$0	$0	$0		$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0 -		$0	-	$0	$0	$0	$0	$0		$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0 -		$0	-	$0	$0	$0	$0	$0		$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0 -		$0	-	$0	$0	$0	$0	$0		$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0 -		$0	-	$0	$0	$0	$0	$0		$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$31,457	$15,099		$46,556	4.2%	$32,786	$15,737	$48,523	$0	$48,523	23.1%	$40,346	$19,366	$59,712
01	LANDS AND DAMAGES	$0	$0 -		$0	-	$0	$0	$0	$0	$0		$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$11,010	$5,285	48.0%	$16,295	2.5%	$11,285	$5,417	$16,702	$0	$16,702	18.6%	$13,380	$6,422	$19,803
31	CONSTRUCTION MANAGEMENT	$4,089	$1,963	48.0%	$6,052	2.5%	$4,192	$2,012	$6,204	$0	$6,204	23.3%	$5,168	$2,481	$7,649
	PROJECT COST TOTALS:	$46,556	$22,347	48.0%	$68,903		$48,263	$23,166	**$71,429**	$0	**$71,429**	22.0%	$58,894	$28,269	$87,164

_____ CHIEF, COST ENGINEERING, xxx

_____ PROJECT MANAGER, xxx

_____ CHIEF, REAL ESTATE, xxx

_____ CHIEF, PLANNING, xxx

_____ CHIEF, ENGINEERING, xxx

_____ CHIEF, OPERATIONS, xxx

_____ CHIEF, CONSTRUCTION, xxx

_____ CHIEF, CONTRACTING,xxx

_____ CHIEF, PM-PB, xxxx

_____ CHIEF, DPM, xxx

ESTIMATED TOTAL PROJECT COST: **$87,164**

PLANNING SPENT COST: **$1,431**
ESTIMATED TOTAL FEDERAL PROJECT COST: **$88,595**

Filename: B5UMRR131801-EST_COST-2021-12-10-TPCS_Alt2.xlsx
TPCS

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Figure F-1. Total Project Cost Summary Sheet for the Maximum Alternative

**** TOTAL PROJECT COST SUMMARY ****

Printed:8/23/2022
Page 1 of 11

PROJECT: Lower Pool 13 HREP, Efficient Plan (Alt 3)
PROJECT NO: P2 469162
LOCATION: Clinton County, Iowa and Whiteside County, Illinois

DISTRICT: Rock Island District (MVR)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 8/1/2022

This Estimate reflects the scope and schedule in report; UMRR Feasibility Report Lower Pool 13 HREP

Program Year (Budget EC): 2023
Effective Price Level Date: 1 OCT 22

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1-Oct-21 ($K)	TOTAL FIRST COST ($K)	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)	
A	B	C	D	E	F	G	H	I	J		K	L	M	N	O	
06	FISH & WILDLIFE FACILITIES	$789	$379	48.0%	$1,168	4.2%	$822	$395	$1,217		$0	$1,217	9.6%	$901	$432	$1,333
09	CHANNELS & CANALS	$8,929	$4,286	48.0%	$13,215	4.2%	$9,306	$4,467	$13,773		$0	$13,773	19.9%	$11,159	$5,357	$16,516
16	BANK STABILIZATION	$7,368	$3,537	48.0%	$10,905	4.2%	$7,679	$3,686	$11,365		$0	$11,365	18.3%	$9,087	$4,362	$13,449
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0		$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0		$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0		$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0		$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0		$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$17,086	$8,201		$25,287	4.2%	$17,808	$8,548	$26,355		$0	$26,355	18.8%	$21,147	$10,151	$31,298
01	LANDS AND DAMAGES	$0	$0	-	$0	-	$0	$0	$0		$0	$0	-	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$5,980	$2,870	48.0%	$8,851	2.5%	$6,130	$2,942	$9,072		$0	$9,072	14.8%	$7,036	$3,377	$10,413
31	CONSTRUCTION MANAGEMENT	$2,221	$1,066	48.0%	$3,287	2.5%	$2,277	$1,093	$3,370		$0	$3,370	18.8%	$2,704	$1,298	$4,002
	PROJECT COST TOTALS:	$25,287	$12,138	48.0%	$37,425		$26,214	$12,583	$38,797		$0	$38,797	17.8%	$30,888	$14,826	$45,714

_____ CHIEF, COST ENGINEERING, xxx
_____ PROJECT MANAGER, xxx
_____ CHIEF, REAL ESTATE, xxx
_____ CHIEF, PLANNING, xxx
_____ CHIEF, ENGINEERING, xxx
_____ CHIEF, OPERATIONS, xxx
_____ CHIEF, CONSTRUCTION, xxx
_____ CHIEF, CONTRACTING,xxx
_____ CHIEF, PM-PB, xxxx
_____ CHIEF, DPM, xxx

ESTIMATED TOTAL PROJECT COST: $45,714

PLANNING SPENT COST: $1,431
ESTIMATED TOTAL FEDERAL PROJECT COST: $47,145

Filename: B5UMRR131801-EST_COST-2021-12-10-TPCS_Alt3.xlsx
TPCS

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Figure F-2. Total Project Cost Summary Sheet for the Efficient Alternative

**** TOTAL PROJECT COST SUMMARY ****

Printed:8/23/2022
Page 1 of 11

PROJECT: Lower Pool 13 HREP, "SAV" Plan (Alt 4)
PROJECT NO: P2 469162
LOCATION: Clinton County, Iowa and Whiteside County, Illinois

DISTRICT: Rock Island District (MVR)
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 8/1/2022

This Estimate reflects the scope and schedule in report; UMRR Feasibility Report Lower Pool 13 HREP

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2023 Effective Price Level Date: 1 OCT 22									
WBS NUMBER A	Civil Works Feature & Sub-Feature Description B	COST ($K) C	CNTG ($K) D	CNTG (%) E	TOTAL ($K) F	ESC (%) G	COST ($K) H	CNTG ($K) I	TOTAL ($K) J	Spent Thru: 1-Oct-21 ($K)	TOTAL FIRST COST ($K) K	INFLATED (%) L	COST ($K) M	CNTG ($K) N	FULL ($K) O
06	FISH & WILDLIFE FACILITIES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
09	CHANNELS & CANALS	$11,911	$5,717	48.0%	$17,628	4.2%	$12,414	$5,959	$18,373	$0	$18,373	22.1%	$15,154	$7,274	$22,427
16	BANK STABILIZATION	$15,510	$7,445	48.0%	$22,955	4.2%	$16,165	$7,759	$23,924	$0	$23,924	25.7%	$20,325	$9,756	$30,081
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
ALL	COMPOSITE INDEX (WEIGHTED AVERAGE	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$27,421	$13,162		$40,583	4.2%	$28,579	$13,718	$42,297	$0	$42,297	24.1%	$35,479	$17,030	$52,508
01	LANDS AND DAMAGES	$0	$0	-	$0	-	$0	$0	$0	$0	$0	-	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$9,597	$4,607	48.0%	$14,204	2.5%	$9,837	$4,722	$14,559	$0	$14,559	19.8%	$11,783	$5,656	$17,439
31	CONSTRUCTION MANAGEMENT	$3,565	$1,711	48.0%	$5,276	2.5%	$3,654	$1,754	$5,408	$0	$5,408	24.3%	$4,542	$2,180	$6,722
	PROJECT COST TOTALS:	$40,583	$19,480	48.0%	$60,063		$42,070	$20,194	$62,264	$0	$62,264	23.1%	$51,804	$24,866	$76,669

_____ CHIEF, COST ENGINEERING, xxx

_____ PROJECT MANAGER, xxx

_____ CHIEF, REAL ESTATE, xxx

_____ CHIEF, PLANNING, xxx

_____ CHIEF, ENGINEERING, xxx

_____ CHIEF, OPERATIONS, xxx

_____ CHIEF, CONSTRUCTION, xxx

_____ CHIEF, CONTRACTING,xxx

_____ CHIEF, PM-PB, xxxx

_____ CHIEF, DPM, xxx

ESTIMATED TOTAL PROJECT COST: **$76,669**

PLANNING SPENT COST: **$1,431**
ESTIMATED TOTAL FEDERAL PROJECT COST: **$78,100**

Filename: B5UMRR131801-EST_COST-2021-12-10-TPCS_Alt4.xlsx
TPCS

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Figure F-3. Total Project Cost Summary Sheet for the SAV Only Alternative

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

LOWER POOL 13
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER MILES 522.5-529.0
CARROLL AND WHITESIDE COUNTIES, ILLINOIS
AND CLINTON COUNTY, IOWA

APPENDIX G
PLATES

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DRAFT

US Army Corps
of Engineers®

ROCK ISLAND DISTRICT

MISSISSIPPI RIVER BASIN
LOWER POOL 13 SOUTHWEST CORNER
CLINTON COUNTY IA, CARROLL AND WHITESIDE COUNTIES IL
LOWER POOL 13 HABITAT REHABILITATION AND ENHANCEMENT PROJECT



SOLICITATION/MATOC/SATOC NO:

CONTRACT/TASK ORDER NO:

ISSUE DATE: MAY 2022

DRAFT

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: T GAMBON
DRAWN BY: J FRATAMICO
CHECKED BY: K MITVALSKY
SUBMITTED BY: A HEDLESTEN
SCALE: AS NOTED
ISSUE DATE: 2022/05/20
SOLICITATION NO.:
CONTRACT NO.:
B5UMRR131601

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
LOWER POOL 13 SOUTHWEST CORNER
CLINTON COUNTY IA, CARROLL AND WHITESIDE COUNTIES IL
LOWER POOL 13 HABITAT REHABILITATION AND ENHANCEMENT PROJECT

COVER SHEET

SHEET ID

G-001

REVIEW

GENERAL NOTES

1. NOTE 1
2. NOTE 2
3. NOTE 3

DRAFT

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: T GAMBON	ISSUE DATE: 2022/05/20
DRAWN BY: J FRATAMICO	SOLICITATION NO.:
CHECKED BY: K MITVALSKY	CONTRACT NO.:
SUBMITTED BY: A HEDDLESTEN	B5UMRR131801
SIZE: ANSI D	

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
LOWER POOL 13 SOUTHWEST CORNER
CLINTON COUNTY IA, CARROLL AND WHITESIDE COUNTIES IL
LOWER POOL 13 HABITAT REHABILITATION AND ENHANCEMENT PROJECT

INDEX AND GENERAL NOTES

SHEET ID

G-002

REVIEW

ABBREVIATIONS

L	ANGLE	CS	CAST STONE	FRT	FIRE-RETARDANT	LTG	LIGHTING	PS CONC	PRESTRESSED CONCRETE	THK	THICK(NESS)				
A/C	AIR CONDITIONING	CSK	COUNTERSUNK	FS	FULL SIZE	LTNG	LIGHTNING	PSF	POUNDS PER SQUARE FOOT	THRES	THRESHOLD				
A/C UNIT	AIR CONDITIONING UNIT	CSMT	CASEMENT	FSTNR	FASTEN(ER)	LVR	LOUVER	PSI	POUNDS PER SQUARE INCH	TK BD	TACKBOARD				
AB	ANCHOR BOLT	CT	CERAMIC TILE	FT	FEET	LWC	LIGHTWEIGHT CONCRETE	PT	PNEUMATIC TUBE	TKS	TACKSTRIP				
ABV	ABOVE	CT	CURRENT TRANSFORMER	FTG	FOOTING	LWT	LEAVING WATER TEMPERATURE	PT.	POINT	TO	TOP OF				
AC	ALTERNATING CURRENT	C TO C	CENTER TO CENTER	FURG	FURRING	m	METER(S)	PT CONC	POST-TENSIONED CONCRETE	TOL	TOLERANCE				
ACC	ACCESSIBLE	CTR	CENTER	FUT	FUTURE	M&B	MATCHED AND BEADED	PTD	PAPER TOWEL DISPENSER	TOPO	TOPOGRAPHY				
ACI	AMERICAN CONCRETE INSTITUTE	CU	CONDENSING UNIT	FW	FIRE WATER	MACH	MACHINE	PTN	PARTITION	TOS	TOP OF SLAB				
ACR	ACRYLIC PLASTIC	Cu	COPPER	FWC	FABRIC WALL COVERING	MAS	MASONRY	PTR	PAPER TOWEL RECEPTACLE	TOS	TOP OF STEEL				
ACS DR	ACCESS DOOR	CU FT	CUBIC FEET	G	NATURAL GAS	MATL	MATERIAL(S)	PV	PAVED	TOW	TOP OF WALL				
ACS PNL	ACCESS PANEL	CUH	CABINET UNIT HEATER	GA	GAGE	MAX	MAXIMUM	PVC	POLYVINYL CHLORIDE	TPD	TOILET PAPER DISPENSER				
ACSR	ALUMINUM CABLE STEEL REINFORCED	CU YD	CUBIC YARDS	GAL	GALLON(S)	MB	MACHINE BOLTS	PVG	PAVING	TPTN	TOILET PARTITION				
ACST	ACOUSTIC	CV	CEILING VENT	GALV	GALVANIZED	MBR	MEMBER	PW	PASS WINDOW	TRANS	TRANSOM				
ACT	ACOUSTICAL CEILING TILE	CVH	CONDUCTIVE VINYL HOMOGENEOUS (SHEET TYPE)	GALV STL	GALVANIZED STEEL	MC	MEDICINE CABINET	QT	QUARRY TILE	TRANS	TRANSVERSE				
ADDM	ADDENDUM	CW	COLD WATER	GB	GRAB BAR	MCJ	MASONRY CONTROL JOINT	QT.	QUART	TSTAT	THERMOSTAT				
ADH	ADHESIVE	CYL	CYLINDER	GC	GENERAL CONTRACTOR	MCO	METAL-CASED OPENING	QTR	QUARTER	TV	TELEVISION				
ADJ	ADJACENT, ADJOINING, ADJUSTABLE	d	PENNY (AS IN NAIL - 10D)	GEN	GENERAL	MDS	METAL DIVIDER STRIP	1/4 RND	QUARTER ROUND	TYP	TYPICAL				
ADO	AUTOMATIC DOOR OPERATOR	DAT	DATUM	GF	GROUND FACE	MECH	MECHANICAL	QTY	QUANTITY	UC	UNIT COOLER				
AFF	ABOVE FINISHED FLOOR	DB	DRY BULB	GFCI	GROUND FAULT CIRCUIT INTERRUPTER	MECH RM	MECHANICAL ROOM	R	RADIUS	UGND	UNDERGROUND				
AGGR	AGGREGATE	DBL	DOUBLE	GFE	GOVERNMENT-FURNISHED EQUIPMENT	MED	MEDIUM	R	RANGE	UH	UNIT HEATER				
AHR	ANCHOR	DBL ACT DR	DOUBLE ACTING DOOR	GFE/CI	GOVERNMENT-FURNISHED EQUIPMENT CONTRACTOR INSTALLED	MEMB	MEMBRANE	R	RISER	UL	UNDERWRITERS LABORATORIES				
AHU	AIR HANDLING UNIT	DCJ	DOWELED CONTROL JOINT	GI	GALVANIZED IRON	MES	METAL EDGE STRIP	RA	RETURN AIR	UNEX	UNEXCAVATED				
AI	AREA INLET	DCJT	DUMMY CONTROL JOINT	GIP	GALVANIZED IRON PIPE	MFD	METAL FLOOR DECKING	RAB	RABBETED	UNFIN	UNFINISHED				
AIC	AMPERE INTERRUPTING CAPACITY	DEG	DEGREE	GKT	GASKET(ED)	MFG	MANUFACTURING	RA GR	RETURN AIR GRILLE	UPS	UNINTERRUPTABLE POWER SUPPLY				
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION	DEMO	DEMOLITION	GL	GLASS	MFR	MANUFACTURER	RAR	RETURN AIR REGISTER	UR	URINAL				
A.L.	ACTIVE LEAF	DEPR	DEPRESSION	GL BLK	GLASS BLOCK	MG	MOTOR GENERATOR	RB	RUBBER BASE, RESILIENT BASE	UTIL	UTILITY				
ALT	ALTERNATE	DEPT	DEPARTMENT	GLF	GLASS FIBER	MGT	MATTE-GLAZED TILE	RBL	RUBBLE STONE	UV	UNIT VENTILATOR				
ALUM	ALUMINUM	DET	DETAIL	GLZ	GLAZING	MH	MANHOLE	RBR	RUBBER	V	VOLT				
AMB	AMBIENT	DF	DRINKING FOUNTAIN	GLZ CMU	GLAZED CONCRETE MASONRY UNITS	MI	MALLEABLE IRON	RC	REMOTE CONTROL	VAR	VARNISH				
AMP	AMPERE	DH	DOUBLE HUNG	G	GROUND	MIN	MINIMUM	RCP	REINFORCED CONCRETE PIPE	VB	VINYL BASE				
ANOD	ANODIZE	DH	DUCT HEATER	GOVT	GOVERNMENT	MIRR	MIRROR	RCVR	RECEIVER	VCT	VINYL COMPOSITION TILE				
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE	DIA	DIAMETER	GPM	GALLONS PER MINUTE	MISC	MISCELLANEOUS	RD	ROOF DRAIN	VCT	VITRIFIED CLAY TILE				
APPD	APPROVED	DIAG	DIAGONAL	GPT	GYPSUM TILE	ML	METAL LATH	RDG INS	RIGID INSULATION	VD	VAULT DOOR				
APPROX	APPROXIMATE	DIM	DIMENSION	GRAN	GRANITE	ML	MONOLITHIC	RECPT	RECEPTACLE	VENT	VENTILATOR(TION)				
ARCH	ARCHITECT	DISC	DISCONNECT	GR LN	GRADE LINE	MLDG	MOULDING	REC ROOM	RECREATION ROOM	VERT	VERTICAL				
ARI	AMERICAN REFRIGERATION INSTITUTE	DISP	DISPENSER	GRTG	GRATING	MLWK	MILLWORK	RECT	RECTIFIER	VEST	VESTIBULE				
ASB	ASBESTOS	DISTR PNL	DISTRIBUTION PANEL	GST	GLAZED STRUCTURAL TILE	mm	MILLIMETER(S)	REF	REFERENCE	VF	VINYL FABRIC				
ASC	ABOVE SUSPENDED CEILING	DIV	DIVISION	GSU	GLAZED STRUCTURAL UNITS	MNIC	MATERIAL NOT IN CONTRACT (INSTALLATION BY CONTRACTOR)	REFL	REFLECT	VG	VERTICAL GRAIN				
ASPH	ASPHALT	DL	DEAD LOAD	GT	GROUT	MO	MASONRY OPENING	REFR	REFRIGERATION	VH	VINYL HOMOGENEOUS				
ATC	ACOUSTICAL TILE CEILING	DMPF	DAMPPROOFING	GWT	GLAZED WALL TILE	MOD	MODULAR	REG	REGISTER	VJ	V-JOINT(ED)				
AUTO	AUTOMATIC	DMPR	DAMPER	GYP	GYPSUM	MOD.	MODIFIED	REG	REGLET	VNR	VENEER				
AVG	AVERAGE	DMT	DEMOUNTABLE	GYP BD	GYPSUM BOARD	MOT	MOTOR	REINF	REINFORCE	VOL	VOLUME				
AWG	AMERICAN WIRE GAUGE	DN	DOWN	GYP PLAS	GYPSUM PLASTER	MP	MOVABLE PARTITION	REM	REMOVE(ABLE)	VR	VAPOR RETARDER				
AWT	ACOUSTICAL WALL TREATMENT	DR	DOOR	HB	HOSE BIBB	MR	MOP RECEPTOR	REQD	REQUIRED	VRM	VERMICULITE				
BB	BULLETIN BOARD	DR	DRAIN	HC	HOLLOW CORE	MRB	MARBLE BASE	RESIL	RESILIENT	VS	VENT STACK				
BC	BOOKCASE	DRB	DRAINBOARD	HCD	HALON CONTAINMENT DAMPER	MRD	METAL ROOF DECKING	RET	RETURN	V.T.	VOLTAGE TRANSFORMER				
BD	BOARD	DR CL	DOOR CLOSER	HCP	HANDICAPPED	MS	MACHINE SCREWS	REV	REVISION	VTR	VENT THRU ROOF				
BDRY	BOUNDARY	DS	DOUBLE STRENGTH (GLASS)	HD	HEAD	MT	METAL THRESHOLD	RFG	ROOFING	VWC	VINYL WALL COVERING				
BEJ	BRICK EXPANSION JOINT	DS	DOWNSPOUT	HD	HEAVY DUTY	MT	MOUNT	RH	RELATIVE HUMIDITY	W	WEST				
BEV	BEVEL	DT	DRAIN TILE	HDBD	HARDBOARD	MTD	MOUNTED	RH	RIGHT HAND	W/	WITH				
BITUM	BITUMINOUS	DVTL	DOVETAIL	HD JT	HEAD JOINT	MTFR	METAL FURRING	RH	ROOF HATCH	WB	WET BULB				
BJT	BED JOINT	DWG	DRAWING	HDR	HEADER	MTL	METAL	RK	RACK	WBL	WOOD BLOCKING				
BL	BUILDING LINE	DWLS	DOWELS	HDW	HARDWARE	MVBL	MOVABLE	RLG	RAILING	WC	WATER CLOSET				
BLDG	BUILDING	DWR	DRAWER	HDWD	HARDWOOD	MULL	MULLION	RM	ROOM	W/C	WHEELCHAIR				
BLW	BELOW	DWTR	DUMBWAITER	HES	HIGH EARLY-STRENGTH CEMENT	N	NORTH	RND	ROUND	WCO	WOOD-CASED OPENING				
BM	BENCHMARK	DX	DIRECT EXPANSION	HEX	HEXAGON	NAT	NATURAL	RO	ROUGH OPENING	WD	WOOD				
BO	BOTTOM OF	E	EAST	HH	HANDHOLE	NC	NORMALLY CLOSED	ROW	RIGHT OF WAY	WD	WOOD DOOR				
BOT	BOTTOM	EA	EACH	HK	HOOK(S)	NEC	NATIONAL ELECTRICAL CODE	RP	RETRACTABLE PARTITION	WDSP	WASTE DISPOSER				
BP	BACK PLASTER(ED)	EAT	ENTERING AIR TEMPERATURE	HM	HOLLOW METAL	NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION	RPM	REVOLUTIONS PER MINUTE	WDW	WINDOW				
BRCG	BRACING	EF	EACH FACE	HNDRL	HANDRAIL	NFPA	NATIONAL FIRE PROTECTION ASSOCIATION	RPRT	RAISED PATTERN RUBBER TILE	WF	WIDE FLANGE				
BRDG	BRIDGING	EJ	EXPANSION JOINT	HORIZ	HORIZONTAL	NI	NICKEL	RTF	RUBBER TILE FLOOR	WGL	WIRED GLASS				
BRG	BEARING	EL	ELEVATION - GRADE OR BUILDING	HP	HIGH PRESSURE	NIC	NOT IN CONTRACT	RVS	REVERSE	WH	WALL HUNG				
BRG PL	BEARING PLATE	ELEC	ELECTRIC	HP	HORSEPOWER	NL	NAILABLE	RVT	RIVET	WH	WATER HEATER				
BRK	BRICK	EM	EXPANDED METAL	HPT	HIGH POINT	N.L.	NEOPRENE LATEX	RWC	RAINWATER CONDUCTOR	WHB	WHEEL BUMPER				
BRKT	BRACKET	EMD	ESTIMATED MAXIMUM DEMAND	HR	HOUR	NM	NONMETALLIC	S	SOUTH	WHM	WATT-HOUR METER				
BRZ	BRONZE	EMER	EMERGENCY	HS	HIGH STRENGTH	NO	NORMALLY OPEN	SA	SUPPLY AIR	WI	WROUGHT IRON				
BS	BOTH SIDES	ENCL	ENCLOSE(URE)	HSGYP	HIGH-STRENGTH GYPSUM PLASTER	NO	NUMBER	SB	SPLASH BLOCK	WKSH	WORK SHOP				
BSMT	BASEMENT	ENTR	ENTRANCE, ENTERING	HSKPG	HOUSEKEEPING	NOM	NOMINAL	S.B.	SECURITY BARS	WM	WIRE MESH				
Btu	BRITISH THERMAL UNIT	EP	ELECTRICAL PANELBOARD	HT	HEIGHT	NR	NOISE REDUCTION	SC	SOLID CORE	W/O	WITHOUT				
BtuH	BTU PER HOUR	EPRF	EXPLOSION PROOF	HTG	HEATING	NRC	NOISE REDUCTION COEFFICIENT	SCHED	SCHEDULE	WP	WATERPROOF(ING)				
BTWN	BETWEEN	EPY	EPOXY COATING	HTR	HEATER	N'REQD	NOT REQUIRED	SCRN	SCREEN	WP	WEATHERPROOF				
BUR	BUILT-UP ROOFING	EQ	EQUAL	HVAC	HEATING, VENTILATING AND AIR CONDITIONING	NTS	NOT TO SCALE	SCT	STRUCTURAL CLAY TILE	WP	WORKING POINT				
BW	BOTH WAYS	EQUIP	EQUIPMENT	HYDR	HYDRAULIC	OA	OUTSIDE AIR	SD	STORM DRAIN	WR	WASTE RECEPTACLE				
CAB	CABINET	ESCAL	ESCALATOR	Hz	HERTZ	OBSC	OBSCURE	SDI	STEEL DOOR INSTITUTE	WRB	WARDROBE				
CAP	CAPACITY	EST	ESTIMATE(D)	IC	INTERCOM	OBW	OBSERVATION WINDOW	SECT	SECTION	WS	WATERSTOP				
CB	CATCH BASIN	EWC	ELECTRIC WATER COOLER	ID	INSIDE DIAMETER	OC	ON CENTER	SEQ	SEQUENCE	W.S.	WASTE STACK				
CCT	CUBICLE CURTAIN TRACK	EWT	ENTERING WATER TEMPERATURE	IESNA	ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA	OCEW	ON CENTER EACH WAY	SFGL	SAFETY GLASS	WSCT	WAINSCOT				
CCTV	CLOSED CIRCUIT TELEVISION	EXC	EXCAVATE	ILK	INTERLOCK	OD	OUTSIDE DIAMETER	SFTU	STRUCTURAL FACING TILE UNIT	WT	WEIGHT				
CE	COVER ELEVATION	EXH	EXHAUST	IN	INCH	OFC	OFFICE	SFU	STRUCTURAL FACING UNIT	WTH	WIDTH				
CEM	CEMENT	EXH A	EXHAUST AIR	INCIN	INCINERATOR	OGL	OBSCURE GLASS	SG	SHEET GLASS	WW	WALL TO WALL				
CEM PLAS	CEMENT PLASTER	EXST	EXISTING	INCL	INCLUDED	OH	OVERHEAD	SHLDR	SHOULDER	WWF	WELDED WIRE FABRIC				
CER	CERAMIC	EXP	EXPANSION	INSF	INSULATING FILL	OHMS	OVALHEAD MACHINE SCREW	SHT	SHEET	WWM	WELDED WIRE MESH				
CFI	CONDUCTIVE FLOORING	EXP	EXPOSED	INSUL	INSULATION	OHWS	OVALHEAD WOOD SCREW	SHTHG	SHEATHING	WWR	WELDED WIRE REINFORCEMENT				
CFLG	COUNTERFLASHING	EXP BT	EXPANSION BOLT	INT	INTERIOR	OPH	OPPOSITE HAND	SHV	SHELVING	XFMR	TRANSFORMER				
CFM	CUBIC FEET PER MINUTE	EXT	EXTERIOR	INTM	INTERMEDIATE	OPNG	OPENING	SIM	SIMILAR	YD	YARD				
CG	CORNER GUARD	F	FAHRENHEIT	INV	INVERT	OPP	OPPOSITE	SJI	STEEL JOIST INSTITUTE	YD	YARD DRAIN				
CH BD	CHALKBOARD	FA	FIRE ALARM	IP	IRON PIPE	OPQ	OPAQUE	SKLT	SKYLIGHT						
CHFR	CHAMFER	FA	FRESH AIR	IPS	IRON PIPE SIZE	OPS	OPERATIONS	SLNT	SEALANT						
CHIM	CHIMNEY	FAC	FIRE APPARATUS CLOSET	I.P.S.	INSIDE PIPE SIZE	OS & Y	OUTSIDE SCREW AND YOKE	SLV	SLEEVE						
CHK	CHECK	FAI	FRESH AIR INTAKE	JAN CLO	JANITOR'S CLOSET	OWGL	OBSCURE WIRED GLASS	SM	SHEET METAL						
CHR PL	CHROME PLATED	F BRK	FIRE BRICK	J-BOX	JUNCTION BOX	P	POLE	SMS	SHEET METAL SCREWS						
CI	CAST IRON	FC	FOOT CANDLE	JCT	JUNCTION	PA	PUBLIC ADDRESS	SOV	SHUT OFF VALVE						
CI	CURB INLET	FC BRK	FACE BRICK	JST	JOIST	PAR	PARALLEL	SPC	SPACER						
CIP	CAST-IN-PLACE	FCG	FACING	JT	JOINT	PB	PANIC BAR	SPCL	SPECIAL						
CIRC	CIRCULAR	FCJ	FLOOR CONSTRUCTION JOINT	KIP	KILOPOUND (1000 POUNDS)	PBD	PARTICLE BOARD	SPD	SOUNDPROOF DOOR						
CJ	CONTROL JOINT	FCO	FLOOR CLEANOUT	KIT	KITCHEN	PBS	PUSH BUTTON STATION	SPEC	SPECIFICATION						
CJ	CONSTRUCTION JOINT	FCU	FAN COIL UNIT	KOP	KNOCKOUT PANEL	PC	PIECE	SPF	SOUNDPROOF						
CKT	CIRCUIT	FD	FLOOR DRAIN	KPL	KICKPLATE	PCC	PRECAST CONCRETE	SP FIN	SPECIAL FINISH						
CKT BRKR	CIRCUIT BREAKER	FDMPR	FIRE DAMPER	km	KILOMETER	PCF	POUNDS PER CUBIC FOOT	SPH	SPACE HEATER						
CL	CENTER LINE	FDTN	FOUNDATION	kV	KILOVOLTS	PCP	CEMENT PLASTER (PORTLAND)	SPKR	SPEAKER						
CLG	CEILING	FE	FIRE EXTINGUISHER	kVA	KILOVOLT AMPERES	PD	PAVEMENT DRAIN	SQ	SQUARE						
CEILG HT	CEILING HEIGHT	FEB	FIRE EXTINGUISHER BRACKET	kVAR	KILOVOLT AMPERES REACTIVE	PED	PEDESTAL	SQHD	SQUARE HEAD						
CLGL	CLEAR GLASS	FEC	FIRE EXTINGUISHER CABINET	kW	KILOWATT	PERF	PERFORATE(D)	S&R	SHELF AND ROD						
CLL	CONTRACT LIMIT LINE	FF	FACTORY FINISH	KWY	KEYWAY	PERIM	PERIMETER	SS	SERVICE SINK						
CLO	CLOSET	FGL	FIBERGLASS	LAB	LABORATORY	PH	PHASE	SS	STANDING SEAM (ROOF)						
CLOS	CLOSURE	FH	FIRE HYDRANT	LAD	LADDER	PHAR	PHARMACY	SST	STAINLESS STEEL						
CLR	CLEAR(ANCE)	FH	FLAT HEAD	LAM	LAMINATE	PI	POINT OF INTERSECTION	STA	STATION						
CLWG	CLEAR WIRED GLASS	FHC	FIRE HOSE CABINET	LAT	LEAVING AIR TEMPERATURE	PIPU	PREFAB ISOLATION POWER UNIT	STD	STANDARD						
cm	CENTIMETER(S)	FHMS	FLAT HEAD MACHINE SCREW	LAU	LAUNDRY	PIV	POST INDICATING VALVE	STG	SEATING						
CMP	CORRUGATED METAL PIPE	FHR	FIRE HOSE RACK	LAV	LAVATORY	PL	PLATE	STL	STEEL						
CMPST	COMPOSITE	FHS	FIRE HOSE STATION	LB	LAG BOLT	PL	PROPERTY LINE	STOR	STORAGE						
CMU	CONCRETE MASONRY UNIT	FHWS	FLAT HEAD WOOD SCREW	LB	POUND	PLAM	PLASTIC LAMINATE	ST PR	STATIC PRESSURE						
CND	CONDUIT	FIG	FIGURE	LBL	LABEL	PLAS	PLASTER	STR	STRINGER						
CNL	CONDUCTIVE NEOPRENE LATEX	FIN	FINISH	LBR	LUMBER	PLAT	PLATFORM	STRUCT	STRUCTURAL						
CNR	CORNER	FIN FLR	FINISH FLOOR	LC	LIGHT CONTROL	PLBG	PLUMBING	STWY	STAIRWAY						
CNTR	COUNTER	FIXT	FIXTURE	LD	LOAD	PLF	POUNDS PER LINEAR FOOT	SUB FL	SUBFLOOR						
CO	CLEANOUT	FJT	FLUSH JOINT	LDG	LOADING	PLG	PILING	SUSP	SUSPENDED						
CO2	CARBON DIOXIDE	FLASH	FLASHING	LG	LENGTH	PL GL	PLATE GLASS	SV	SHEET VINYL						
COL	COLUMN	FLR	FLOOR	LH	LEFT HAND(ED)	PLYWD	PLYWOOD	SW	SWITCH						
COM	COMMON	FLEX	FLEXIBLE	LIN	LINEAR	PNL	PANEL	SWBD	SWITCHBOARD						
COMB	COMBUSTION	FLG	FLOORING	LKR	LOCKER	PT	PAINT(ED)	SYMM	SYMMETRICAL						
COMPT	COMPARTMENT	FLR PL	FLOOR PLATE	LL	LIVE LOAD	POL	POLISHED	SYNTH	SYNTHETIC						
CONC	CONCRETE	FLUOR	FLUORESCENT	LLD	LEAD-LINED DOOR	PORC	PORCELAIN	SYS	SYSTEM						
CONN	CONNECT	FN	FENCE	LM	LUMEN	PORT	PORTABLE	T	TREAD						
CONSTR	CONSTRUCTION	FOC	FACE OF CONCRETE	LMST	LIMESTONE	PPGL	POLISHED PLATE GLASS	TAN	TANGENT						
CONT	CONTINUE	FOF	FACE OF FINISH	LNTL	LINTEL	PPM	PARTS PER MILLION	TB	TOWEL BAR						
CONTR	CONTRACTOR	FOM	FACE OF MASONRY	LONG	LONGITUDINAL	PR	PAIR	TC	TERRA COTTA						
CORR	CORRIDOR	FOS	FACE OF STUD	LP	LIGHTPROOF	PREFAB	PREFABRICATE(D)	TEL	TELEPHONE						
COV	COVER	FP	FIRE PARTITION	LPD	LIGHTPROOF DOOR	PREFIN	PREFINISHED	TEMP	TEMPERATURE						
CPRS	COMPRESSIBLE	FP	FIREPROOF	LPL	LIGHTPROOF LOUVER	PREFMD	PREFORMED	TEMP	TEMPORARY						
CPT	CARPET	FPM	FEET PER MINUTE	LPT	LOW POINT	PRKG	PARKING	TER	TERRAZZO						
CRCMF	CIRCUMFERENCE	FR	FIRE RESISTANT	LR	LIVING ROOM	PROJ	PROJECT	TERM	TERMINAL						
CRES	CORROSIVE RESISTANT STEEL	FR	FRAME	LS	LAWN SPRINKLER	PRV	PRESSURE-REGULATING VALVE	T&G	TONGUE AND GROOVE						
CRG	CROSS GRAIN	FRG	FORGED	LT	LIGHT	PS	PIPE SPACE	TGL	TOGGLE						
CRS	COURSE(S)	FRMG	FRAMING	LT WT	LIGHTWEIGHT	P.S.	PRESSED STEEL	TH	TRUSS HEAD						

DRAFT

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: T GAMBON
DRAWN BY: J FRATAMICO
CHECKED BY: K MITVALSKY
SUBMITTED BY: A HEDDLESTEN
SIZE: ANSI D
ISSUE DATE: 2022/05/20
SOLICITATION NO.:
CONTRACT NO.:
B5UMRR131801

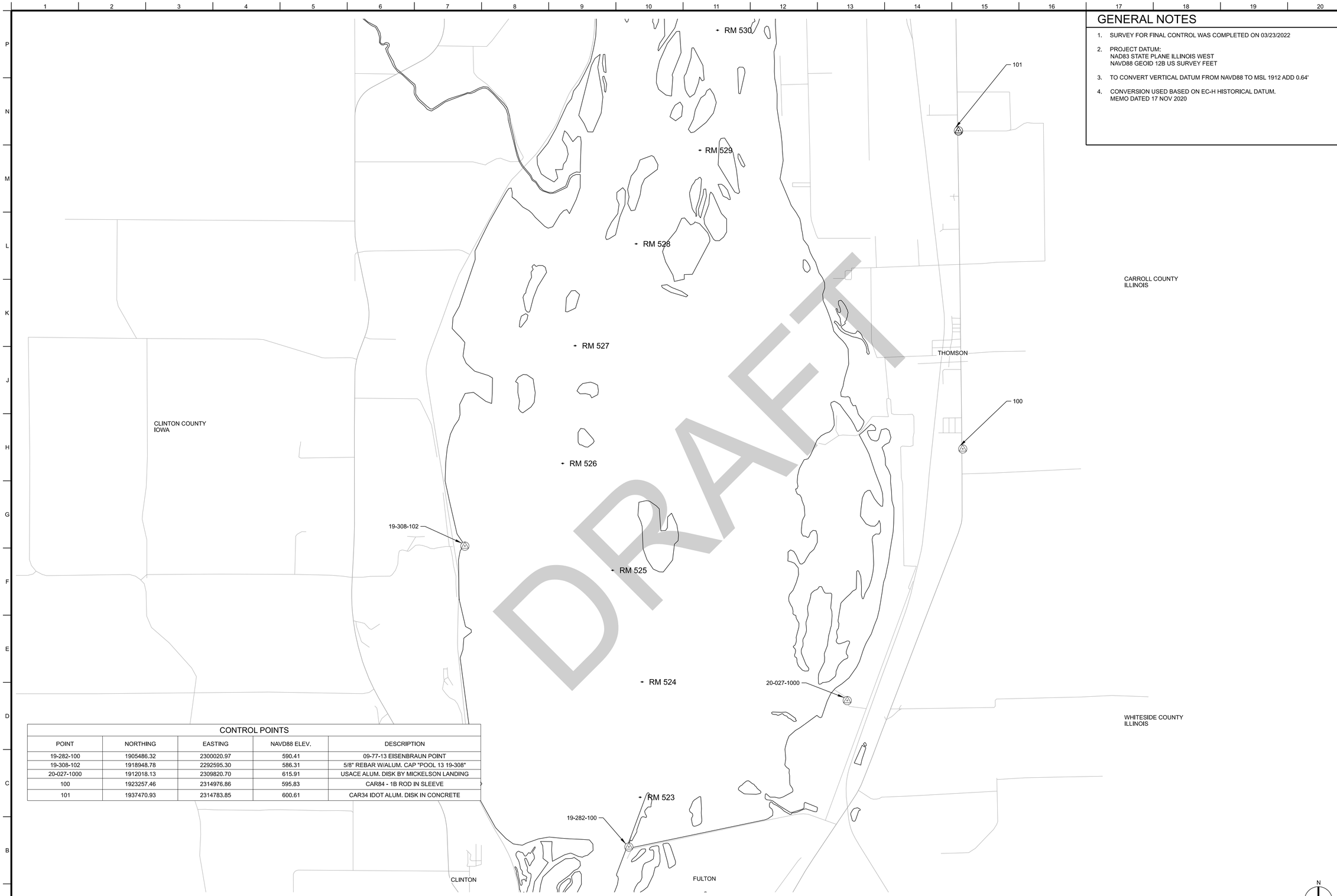
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
LOWER POOL 13 SOUTHWEST CORNER
CLINTON COUNTY IA, CARROLL AND WHITESIDE COUNTIES IL
LOWER POOL 13 HABITAT REHABILITATION AND ENHANCEMENT PROJECT

ABBREVIATIONS

SHEET ID
G-003

REVIEW



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GENERAL NOTES

1. SURVEY FOR FINAL CONTROL WAS COMPLETED ON 03/23/2022
2. PROJECT DATUM:
   NAD83 STATE PLANE ILLINOIS WEST
   NAVD88 GEOID 12B US SURVEY FEET
3. TO CONVERT VERTICAL DATUM FROM NAVD88 TO MSL 1912 ADD 0.64'
4. CONVERSION USED BASED ON EC-H HISTORICAL DATUM.
   MEMO DATED 17 NOV 2020

CONTROL POINTS

POINT	NORTHING	EASTING	NAVD88 ELEV.	DESCRIPTION
19-282-100	1905486.32	2300020.97	590.41	09-77-13 EISENBRAUN POINT
19-308-102	1918948.78	2292595.30	586.31	5/8" REBAR W/ALUM. CAP "POOL 13 19-308"
20-027-1000	1912018.13	2309820.70	615.91	USACE ALUM. DISK BY MICKELSON LANDING
100	1923257.46	2314976.86	595.83	CAR84 - 1B ROD IN SLEEVE
101	1937470.93	2314783.85	600.61	CAR34 IDOT ALUM. DISK IN CONCRETE

A1 PLAN - SURVEY CONTROL
SCALE: 1" = 2000'

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MARK	DESCRIPTION	DATE

DESIGNED BY: E. SELFE
DRAWN BY: E. SELFE
CHECKED BY: M. MANTERNACH
SUBMITTED BY: J. BIGELOW
SIZE: ANSI D
ISSUE DATE: 2022/05/20
SOLICITATION NO.:
CONTRACT NO.: B5UMRR131801

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PLAN
SURVEY CONTROL

SHEET ID
V-101

REVIEW





A1 SITE PLAN - MAXIMUM ALTERNATIVE OPTION 1

SCALE: NO SCALE

GENERAL SHEET NOTES

1. NOTE 1
2. NOTE 2
3. NOTE 3

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SITE PLAN
MAXIMUM ALTERNATIVE OPTION 1

SHEET ID

C-102

REVIEW



A1 SITE PLAN - EFFICIENT ALTERNATIVE OPTION 2
SCALE: NO SCALE

GENERAL SHEET NOTES

1. NOTE 1
2. NOTE 2
3. NOTE 3

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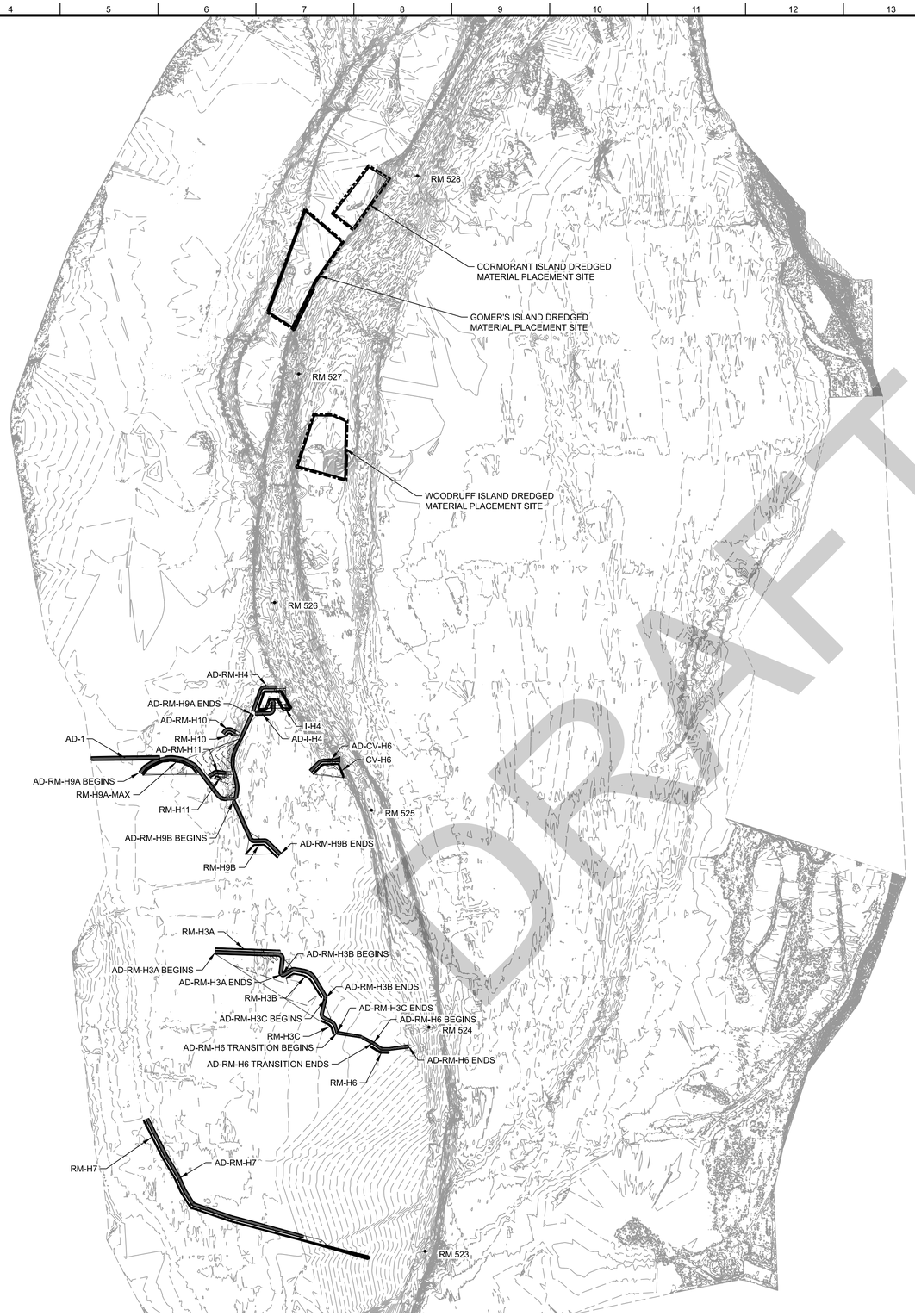
SITE PLAN
EFFICIENT ALTERNATIVE OPTION 2

SHEET ID
C-103

REVIEW

DRAFT



DRAFT

A1 SITE PLAN - SAV ALTERNATIVE OPTION 3

SCALE: NO SCALE

GENERAL SHEET NOTES

1. NOTE 1
2. NOTE 2
3. NOTE 3

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CONTRACT NO.:	
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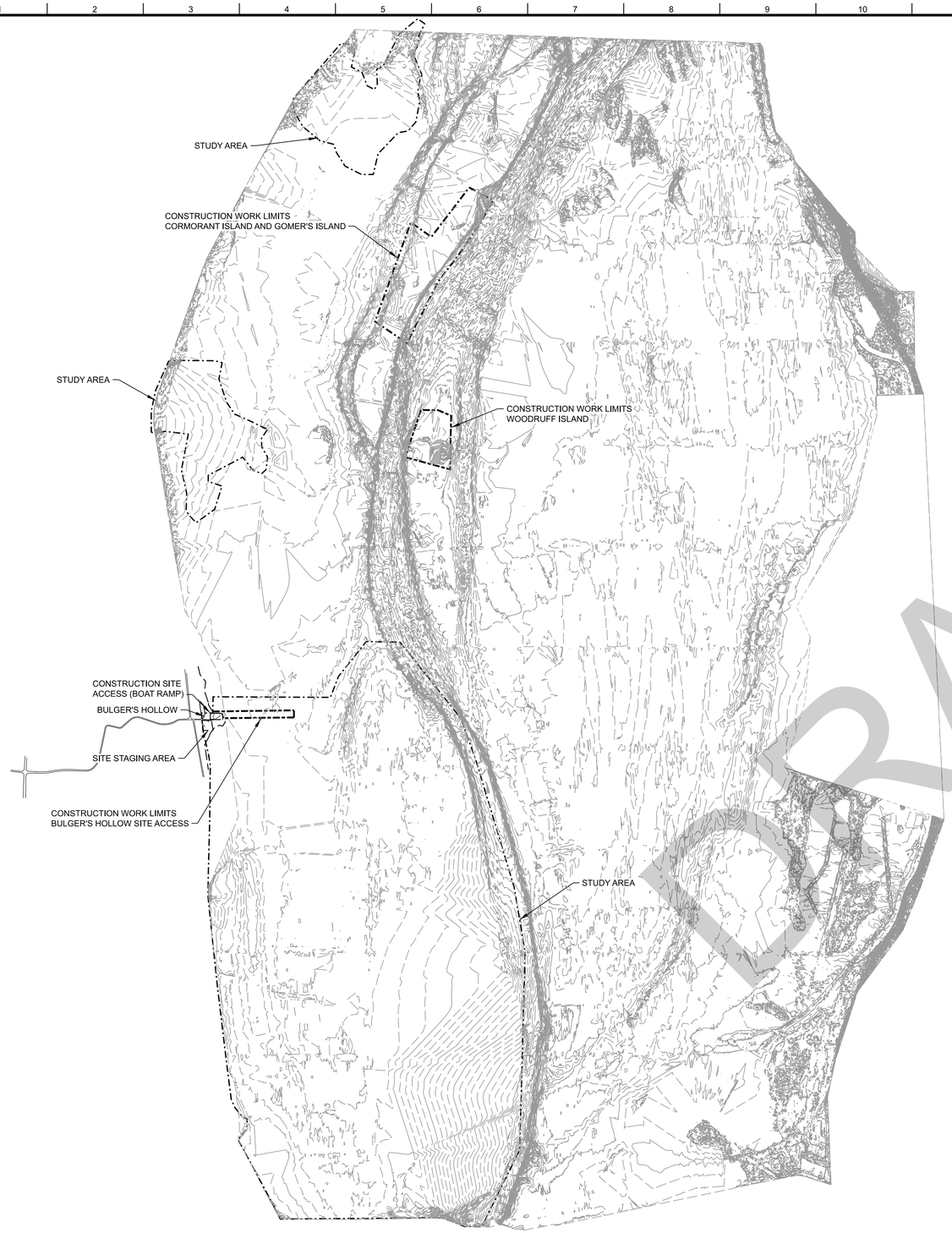
SITE PLAN
SAV ALTERNATIVE OPTION 3

SHEET ID

C-104

REVIEW



DRAFT

PLAN NORTH

A1 SITE PLAN - STAGING AREA AND CONSTRUCTION WORK LIMITS
SCALE: NO SCALE

GENERAL SHEET NOTES

1. CONSTRUCTION WORK LIMITS ARE SHOWN OUTSIDE OF THE PROJECT BOUNDARY.
2. CONSTRUCTION WORK LIMITS WILL BE REFINED WITHIN THE PROJECT STUDY AREA DURING DESIGN.
3. PROJECT STAGING AREA IS SHOWN NEAR BULGAR'S HOLLOW BOAT RAMP.
4. ACCESS TO FEATURES IS BY WATER.

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APPR'D:
ANSI D

ISSUE DATE: 2022/05/20
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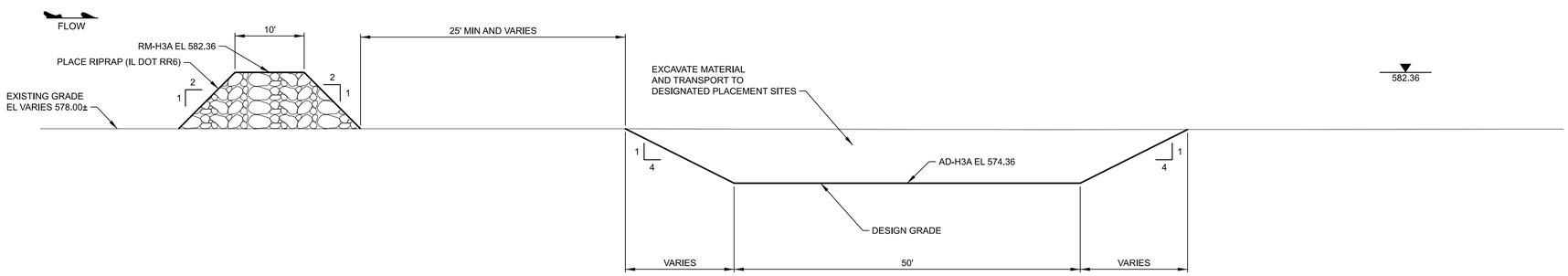
SITE PLAN
STAGING AREA AND CONSTRUCTION WORK LIMITS

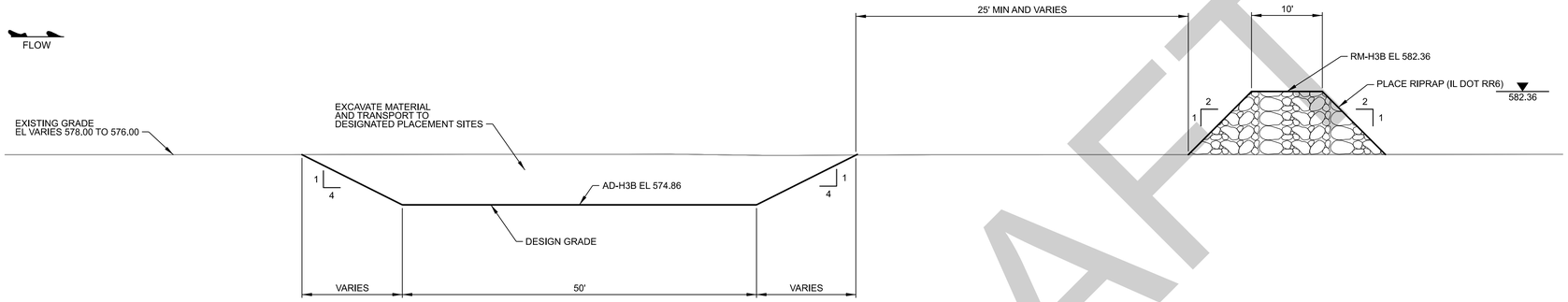
SHEET ID
C-105

REVIEW



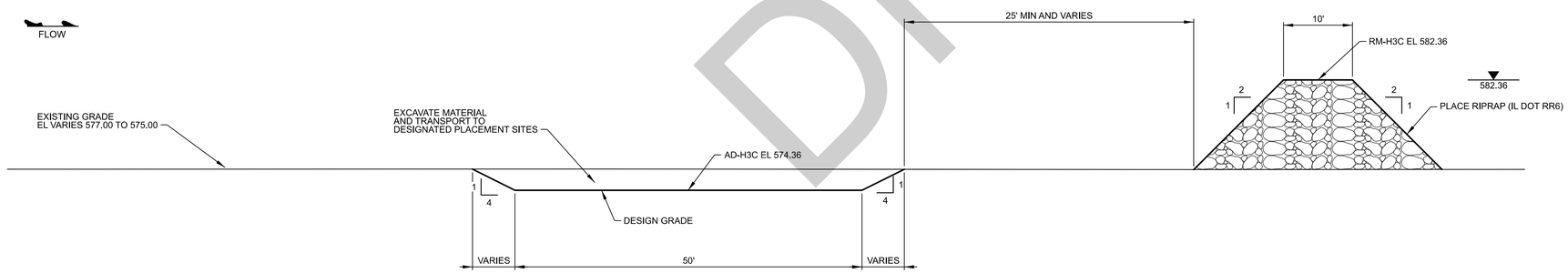
L1 RM-H3A SECTION

SCALE: 1"=10'-0"



G1 RM-H3B SECTION

SCALE: 1"=10'-0"



C1 RM-H3C SECTION

SCALE: 1"=10'-0"

GENERAL NOTES

1. TYPICAL SECTIONS ARE SHOWN.
2. DESIGN ELEVATIONS AND SIDE SLOPES SHOWN USED FOR FEASIBILITY LEVEL DESIGN.
3. EXISTING GROUND ELEVATION VARIES AND A RANGE IS SHOWN.

DRAFT

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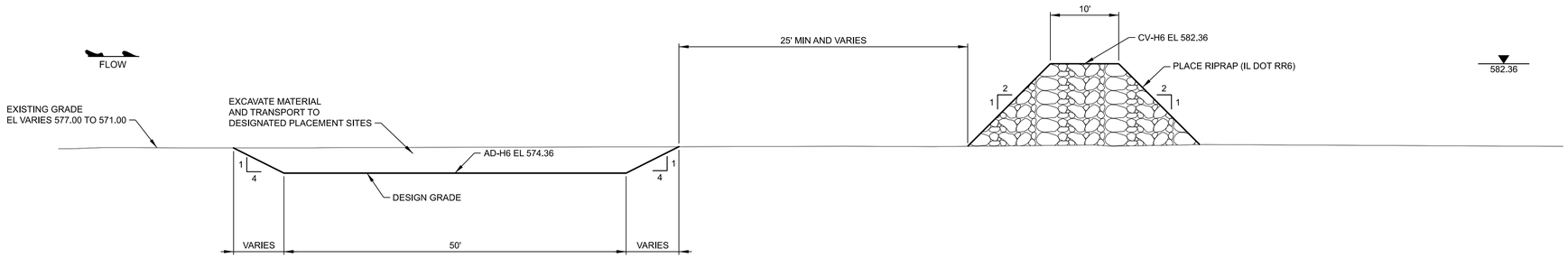
TYPICAL SECTIONS

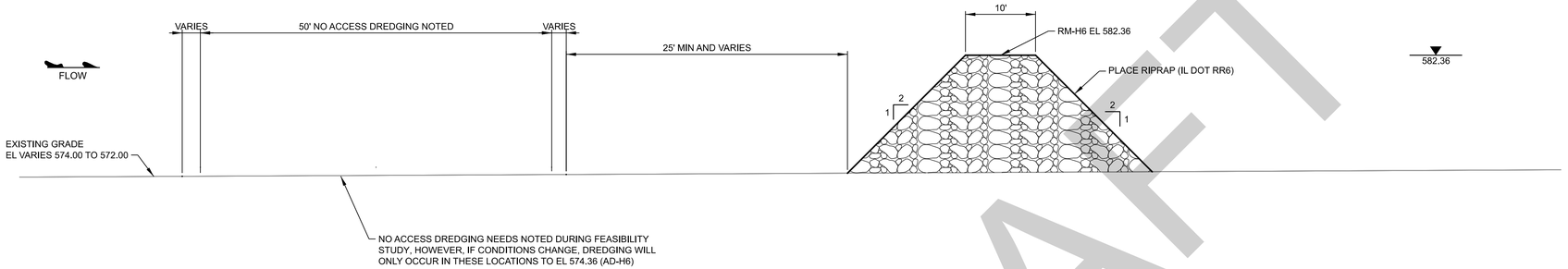
SHEET ID
C-301

REVIEW



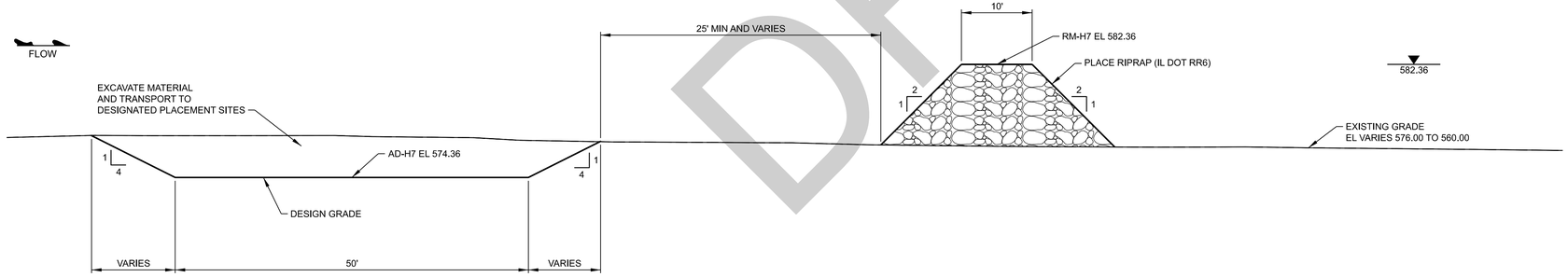
L1 CV-H6 SECTION

SCALE: 1"=10'-0"



G1 RM-H6 SECTION

SCALE: 1"=10'-0"



C1 RM-H7 SECTION

SCALE: 1"=10'-0"

DRAFT

GENERAL SHEET NOTES

1. TYPICAL SECTIONS ARE SHOWN
2. DESIGN ELEVATIONS AND SIDE SLOPES SHOWN USED FOR FEASIBILITY LEVEL DESIGN.
3. EXISTING GROUND ELEVATION VARIES AND A RANGE IS SHOWN.

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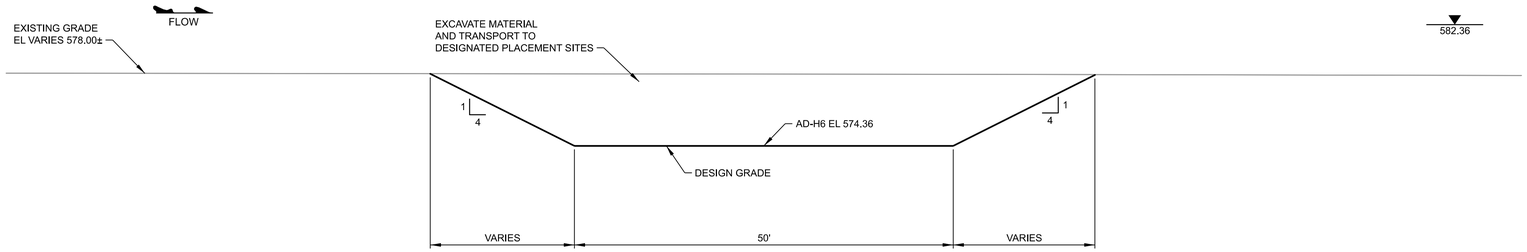
TYPICAL SECTIONS

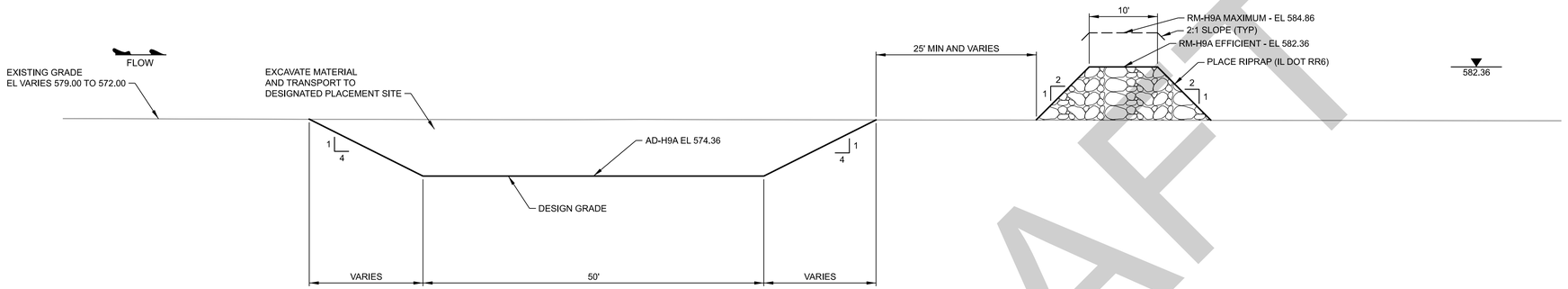
SHEET ID
C-302

REVIEW



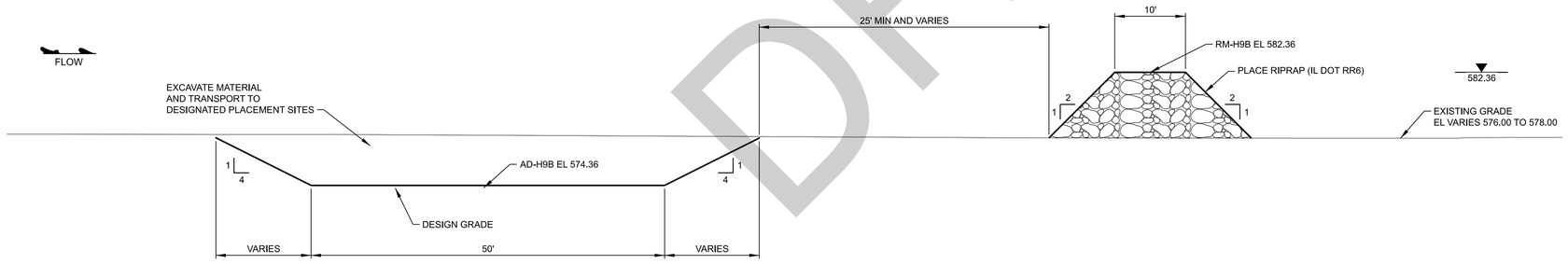
L1 AD-1

SCALE: 1"=10'-0"



G1 RM-H9A SECTION EFFICIENT AND MAXIMUM

SCALE: 1"=10'-0"



C1 RM-H9B SECTION

SCALE: 1"=10'-0"

DRAFT

GENERAL SHEET NOTES

1. TYPICAL SECTIONS ARE SHOWN.
2. DESIGN ELEVATIONS AND SIDE SLOPES SHOWN USED FOR FEASIBILITY LEVEL DESIGN.
3. EXISTING GROUND ELVATIONS VARIES AND A RANGE IS SHOWN.

US Army Corps of Engineers®

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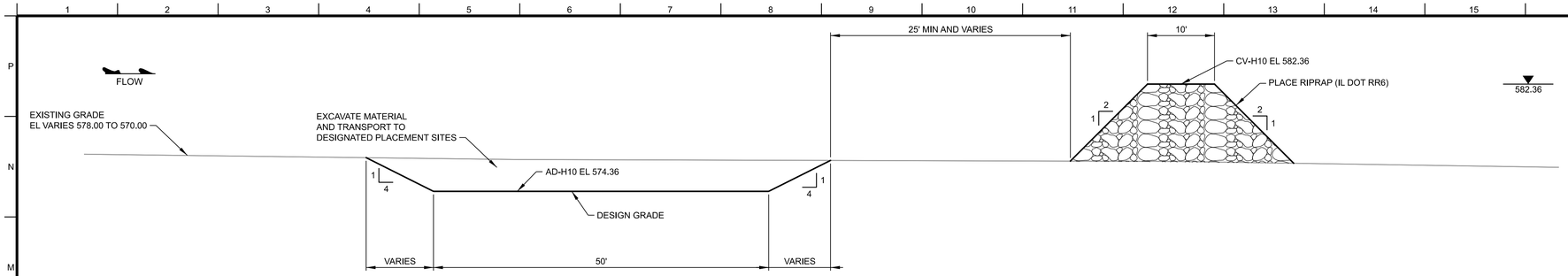
TYPICAL SECTIONS

SHEET ID

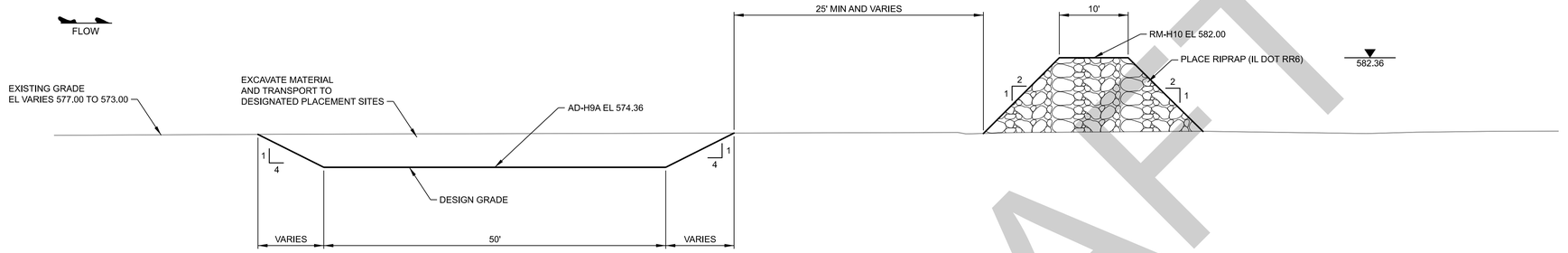
C-303

REVIEW



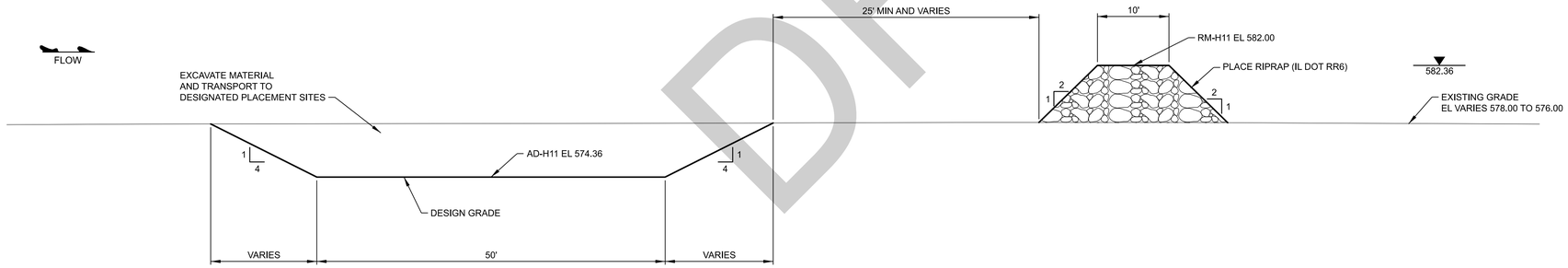
L1 CV-H10 SECTION

SCALE: 1"=10'-0"



G1 RM-H10 SECTION

SCALE: 1"=10'-0"



C1 RM-H11 SECTION

SCALE: 1"=10'-0"

DRAFT

GENERAL SHEET NOTES

1. TYPICAL SECTIONS ARE SHOWN.
2. DESIGN ELEVATIONS AND SIDE SLOPES SHOWN USED FOR FEASIBILITY LEVEL DESIGN.
3. EXISTING GROUND ELVATIONS VARIES AND A RANGE IS SHOWN.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY:	ISSUE DATE:
T GAMBON	
DRAWN BY:	SOLICITATION NO.:
J FRATAMICO	
CHECKED BY:	CONTRACT NO.:
K MITVALSKY	
SUBMITTED BY:	B5UMRR131801
A HEDLESTEN	
SIZE:	
ANSI D	

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT

ROCK ISLAND, ILLINOIS 6/1201

MISSISSIPPI RIVER BASIN
LOWER POOL 13 SOUTHWEST CORNER
CLINTON COUNTY IA, CARROLL AND WHITESIDE COUNTIES IL
LOWER POOL 13 HABITAT REHABILITATION AND ENHANCEMENT PROJECT

TYPICAL SECTIONS

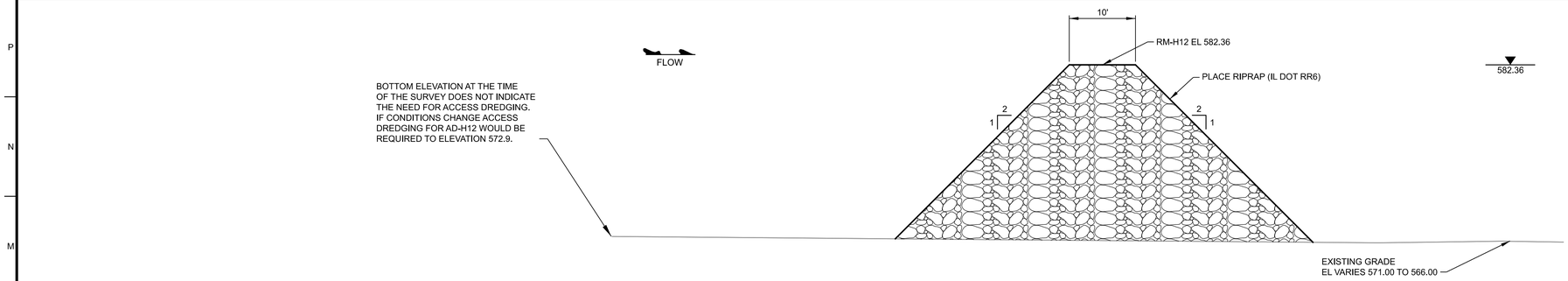
SHEET ID

C-304

REVIEW

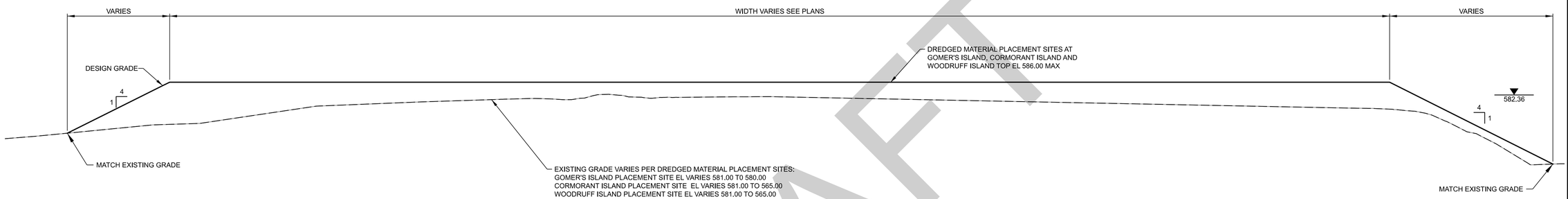
GENERAL SHEET NOTES

1. TYPICAL SECTIONS ARE SHOWN.
2. DESIGN ELEVATIONS AND SIDE SLOPES SHOWN USED FOR FEASIBILITY LEVEL DESIGN.
3. EXISTING GROUND ELVATIONS VARIES AND A RANGE IS SHOWN.



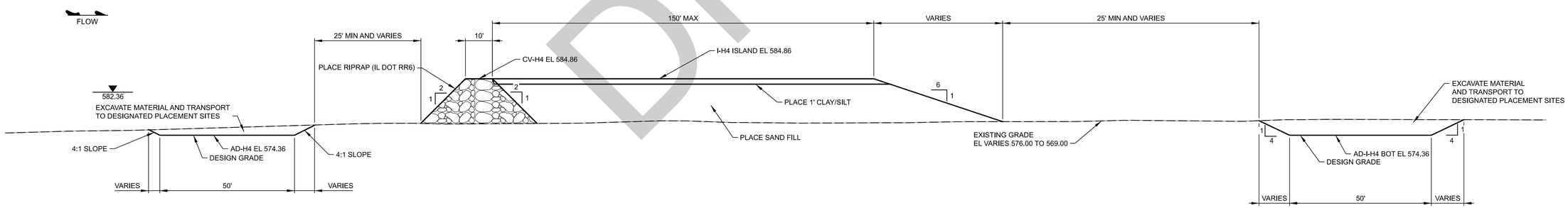
L1 RM-H12 SECTION

SCALE: 1"=10'-0"



G1 DREDGED MATERIAL PLACEMENT SITE SECTION

SCALE: 1"=30'-0"



C1 I-H4 ISLAND

SCALE: 1"=20'-0"

DRAFT

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MARK	DESCRIPTION	DATE

DESIGNED BY: T GAMBON
DRAWN BY: J FRATAMICO
CHECKED BY: K MITVALSKY
SUBMITTED BY: A HEDDLESTEN
SIZE: ANSI D
ISSUE DATE:
SOLICITATION NO.:
CONTRACT NO.: B5UMRR131801

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS 61201

MISSISSIPPI RIVER BASIN
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CLINTON COUNTY IA, CARROLL AND WHITESIDE COUNTIES IL
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TYPICAL SECTIONS

SHEET ID

C-305

REVIEW