UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

YORKINUT SLOUGH
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

ILLINOIS RIVER MILES 5-11
CALHOUN COUNTY, ILLINOIS

Photo: Office Moist Soil Unit at Yorkinut Slough (image: USFWS)

US Army Corps of Engineers ®
St. Louis District

April 2023

Draft Version

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EXECUTIVE SUMMARY

Purpose of Report. The purpose of this draft feasibility report with integrated environmental assessment (EA), including the draft unsigned Finding of No Significant Impact (FONSI), is to document the decision-making process for the proposed Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation and Enhancement Project (Project) at Yorkinut Slough located at the Two Rivers National Wildlife Refuge (Refuge). The U.S. Army Corps of Engineers (USACE) is the lead federal agency and the U.S. Fish and Wildlife Service (USFWS) is serving as the federal project partner and cooperating agency under National Environmental Policy Act of 1969. This report provides planning level design for the Project including compliance with National Environmental Policy Act (NEPA) CFR 1500 et seq updated in July of 2020, for the Tentatively Selected Plan (TSP).

Project Location. The Yorkinut Slough HREP is located on the right descending bank of the Illinois River between river miles 5 and 11, approximately 18 miles west of Alton, Illinois, in Calhoun County, Illinois. The nearest river gage is located approximately 4 miles to the east, in Grafton, Illinois. The study area is comprised of 2,350 acres, which includes wetland, early successional habitats, woodland, and floodplain forest.

Problem Identification. Human activity over the past two centuries within the Illinois River basin, floodplain, and channel has altered the hydrology and biotic communities historically present in the study area. These alterations have reduced the diversity and quality of wetlands, bottomland grasslands, floodplain woodlands, and floodplain forests in the region. The human-induced stressors are likely to continue, resulting in a continued decline in habitat quality. This study provides an opportunity to improve the quality and diversity of these critical habitats. The specific problems as they relate to the study area include:

1. Inability to achieve early successional and emergent wetland vegetation for waterfowl, wading birds, shorebirds, and neotropical migrants, limiting food availability, resting, and other habitat needs.
2. Loss of woodland and forest species and structural diversity.
3. Loss of ridge and swale topography that has led to loss of elevation/hydrological diversity and associated plant community diversity.

Study Goal and Objectives. The goal of the Project is to restore and improve the quality and diversity of emergent wetland, woodland, and forest resources within the study area. The objectives identified for the 50-year period of analysis (planning horizon) from 2025-2075 are:

1. Restore and increase early successional and emergent wetland within the study area over the 50-year period of analysis
2. Restore and increase floodplain forests within the study area over the 50-year period of analysis
3. Improve hydrologic conditions for wildlife including waterfowl, shorebirds, wading birds, Neotropical migrants, and others within the study area over the 50-year period of analysis

Objectives 1, 2, and 3, when achieved, would result in enhancement of food sources for migratory and resident wildlife.

Plan Formulation, Evaluation, and Comparison. An interagency planning team, comprised of biologists, engineers, and planners from USACE and USFWS developed an assortment of measures to address the identified problems. Measures were then assessed for their ability to address Project problems, goal, and objectives. The final list of measures includes water control structures, pump stations, well pumps, excavation, berm modifications and additions, and non-structural measures (i.e., tree planting and timber stand improvement).

The study team reviewed the measures to determine which measures would be carried forward, and refined the retained measures based on additional information and analysis, ensuring that all measures retained would meet at least one of the Project objectives. The measures were then combined into distinctly different alternatives based on dependencies and exclusivities. This resulted in an initial array of eight alternatives including the No Action alternative. Three alternatives were subsequently screened, so that five alternatives were moved forward for detailed analysis. Each alternative was evaluated through an environmental benefits analysis to determine the magnitude of ecosystem benefits to be expected if the alternative were implemented. Habitat benefits were estimated using the Habitat Evaluation Procedures (HEP). The benefits were then assessed against costs for each alternative. Cost-effectiveness and incremental cost analyses (CE/ICA) were conducted to identify cost effective plans and reveal changes in cost for increasing levels of environmental outputs (i.e., average annual habitat units). These analyses resulted in three “Best Buy” alternatives that were then compared and assessed on their ability to meet Project objectives, NEPA compliance, and achieving the USACE Principles and Guidelines evaluation criteria of acceptability, completeness, effectiveness, and efficiency (ER 1105-2-100).

Plan Selection. The TSP for the Yorkinut Slough HREP (Alternative 3 Intermediate B) is shown in **Figure ES-1 and Figure ES-2**. It consists of the following measures: modified Moist Soil Units (MSUs), including tiered wetland MSUs at higher elevations; drainage to the Illinois/Mississippi rivers through Calhoun Point; ridge and swale construction; modification of berms; new wells and pipe work for wells recently installed by Ducks Unlimited; raising the berm on the north side of Yorkinut Slough; rerouting upland flow; raising the spillway on the Six Mile Island/Illinois River berm; tree planting; and Timber Stand Improvement (TSI).

The TSP was identified as the National Ecosystem Restoration (NER) Plan. For ecosystem restoration projects, the plan that maximizes ecosystem benefits compared to costs is selected as the NER Plan. The TSP is a best buy alternative that yields 563 net average annual habitat units (AAHU) at an average annualized cost of $1,746 per AAHU (FY2023 price level; FY2023 federal discount rate of 2.5%). It best meets the study objectives and has sponsor support from USFWS. Implementation of the TSP would increase the quality and quantity of ecosystem resources and meet the needs for a large variety of native wetland species, forest species, and migratory wildlife within the Illinois-Mississippi Rivers Confluence area. The Project outputs are also consistent with the goals and objectives of the UMRR Program.

All Project measures would be located within the lands and waters of the United States, are federally owned, and managed by the USFWS as part of the Refuge. As such, project first cost funding for restoration measures would be 100 percent federal; responsibility for the operation, maintenance, rehabilitation, replacement, and repair of the Project would be the responsibility of the USFWS.

The St. Louis District has reviewed the Project outputs, a gain of 563 net AAHUs, and determined that the TSP would be in the federal interest.. The current estimated project first cost is $29,920,000 (FY2023 price level) with monitoring and adaptive management costs of $958,000. The average annual cost based on the project first cost is $1,077,000. USFWS would be responsible for Project operation, maintenance, and repair (OMR) at an estimated average annual cost of $118,000.

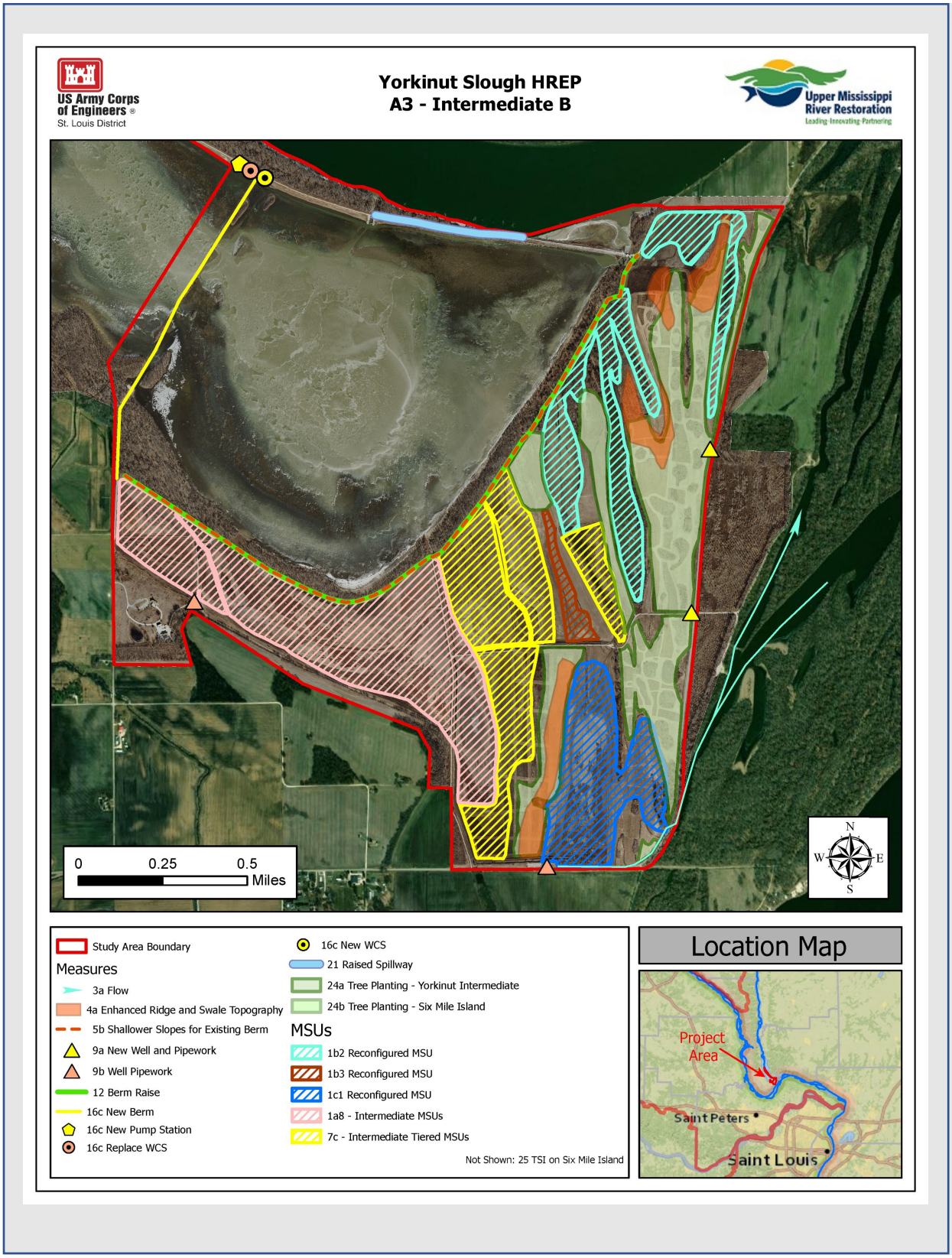

Figure ES-1. Tentatively Selected Plan – Yorkinut Slough view

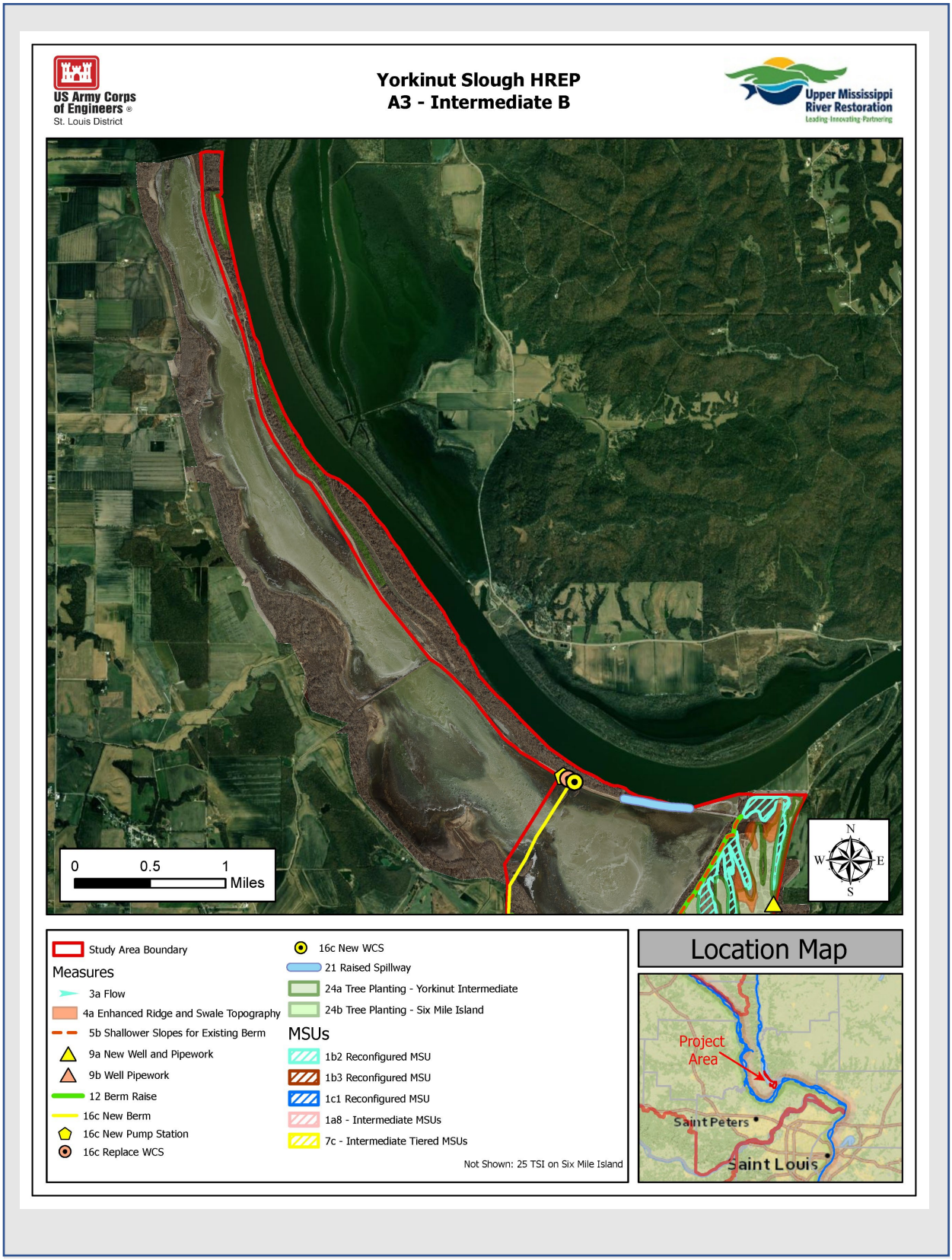

Figure ES-2. Tentatively Selected Plan – Six Mile Island view

ACRONYMS

Table of acronyms used in this report

Average Annual Habitat Unit	**AAHU**	Migratory Bird Treaty Act	**MBTA**
Area of Potential Effect	**APE**	USACE, Mississippi Valley Division	**MVD**
Cost Effectiveness & Incremental Cost Analyses	**CE/ICA**	North American Vertical Datum of 1988	**NAVD 88**
Cubic Yards	**CY**	National Environmental Policy Act	**NEPA**
St. Louis District	**District**	National Wildlife Refuge	**NWR**
Dissolved Oxygen	**DO**	National Register of Historic Places	**NRHP**
Environmental Assessment	**EA**	Operation, maintenance, repair, replacement, and rehabilitation	**OMRR&R**
Engineering Circular	**EC**	Plans & Specifications	**P&S**
Essential Habitat Area	**EHA**	River Mile	**RM**
Environmental Protection Agency	**EPA**	River Resources Action Team	**RRAT**
Engineer Regulation	**ER**	River Resources Action Team – Technical Section	**RRAT-Tech**
Engineer Research and Development Center	**ERDC**	River Resources Coordinating Team	**RRCT**
Endangered Species Act	**ESA**	River Resources Forum	**RRF**
Fish and Wildlife Coordination Act	**FWCA**	State Historic Preservation Office	**SHPO**
Fish and Wildlife Interagency Committee	**FWIC**	Timber Stand Improvement	**TSI**
Fish and Wildlife Work Group	**FWWG**	Tentatively Selected Plan	**TSP**
Hydrologic Engineering Center-Ecosystem Functions Model	**HEC-EFM**	Total Suspended Solids	**TSS**
Habitat Evaluation Procedures	**HEP**	Upper Mississippi River	**UMR**
Habitat Needs Assessment-II	**HNA-II**	Upper Mississippi River Restoration	**UMRR**
Habitat Rehabilitation and Enhancement Project	**HREP**	Upper Mississippi River System	**UMRS**
Habitat Suitability Index	**HSI**	Upper Mississippi River and Great Lakes Region Joint Venture	**UMRGLJV**
Hazardous, Toxic, and Radioactive Waste	**HTRW**	U.S. Fish and Wildlife Service	**USFWS**
Long Term Resource Monitoring	**LTRM**	Water Control Structure	**WCS**
Lock(s) and Dam	**L&D**	Water Resources Development Act	**WRDA**

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CHAPTER 1- INTRODUCTION

The U.S. Army Corps of Engineers (USACE), St. Louis District (District), has prepared this Feasibility Report with Integrated Environmental Assessment (FR/EA) to present a detailed account of the planning, engineering, construction considerations, and environmental considerations that resulted in the Tentatively Selected Plan for the Yorkinut Slough Habitat Rehabilitation and Enhancement Project (HREP) (Project). The FR/EA (Report) meets USACE planning guidance and National Environmental Protection Act (NEPA) requirements. The planning and decision process includes:

- Scoping (identifying problems, opportunities, objectives, and constraints)
- Identifying existing conditions and future without project (FWOP) conditions
- Plan formulation (identifying measures, formulating plans, evaluating and comparing plans)
- Plan selection

Evidence gathering, risk management, and stakeholder involvement occurs throughout the planning process. The Report summarizes the multidisciplinary efforts of the District, the Sponsor, and Project partners.

A. Authority and Project Selection

The Upper Mississippi River Restoration (UMRR) program was originally authorized by the Water Resources Development Act (WRDA) of 1986 under Section 1103 (33 U.S.C. 2210 et seq.; P.L. 99-662, 1986). The UMRR program is composed of two elements: (1) plan, construct, and evaluate measures for fish and wildlife habitat improvement through HREPs, and (2) monitor the natural resources of the river system through the Long Term Resource Monitoring element. It is a regional program that includes the USACE St. Paul, Rock Island, and St. Louis Districts. Additional information on the program authority can be found at: https://www.mvr.usace.army.mil/Missions/Environmental-Stewardship/Upper-Mississippi-River-Restoration/Key-Documents/.

Interagency groups identify, prioritize, and select the HREP's. Field managers from the cooperating agency groups identify areas with degraded aquatic, wetland, and bottomland forest habitats and which UMRR authorized objectives are priority for the area. After considering resource needs and deficiencies pool by pool, the River Resources Action Team – Executive Team (RRAT) supported and recommended the Project as providing significant aquatic, wetland, and floodplain benefits with opportunities for habitat enhancement. The Mississippi Valley Division (MVD) approved the Fact Sheet on August 23, 2018.

Partners. Planning partners for Yorkinut HREP included the Two Rivers National Wildlife Refuge, USFWS Region 3 offices, and Illinois Department of Natural Resources (IDNR). Development of this FR/EA was actively coordinated with the participants during team meetings, phone conversations, and on-site visits to the study area.

USACE, St. Louis District. USACE is responsible for Project management and coordination with the Sponsor, Project partners, and other affected agencies. USACE will submit the FR/EA,

program funds, finalize Plans & Specifications (P&S), complete all NEPA requirements, advertise and award a construction contract, and perform construction contract supervision and administration. Section 906(e) of WRDA 1986 states that first cost funding for enhancement measures will be 100% federal cost because the Project measures will be located on federally owned land.

Sponsor. The U.S. Fish and Wildlife Service is the Sponsor. Under federal regulations governing the implementation of National Environmental Policy Act (NEPA), the U.S. Fish and Wildlife Service (USFWS) is a cooperating agency. Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R), as described in Section VI.F, is the responsibility of the Sponsor in accordance with Section 107(b) of WRDA 1992, Pub. L. 102-580, 33 U.S.C. § 652(e)(7)(A). The operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) responsibilities of the Sponsor will be addressed in the proposed draft *Appendix P – Memorandum of Agreement* for the Project.

B. Purpose and Scope*

The District proposes to rehabilitate and enhance the study area through construction of measures to restore wetlands and forest habitat that is currently declining due to altered hydrology. The decline in ecosystem structure and function impacts forest community and emergent wetland development, species composition, diversity, and resources for resident and migratory wildlife. The federal interest for rehabilitation and enhancement is also demonstrated in the following reports:

- *The Two Rivers National Wildlife Refuge Habitat Management Plan* (FWS, 2011) identifies a desire to protect a natural diversity of habitat types able to support healthy native wildlife populations. An emphasis was placed on wetland resources and their associated migratory and resident wildlife species; patch size and structural diversity of floodplain forest resources; and reducing the impacts of sedimentation on fish and wildlife resources.
- The *Upper Mississippi River System Habitat Needs Assessment II* (McCain, Schmuecker, & De Jager, 2018). The HNA II summarized the desired future conditions in relation to high importance indicators for the Lower Illinois River as 1) Enhance native fish passage during time periods of key life stages; 2) Restore former agricultural areas to native floodplain vegetation; 3) Reduce sedimentation; 4) Restore deep, lentic, and lotic habitats; 5) Restore open water areas; 6) Increase off-channel and floodplain lentic areas; 7) Restore aquatic vegetation; 8) Restore floodplain topographic diversity and associated inundation periods; 9) Reduce variability in water surface elevations; and 10) Restore floodplain vegetation diversity.
- *2012 North American Waterfowl Management Plan* (Canada Ministry of the Environment, U.S. Department of Interior, & Mexico Secretariat of Environment and Natural Reso, 2012) identifies the importance of the confluence region for migratory waterfowl.
- *Upper Mississippi Great Lake Joint Venture Waterfowl Conservation Strategy* (Soulliere, et al., 2017) identifies the confluence region as an area of high concentration for migratory, nonbreeding waterfowl habitat.

- *Upper Mississippi Great Lakes Joint Venture Waterbird Conservation Strategy* (UMRGLJV, 2018) identifies the importance of the confluence region for breeding and migratory waterbirds.

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

C. Study Area

Two Rivers National Wildlife Refuge (Refuge) includes approximately 9,360 acres of riverine and floodplain habitat along the Illinois and Mississippi Rivers. Yorkinut Slough consists of approximately 2,350 acres, of which 1,031 acres are bottomland forest, woodland, and wetland, and is located on the right descending bank of the Illinois River between River Miles 5 and 11 in Calhoun County, Illinois. The study area is located 22.5 RM upstream of Melvin Price Locks & Dam. This structure was constructed on the Mississippi River near Alton, Illinois, and was placed into full operation on 01 February 1990. When the tainter gates are lowered into the water at Melvin Price Locks & Dam, the navigation pool that is created extends into both the Mississippi River and the Illinois River. All lands in the study area are in federal ownership and are managed by the USFWS as part of the Two Rivers National Wildlife Refuge (NWR). **Figure 1** is a vicinity map of the area surrounding the study area and **Figure 2** is a study area location map for the Yorkinut Slough HREP.

Yorkinut Slough HREP is named after Yorkinut Slough, which is a prominent deep water slough that bisects the study area boundary. “Yorkinut” is a slang term for the seeds produced by the American lotus plant (*Nelumbo lutea*). American lotus is an aquatic emergent perennial plant that formerly occurred in great abundance in the early 1900’s at the Refuge, including Yorkinut Slough. Yorkinut seeds are known to have seed viabilities that can last for centuries. The seeds are commonly consumed by waterfowl and are edible to humans. This Project may enhance water level management capabilities that would restore conditions for American lotus to occur once again within Yorkinut Slough.

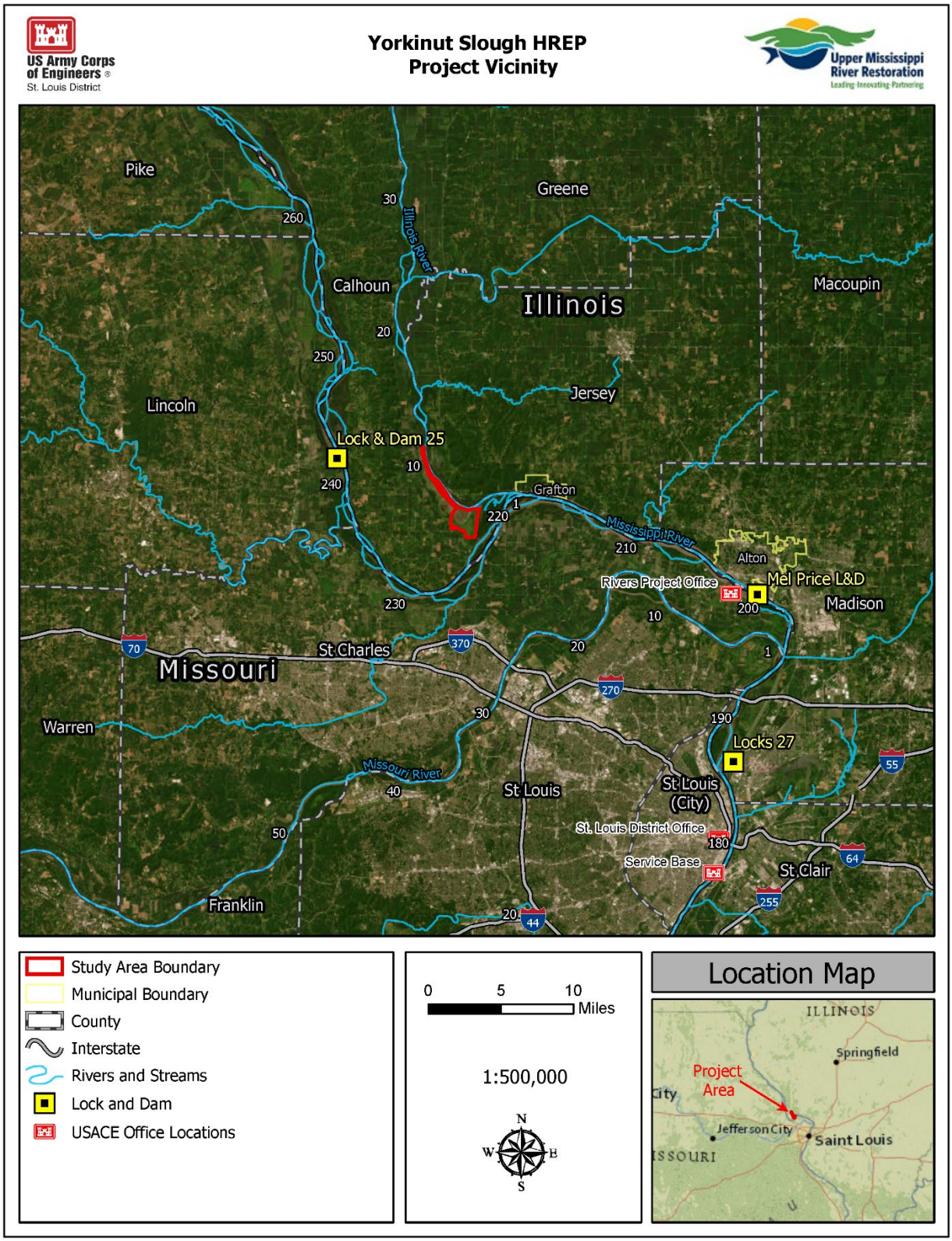

Figure 1. Project Vicinity Map

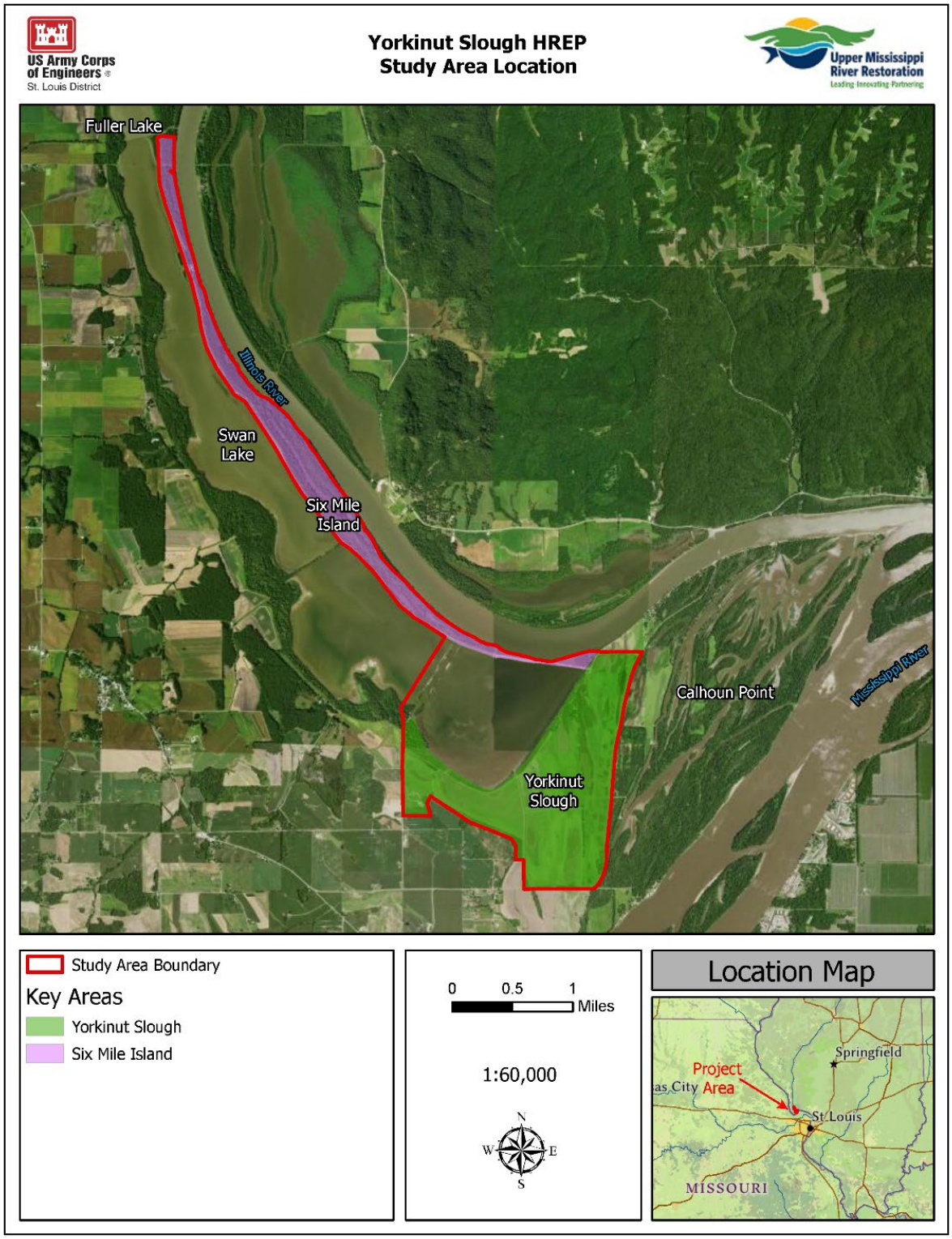

Figure 2. Study Area Location Map

D. Prior Reports, Existing Water Projects, and Ongoing Programs

Table 1 summarizes prior reports, existing water projects, and ongoing programs which provided valuable information, experience, or guidance in the planning of the Project. Additional literature cited can be found in the References section of this report and appendices.

Table 1. Prior Reports, Projects, and Programs

Project Year	Study/Report/Environmental Document Title	Project Relevance
2012	*Upper Missippi River Systemic Forest Stewardship Plan*	This report highlights the ecological importance of floodplain forests along the UMRS, and provides the general desired conditions for floodplain forests. Existing USACE forestry data were used to evaluate how current forest conditions deviate from systemic forestry goals.
2007	*Heitmeyer, M.E., K. Westphall. 2007. An Evaluation of Ecosystem Restoration and Management Options for the Calhoun and Gilbert Lake Divisions of Two Rivers National Wildlife Refuge.* USACE St. Louis District.	This report evaluates ecosystem restoration options and helped develop a comprehensive habitat management plan for the Two Rivers National Wildlife Refuge lands near the Illinois-Mississippi River confluence. The report documented historical ecosystem conditions and changes to hydrology, vegetation, and resource distribution after construction of the UMRS Lock and Dam Navigation system. The report was used to evaluate potentially appropriate habitat restoration options within the study area.
2008	*Status and Trends of Selected Resources of the Upper Mississippi River System. U.S. Geological Survey, La Crosse, WI. Technical Report LTRMP 2008-T002* (Johnson & Hagerty, 2008)	This report was used to evaluate historic and existing ecosystem conditions along the UMRS. The report also discusses the status and trends of biological, physical, and chemical indicators of system health developed through the UMRR-LTRM which was incorporated where appropriate in Chapter 3.
2011	*USFWS. 2011. Two Rivers National Wildlife Refuge Habitat Management Plan. U.S. Fish and Wildlife Service. 138 pp.*	This plan provides guidance for implementation of habitat management strategies identified during comprehensive conservation planning. The plan was used to evaluate the existing conditions for habitat management and objectives in the study area.
2012	*Upper Mississippi River Restoration Environmental Design Handbook.* 2012. USACE, Rock Island District, Rock Island, Illinois.	The design handbook was used to evaluate potential project features and incorporate lessons learned from other HREPs.
2015	*USACE. 2015. Rivers Project Office Master Plan. U.S. Army Corps of Engineers. 456 pp.*	This plan includes a classification of project lands, discussion of special concerns and special programs and planning considerations, identification of facility needs, and management area descriptions and proposals (including monitoring and management

		potential in the study area). The updated land use classifications and related USACE, State and USFWS agreements will effectively meet current and future public use demand for federal lands while sustaining the inherent resource quality for fish and wildlife management and enhancement.
2018	*McCain, K., Schmuecker, S., and De Jager, N. 2018. Habitat Needs Assessment-II: Linking Science to Management Perspectives.*	This report summarizes the second Habitat Needs Assessment of the UMRS and is intended to help inform the UMRR Program in selecting, designing, and evaluating future restoration projects to achieve the UMRR Program's vision. It describes and compares historical, existing, forecasted, and desired future conditions to identify habitat needs within the UMRS. The report was used to evaluate potential to address limiting habitat or processes in the study area for the lower Illinois River reach. This included addressing loss of vegetation diversity and hard-mast resources.
1993	*Swan Lake Habitat Rehabilitation and Enhancement Project (HREP)*	The Swan Lake HREP, located in Calhoun County, Illinois between river miles 13.3 and 5.0, is operated by the USFWS and IDNR. The project, finished construction in 2001, is bottomland forest and oxbow lake approximately 2,900 acres. This is the largest backwater complex in Pool 26 of the Mississippi River and one of the largest on the Illinois River. Project goals were to: 1) Restore aquatic macrophyte beds and associated invertebrate communities for the benefit of migratory waterfowl; 2) Provide habitat for over winter survival of fish; 3) Provide habitat for spawning and rearing of fish; and 4) Increase the overall habitat value for waterfowl and fishes. In order to achieve these goals, sedimentation, lack of water level control, and wind fetch at the site needed to be addressed. The report was used as background information on stressors and problems affecting habitat management near the Yorkinut Slough study area.
2023	*Swan Lake Flood Damage Assessment (FDA) Project*	The purpose of this assessment is to evaluate the impacts of flooding on the performance of the Swan Lake HREP project and determine if additional federal action is needed to rehabilitate the project. The design of the original Swan Lake HREP was to provide the physical conditions necessary to improve and enhance wetland and aquatic habitat quality for both waterfowl and fish. The HREP project included approximately 4,600 acres of habitat: 2,900-acre Swan Lake, 200-acre Fuller Lake, 950 acres of bottomland forest and 550 acres of cropland surrounding the lakes. Construction of the HREP

		project was completed in 2003. Since the Swan Lake project feasibility report was completed in 1991 (revised edition completed in 1993), there have been an unprecedented number of historic floods occurring in the area. A study team was assembled to analyze the extent of damages at Swan Lake and determine next steps to repair with resiliency.

CHAPTER 2- PURPOSE AND NEED FOR FEDERAL ACTION*

This section describes the identification of problems and opportunities, assessment of resource significance of the study area, goals and recommendations of overarching programs and development of Project objectives and identification of constraints and considerations. For planning purposes, the period of analysis was established as 50 years starting in 2025 - 2075.

Problem statements are concise characterizations of broad issues to be addressed through plan formulation within the study area. Opportunity statements consist of an array of opportunities presented by virtue of planning and construction activities occurring at the corresponding problem location, and can also be ancillary to the identified problems. A conceptual ecological model (CEM) was developed to assist in communication and planning for Yorkinut Slough HREP. CEMs are non-quantitative planning tools used to identify major drivers and stressors on natural systems, and the ecological effects of these stressors. The CEM for Yorkinut Slough HREP is illustrated in **Figure 3**. This section was developed to meet ER 1105-2-100 Step 2. Problems and Opportunities and NEPA requirement for description of Purpose and Need (40 C.F.R Sec. 1502.13).

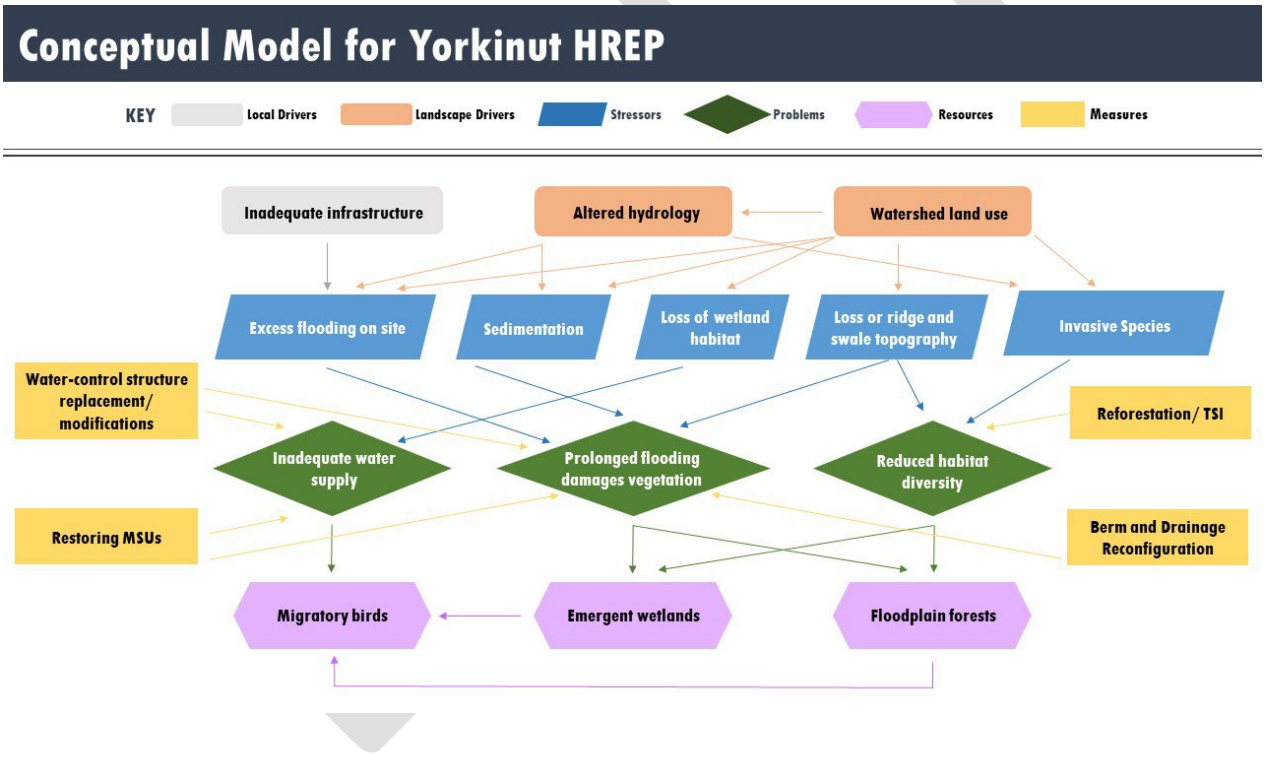

Figure 3. Yorkinut Slough HREP Conceptual Ecological Model (CEM)

A. Problems and Opportunities

Human-induced physical modifications over the past two centuries within the Lower Illinois River floodplain have altered hydrology, topography, and biotic communities historically present within the study area. These alterations have degraded aquatic resources (i.e., side channel, fisheries, and wetland habitat), reduced forest community diversity (i.e., age, structure, and species

composition), impaired ecosystem functions, and threatened the future sustainability of the river-floodplain ecosystem.

The following problems and opportunities have been identified.

Problem Statement 1. Inability to achieve early successional and emergent wetland habitat for waterfowl, wading birds, shorebirds, and neotropical migrants reducing food availability, migration resting sites, and other habitat needs.

River habitats along the Illinois River have higher water elevations than pre-settlement levels, and experience more frequent and rapid short-term fluctuations. Levee and drainage districts reduced connectivity with the floodplain and changed the hydrology of the river reducing the aquatic habitat extent influenced by the river (Havera & Bellrose, 1985). Secondary channels, in Alton Pool, are degraded by excessive sedimentation in an impounded environment (Illinois River Reach Plan, 2009). High levels of sedimentation occur in the reach as the flow from the watershed is concentrated down the narrow mainstem floodway between levees. Heavy sediment loads then drop out in the low velocity environment and fill contiguous floodplains, backwaters, and channels (Illinois River Reach Plan, 2009). The lakes within the study area no longer benefit from the physical and ecological functions of seasonal low river stages as a result of increased river stages from the lock and dam system. Sediments remain saturated and become low quality, unconsolidated silt. Water clarity is degraded when benthic fish, waterfowl, or wind-waves disturb and resuspend the sediments. Resuspended sediments limit the ability of emergent vegetation to establish. Sedimentation in water conveyance channels limit water level management. The existing berms are not of a consistent height which results in frequent inundation from minor riverine flood events which then impacts management in the entire study area. The wetland unit berm configuration does not allow independent management and berms do not always follow the natural drainage patterns of the site which limits management capabilities and habitat diversity. The surrounding watershed drains through the study area and influences water levels along the primary outlet to the Illinois River. This limits the ability to drain or manage water levels in the Yorkinut Slough wetlands. In addition, flood events that impact management capabilities in the study area have increased in frequency. Measures that restore hydrology seasonal fluctuations similar to pre-lock and dam conditions could provide increased quality and quantity of emergent wetland habitat and associated floodplain habitats.

Problem Statement 2. Permanently elevated water levels, caused by impoundment of the Alton Lock and Dam on the Mississippi River and six dams on the Illinois River, and excessive flooding during growing season have resulted in loss of bottomland floodplain forest. These stressors on the floodplain forest reduce hard mast tree establishment impacting food sources for wildlife.

Yorkinut Slough HREP is located at the Illinois-Mississippi River confluence. This location has been significantly altered by humans over approximately the last 200 years. Forests were cleared, as early as the mid-1830's, to fuel increasing numbers of steamboats and growing populations of European settlers (Anfinson, 2003). Large patches of grassland and woodland were converted to agricultural production by the late 1800's.

The Chicago Sanitary and Ship Canal was completed by the USACE in 1900, connecting the Illinois River to Lake Michigan. The Chicago Sanitary and Ship Canal was a significant hydrologic diversion of more than 10,000 cubic feet per second which increased water levels several feet along the entire river (Illinois River Reach Plan, 2009). USACE was tasked with creating a nine-foot navigation channel in the river which stabilized low flow river stages when flow alone is not sufficient to maintain navigable channel depths, which is approximately 50 percent of the time. The increased volume of water raised low water elevations 5.5 feet (ft) when compared to pre-dam conditions (Nelson & Sparks, 1997). The elevated water conditions permanently inundated bottomland forest, wetlands and marsh habitat.

The land use and hydrologic changes described in the previous two paragraphs have favored more flood tolerant tree species such as Silver Maple which has reduced forest diversity. Hard-mast species, such as bottomland oaks and hickories, and early successional forests are declining in the region due to a loss of suitable disturbance and regeneration conditions. The combination of existing forest conditions, reduced area suitable for hard-mast species in the floodplain, and altered hydrology limit the ability for diverse forests to naturally regenerate.

Problem Statement 3. Altered floodplain connectivity and sedimentation regime continues to erode ridge and swale topography, resulting in loss of depth diversity and vegetation diversity.

Floodplain connectivity and sedimentation regimes, on the Illinois River, have been and continue to be impacted by dams, levees, and pollution within the watershed.

Pre-impoundment, low water elevation periods, coincided with the growing season which many floodplain tree species are adapted to in the region. Construction of the lock and dam system increased the low water elevation on the UMRS which led to a decrease in bottomland forest diversity and continues to limit establishment of some species in the present floodplain (Nelson et al. 1994). The increase in water elevation led to a decrease in topographic diversity in UMRS forests and created less favorable conditions for oak-hickory survival and regeneration.

River habitats along the Illinois River have higher water elevations than pre-settlement levels, and experience more frequent and rapid short-term fluctuations. These conditions have reduced the extent and diversity of aquatic vegetation and floodplain habitats (Bellrose, 1941); (Bellrose, Paveglio Jr., & Steffeck, 1979); (Spink & Rogers, 1996) to favor already abundant species that are more tolerant of fluctuating water levels and higher turbidity. Aquatic wetland plants requiring stable water levels have diminished along the Illinois River and are now confined to relatively small patches.

The impounded lakes do not benefit from the physical and ecological functions of seasonal low river stages. Sediments remain saturated and become low- quality, unconsolidated silt. Water clarity is degraded when benthic fish, waterfowl, or wind-waves disturb and resuspend the sediments.

The heavy sediment loads then drop out in the low velocity environment and fill contiguous floodplains, backwaters, channels, and ridge and swale habitat. As sedimentation in swales and backwaters, topographic and bathymetric diversity decreases which reduces habitat diversity needed to support different aquatic and terrestrial plants and wildlife. The Yorkinut Slough

HREP study area has limited low flow conditions during the summer growing season. As mentioned under Problem Statement 1, impounded lakes, within the study area, do not benefit from the physical and ecological functions of seasonal low river stages resulting in sediments remaining saturated and become low quality, unconsolidated silt. Water quality conditions degrade when benthic fish, waterfowl, or wind-waves disturb and resuspend the sediments. Sediment resuspension further reduces the ability for aquatic vegetation to establish.

As noted under Problem #2, the Chicago Sanitary and Ship Canal completed by USACE in 1900 connected the Illinois River to Lake Michigan. Sewage and industrial pollution flushed into the Illinois River from Chicago in the early to mid-1900s also contributed to severe declines in aquatic resources along two-thirds of the Illinois River's length (Theiling, 1999); (Havera & Bellrose, 1985). Pollution has been cleaned up to a large extent compared to the extremes of the recent past, but the waterways have become pathways for a variety of aquatic migrants including invasive carps which are approaching Lake Michigan from downstream (Illinois River Reach Plan, 2009).

Opportunities

Within the study area, there are opportunities for additional beneficial outcomes beyond solving the stated problems related to wetland, floodplain forest, and floodplain woodland habitats.

Opportunities of primary focus for the study include:

- Improve habitat diversity which creates a more resilient ecosystem.
- Improve wetland habitat in a critical area for waterfowl and other migratory birds
- Increase resiliency of ecosystem restoration Project measures
- Ensure adaptability of infrastructure to future climate and hydrologic variability and
- Increase public wildlife viewing and recreational use.

B. 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, as described in ER 1105-2-100. These three categories are used to determine if the ecosystem is significant enough to warrant federal investment. As a subset of the Upper Mississippi River (UMR) Basin, significance in the UMR Basin also applies to the Lower Illinois River Valley (IRV).

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. Congress designated the UMRS as both a "…nationally significant ecosystem and a nationally significant navigation system…" in Section 1103 of the WRDA 1986. Institutional significance of the UMR is demonstrated in a number of region-specific laws and policies including the UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan of 2006, the UMR Wildlife and Fish Refuge Act of 1924, and the Migratory Bird Conservation Act of 1929.

The Upper Mississippi River and Great Lakes Region Joint Venture (UMRGLJV) is one of eighteen bird habitat joint ventures in North America. The Joint Venture (JV) is self-directed

through a partnership of federal, state, and private agencies, and individuals that cooperate and pool resources to achieve bird conservation objectives throughout portions of a ten-state region. Plans such as The Waterbird Habitat Conservation Strategy, Waterfowl Habitat Conservation Strategy (Soulliere, et al., 2017), and Shorebird Habitat Conservation Strategy (Potter, et al., 2007) recognize the importance of conservation and habitat restoration near the Illinois Mississippi River Confluence Area. In addition, the UMRGLJV's assessment of the Illinois Eastern Tallgrass Prairie Bird Conservation Region identifies woodland and semi-permanent wetlands as resources of restoration need in the region. The Project is expected to contribute towards the region's goals for the restoration of semi-permanent wetlands and woodland habitat land cover types.

The Upper Mississippi River Systemic Forest Stewardship Plan was developed to provide a guide for the sustainable management of Upper Mississippi River System (UMRS) forests, to identify opportunities for restoration, and to develop recommendations that maintain the national significance of UMRS forest resources. Without management, forest resources are expected to decline in quality and quantity. In particular, the loss of mast trees as a forest component, and the conversion of forest to other vegetation types in mid-pool areas such as the Yorkinut Slough area will likely continue to occur due to elevated river levels. The Project is expected to support the Upper Mississippi River Systemic Forest Stewardship Plan's desired future conditions framework through restoration of hard-mast forest resources and improvement to forest structure and diversity.

Technical Recognition: Technical recognition means the resource qualifies as significant 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. The UMRR study area encompasses a globally significant flyway used by more than 326 species of birds and as a home for at least 260 species of fish, 37 species of mussels, 47 species of reptiles and amphibians, and 50 species of mammals, including a number of rare and endangered species. The UMR ecosystem includes 318,750 acres designated as Ramsar Wetlands of International Importance.

Numerous scientific analyses and long-term evaluations of the UMRS have documented its significant ecological resources. Since the early 20th century, researchers, government agencies, and private groups have studied the larger river floodplain system and proposed ecosystem restoration in the UMRS. Numerous scientific analyses and long-term studies through USACE's UMRR-LTRM have documented the significance of the resources in the UMR basin.

In a 1995 report (Noss, LaRoe III, & Scott, 1995), the U.S. Department of Interior (DOI) listed a number of endangered ecosystems in the United States that have particular relevance to the Yorkinut Slough study area. The DOI documented a loss of or significant degradation to large rivers and stream in the United States (85-98%), oak dominated woodlands in the Midwest (99%), and Illinois Wetland ecosystems (>89%) since European settlement. Large floodplain-river ecosystems have become increasingly rare worldwide. Two large floodplain-river ecosystems lay within the UMRS, namely the Upper Mississippi and Illinois Rivers. These two ecosystems still retain some seasonal flood pulses, and half of their original floodplains remain

unleveed and open to the rivers (Sparks, Nelson, & Yin, 1998). The UMRS is one of the few areas in the developed world where ecosystem restoration can be implemented on large floodplain-river ecosystems (Sparks R. , 1995).

In addition, technical resource agencies (federal, state, and non-profit) view the resources in the Illinois River as significant, as reflected in the ongoing habitat restoration efforts in the region including completed HREP projects at Calhoun Point, Swan Lake, and Stump Lake. The *Upper Mississippi River System Habitat Needs Assessment II* (McCain, Schmuecker, & De Jager, 2018) has also technically recognized the need to restore wetland habitat, floodplain vegetation diversity, floodplain topographic diversity, and former agricultural areas to native floodplain vegetation within the Lower Illinois River area/floodplain. The Refuge's technical significance is further documented in *Appendix C – Biological Assessment.*

Public Significance: 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. The public recognizes the UMR as a nationally, regionally, and locally significant resource. American Rivers, a non-governmental organization dedicated to protecting and restoring healthy, natural rivers, listed the Mississippi River in America's Top Ten Endangered Rivers for 2004 and added the Mississippi River as a "special mention" on the 2011 list. Non-profit and private organizations recognize the significance of the resources in UMRR study areas through active engagement in UMRR implementation or serving as nonfederal cost-share sponsors of habitat projects.

The National Audubon Society's Important Bird Areas Program has identified the public lands at the confluence of the Illinois and Mississippi Rivers, including Refuge lands and Calhoun Point Wildlife Management Area, as an Important Bird Area for migratory wetland birds and breeding Prothonotary Warblers. This bird conservation program identifies the areas that are most critical to the maintenance and restoration of bird populations.

Additional public recognition for the study area comes through public outreach and conservation work being performed by Ducks Unlimited. This organization is dedicated to the preservation and enhancement of natural resources. Ducks Unlimited replaced two existing non-functional wells to increase water delivery and management capacity to portions of the Refuge in 2023 (see Chapter 3 – C – Hydrology and Hydraulics for more information).

Furthermore, the Refuge is recognized as a public use area for wildlife viewing, hiking, and fishing due to its proximity to the National Scenic Byway and its related resources. The Great Rivers and Routes Tourism Bureau, Explore St. Louis, and River Travel Magazine have all recognized the Refuge as an outdoor destination in the region. The Refuge's significance to the public is further documented in *Appendix C – Biological Assessment*.

C. UPPER MISSISSIPPI RIVER SYSTEM ECOSYSTEM RESTORATION GOALS & OBJECTIVES

Formal planning for UMRS ecosystem management and restoration has been an ongoing process that was institutionalized in the 1970s with a Comprehensive Master Plan completed by the Upper Mississippi River Basin Commission in 1982. The UMRR program was authorized in

1986 and has since gone through several project planning cycles to develop regional ecosystem restoration needs and priorities. Reach Planning processes led to the identification of high priority areas for restoration of natural river processes (as required by Section 8004 of WRDA 2007) and provided context for formulating project measures, defining performance measures, and designing monitoring plans. Goals and objectives for the condition of the river ecosystem are central to river management and are linked to other elements of the framework. The overarching UMRS Ecosystem Goal is to conserve, restore, and maintain the ecological structure and function of the UMRS.

The study area is located within the Lower Illinois River Reach. The following documents the objectives for the Lower Illinois reach that apply to the Yorkinut Slough HREP. The UMRR Reach objectives are:

- Hydraulics and hydrology: a more natural stage hydrograph
- Biogeochemistry: reduced sediment loading and sediment resuspension in backwaters
- Geomorphology: Restored lateral hydraulic connectivity
- Habitat: Restored habitat connectivity and restored floodplain areas
- Biota: Viable populations of native species throughout their range in the UMRS at levels of abundance in keeping with their biotic potential, and restored diversity and extent of native communities throughout their range in the UMRS

Habitat Needs Assessment-II

To address the UMRR program's vision statement of a healthier and more resilient UMR ecosystem that sustains the river's multiple uses, the program developed a suite of 12 indicators in the Habitat Needs Assessment-II (HNA-II) that quantify aspects of ecosystem health and resilience, reflect the ability of large floodplain river ecosystems to adapt and respond to disturbances, and represent ecosystem-based management objectives developed for the UMRS (USACE, 2011). To identify habitat needs for the UMRS, the HNA-II effort compared individual indicators to the conditions desired by the management agencies of the UMRR program. An assessment of current conditions using both quantitative data analysis and qualitative management perspectives was performed at two spatial scales: navigation pool and clusters of navigation pools that shared similar ecological attributes. The UMRR program can use the information provided in the HNA-II to achieve the program's goals and individual HREPs more effectively (McCain, K.N.S., et. al., 2018).

Pool 26 is part of the Lower Illinois River cluster, as identified by the River Teams, and has the following desired future conditions:

- Enhance native fish passage during time periods of key life stages
- Restore former agricultural areas to native floodplain vegetation
- Reduce sedimentation
- Restore deep, lentic and lotic habitats
- Restore open water areas
- Increase off-channel and floodplain lentic areas
- Restore aquatic vegetation
- Restore floodplain topographic diversity and associated inundation periods

- Reduce variability in water surface elevations
- Restore floodplain vegetation diversity

Sponsor Management Goals

The Refuge aims to protect, enhance, and restore the natural diversity of habitat types needed to maintain healthy populations of native wildlife using common habitat management techniques (e.g., water level control, disking, planting, invasive species management, etc.) where appropriate. Plant community distribution, areal coverage, and prescribed management methods adapt to changing conditions on site, and therefore is anticipated to change over time. Currently the Refuge manages lands to provide a diversity of aquatic, forest, bottomland woodland and grassland habitats.

C. Project Objectives

Objectives for Yorkinut Slough HREP were derived based on overarching goals, identification of problems and opportunities, and USFWS and USACE resource and program priorities. The success of the Project planning is determined by the fulfillment of the objectives through identified alternative plans. Yorkinut Slough HREP objectives for the 50-year planning horizon 2025-2075 are:

1. Restore and increase early successional and emergent wetland within the study area over the 50-year period of analysis
2. Restore and increase floodplain forests within the study area over the 50-year period of analysis
3. Improve hydrologic conditions for wildlife including waterfowl, shorebirds, wading birds, Neotropical migrants, and others within the study area over the 50-year period of analysis

The relationship between objectives and the performance criteria to determine Project success is summarized in *Appendix E – Monitoring and Adaptive Management.*

D. Planning Constraints and Considerations

A planning constraint limits the extent of the plan formulation process. Constraints considered for the Yorkinut Slough HREP area:

- Avoid or minimize negative impacts to the existing HREP projects in adjacent areas
- Avoid or minimize negative impacts to Ducks Unlimited projects
- Work will be restricted to federal lands only
- Avoid or minimize increases to flood heights and durations that adversely affect infrastructure and private property
- Project measures should be resilient to frequent flood events
- Avoid or minimize impacts to utilities such as power lines, buried pipes, etc.
- Avoid and minimize threatened and endangered species impacts and migratory species, including Indiana Bat, Northern Long-eared Bat, Tricolored Bat, Decurrent False Aster,

and Monarch which may occur in the study area. Measures were screened or modified to avoid potential adverse impacts during measure development.

- Avoid impacts to cultural resources
- Avoid adverse social justice impacts
- Avoid impacts to private and public landowners

The following considerations were made during planning to formulate and evaluate alternatives to ensure the selected plan is acceptable, efficient, effective, and feasible as required by Principle and Guideline criteria 1983.

- Avoid or minimize wetland and floodplain forest impacts, including hard mast resources (E.O. 11988 & E.O. 11990)
- Maintain hydraulic connectivity to Illinois River to allow for fish access and accommodate invasive carp drawdown management
- Alignment with authorized federal projects and management plans such as the NWR Habitat Management Plan and UMR Forestry Stewardship Plan and Invasive Species Carp Management Plan
- Minimize Operation and Maintenance Repair, Rehabilitation costs during the planning horizon
- Avoid impacts to the state (Illinois) threatened species (American eel, bigeye shiner, black sandshell, Indiana bat, northern long-eared bat, western sand darter, and smooth softshell)

CHAPTER 3- EXISTING CONDITIONS AND FUTURE WITHOUT PROJECT CONDITIONS*

This chapter assesses the existing and future conditions of resources, organized by resource topic, within Pool 26 of the Mississippi River, and more specifically the study area. Resource topics analyzed in detail include resources of the affected environment. This is not a comprehensive discussion of every resource within the study area, but rather focuses on aspects of the environment identified as relevant issues during scoping or which may be affected by the study alternatives. NEPA regulations state that documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail. The environmental consequences that are likely to occur as a result of construction of the proposed restoration or enhancement measures are described in Chapter 5.

Appendix C – Biological Assessment describes some of these resources in greater detail and includes relevant maps.

A. Resources Not Evaluated in Detail

The District considered relevant environmental resources that would potentially be impacted by the proposed alternatives and eliminated resources that were not in the area of potential effect or would not be impacted by any of the alternatives from further evaluation. These resources include:

- Geomorphic/Physiographic
- Mineral and Energy Resources
- Wild and Scenic Rivers

The District focused on information gathered from the study area and the area of potential effect.

Forecasting the future is an essential part of the USACE planning process with the most important recurring forecasts being the future without project (FWOP) and future with project (FWP) conditions. The FWOP is the basis from which alternative plans are formulated and impacts are assessed and can be defined as “the most likely condition to exist in the future in the absence of a proposed water resources project” (ER 1105-2-100 p. 2-8). The FWOP, considered the No Action Alternative, would not include any USACE Project measures, and no additional costs to USACE would be generated.

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

1. USFWS will continue to maintain access areas and roads throughout the study area and manage habitats according to suitability of conditions.
2. There will be continued loss of water management capabilities due to sedimentation, flooding, berm seepage, loss of wells, and aging infrastructure. As a result, there will be decreased seed production by emergent vegetation and a gradual loss of wetland area due to sedimentation and woody encroachment.
3. Natural hard-mast recruitment potential will be negligible in former agricultural areas due to flood frequency and lack of parent trees.

4. Forest health will continue to degrade with the current hydrologic regime.
5. Hard mast tree species dominance will continue to decrease as shade tolerant tree species recruit and develop, while mature hard mast species succumb to mortality.
6. No substantial increases to USFWS's current operation and maintenance budget for the site would occur.
7. Up to two new wells will be installed per the Ducks Unlimited North American Wetlands Conservation Act (NAWCA) grant project. Ducks Unlimited plans to replace existing non-functional wells to increase water delivery and management capacity to portions of the Refuge.
8. Flood events on the Illinois and Mississippi rivers will become more frequent.
9. Work associated with the Swan Lake Flood Damage Assessment would return the Illinois riverside berm surrounding Swan Lake and Fuller Lake to the original design elevation and raise the spillways to the same contour as the adjacent berm. This would result in an increase in protection from frequent low-level annual flood events.

B. Resource History and Current Management

Two Rivers National Wildlife Refuge Calhoun Division includes 4,656 acres near the confluence of the Illinois and Mississippi Rivers, and has nearly 19,000 acres of nearby public conservation lands managed by federal or state agencies. IDNR manages the Calhoun Point Wildlife Area, Fuller Lake, Stump Lake, and Glades areas to promote wetland habitat for waterfowl as well as floodplain forest. Additionally, IDNR manages the Pere Marquette State Park which consists of mostly upland forest located on the Illinois River Bluffs. Gilbert Lake, located across the Illinois River channel from the study area is managed by the USFWS for waterfowl. The remaining public lands near the study area consist mostly of USACE managed forests. This region contains a range of ecological communities, landforms, soils, and hydrological conditions that were developed through fluvial processes of the Illinois and Mississippi Rivers (Hajic, 2000). The study area is 2,350 acres in size and includes wetland, grassland, woodland, and floodplain forest resources in the Refuge's Calhoun Division.

Prior to European settlement, the region supported a wide diversity of habitat types, including backwater lakes, sloughs, ephemeral ponds, prairies, savannas, bottomland hardwood forests (Nelson, Redmond, & Sparks, 1994), abandoned side channels, and side channels (Mills, Starrett, & Bellrose, 1966).

European settlement began slowly in the early 1800s and increased by the 1840s. General Land Office (GLO) landcover maps from the early 1800s show a largely intact landscape (**Figure 4**). Early land conversion to agriculture occurred on relatively small parcels through the 1830s. Limited accessibility, steep terrain, and frequent flooding in the bottomlands were primary factors that led to the relatively slow rate of development in Calhoun County during the early 1800s.

By the late 1800s, much of the prairie and open woodland communities were cleared for agricultural production, and some forests were cleared to fuel steamboats, to provide building materials, or for cordwood export. Additional changes to the river were initiated in the late 1800s and early 1900s by building a connection between the Illinois River and Lake Michigan to

increase commodity transport capabilities and to flush sewage and industrial waste away from Chicago's primary drinking water source; by building levees to aid land conversion in the floodplain of the Illinois River Valley for agriculture; and by constructing navigation dams to provide a reliable channel for transport of goods.

Historic aerial photos taken in the study area during the early 1930s illustrate the land cover conditions just prior to completion of Lock and Dam 26 at Alton in 1938 (**Figure 5a**). At this time much of the study area was privately owned and in agricultural production. Aerial imagery from 1940 illustrates the change in water elevation and plant communities after dam construction (**Figure 5b**). Prior to lock and dam construction, much of the area was forested. Groundwater elevation changes altered and continue to affect vegetation communities in the bottomland areas of the Illinois/Mississippi River confluence area.

Some of the lands in the Yorkinut Slough study area were originally purchased by USACE for the construction of the Mississippi River nine-foot navigation channel (Green, 1947). In 1942, the USFWS was authorized to manage these lands for fish and wildlife enhancement. However, the USACE retained the responsibility for management of the forest resources in compliance with the Forest Cover Act. The Refuge expanded through adjacent agricultural land purchases in 1967, 1979, and 1995. Acreage of each purchase equaled 796, 55, and 33 acres respectively.

Moist Soil Unit (MSU) development in the study area to improve wetland habitat availability for wildlife has occurred since 1967. Units were created by building a series of berms and installing pumps, wells, and water-control structures. An additional 198 acres of MSUs were developed by 1981 (Heitmeyer & Westphall, 2007). Imagery from 1989 is limited in the study area; however, berms for the Upper Calhoun, Lower Calhoun, and Pump Station units can be seen while surrounding areas were managed as agriculture (**Figure 5d**).

Small-scale grassland restoration efforts were initiated in the early 1980s and continued for the next several decades. Several agricultural fields were restored to native grassland between 1981 and 1992. In 2001, 75 acres of cropland near Pohlman Slough, east of highway 1, were planted with hardwood saplings. In 2008, an additional 36 acres of hardwood saplings were planted on the ridge west of highway 1. Together, these plantings provide valuable information on the likelihood of hard mast tree species establishment at a range of elevations. All planted bottomland hard-mast species have survived at elevations greater than 430 ft (NAVD 88), and Pecan and Nuttall Oak have survived to elevations as low as 427 ft (NAVD 88).

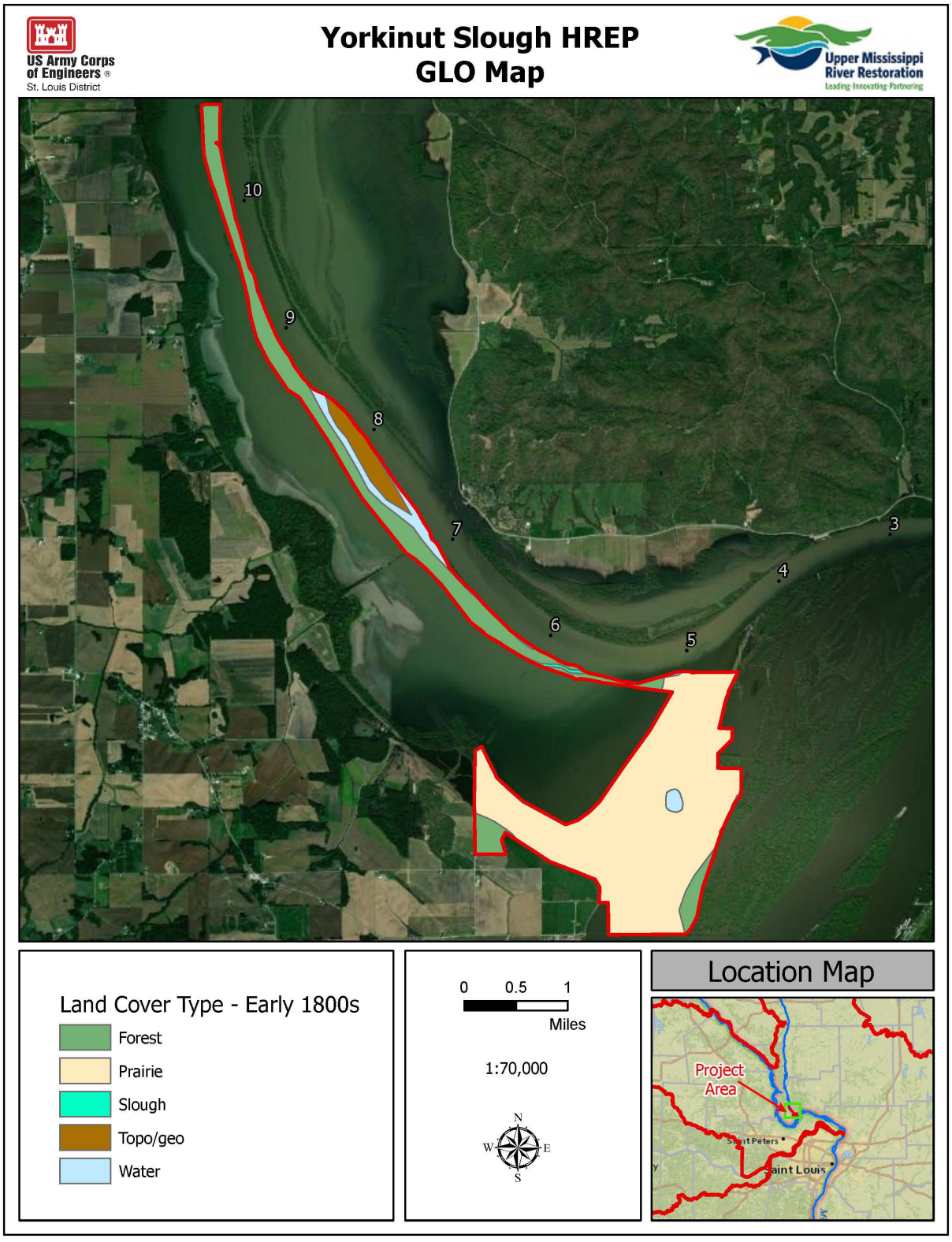

Figure 4. Early 1800's GLO Landcover within the Yorkinut Slough HREP study area.

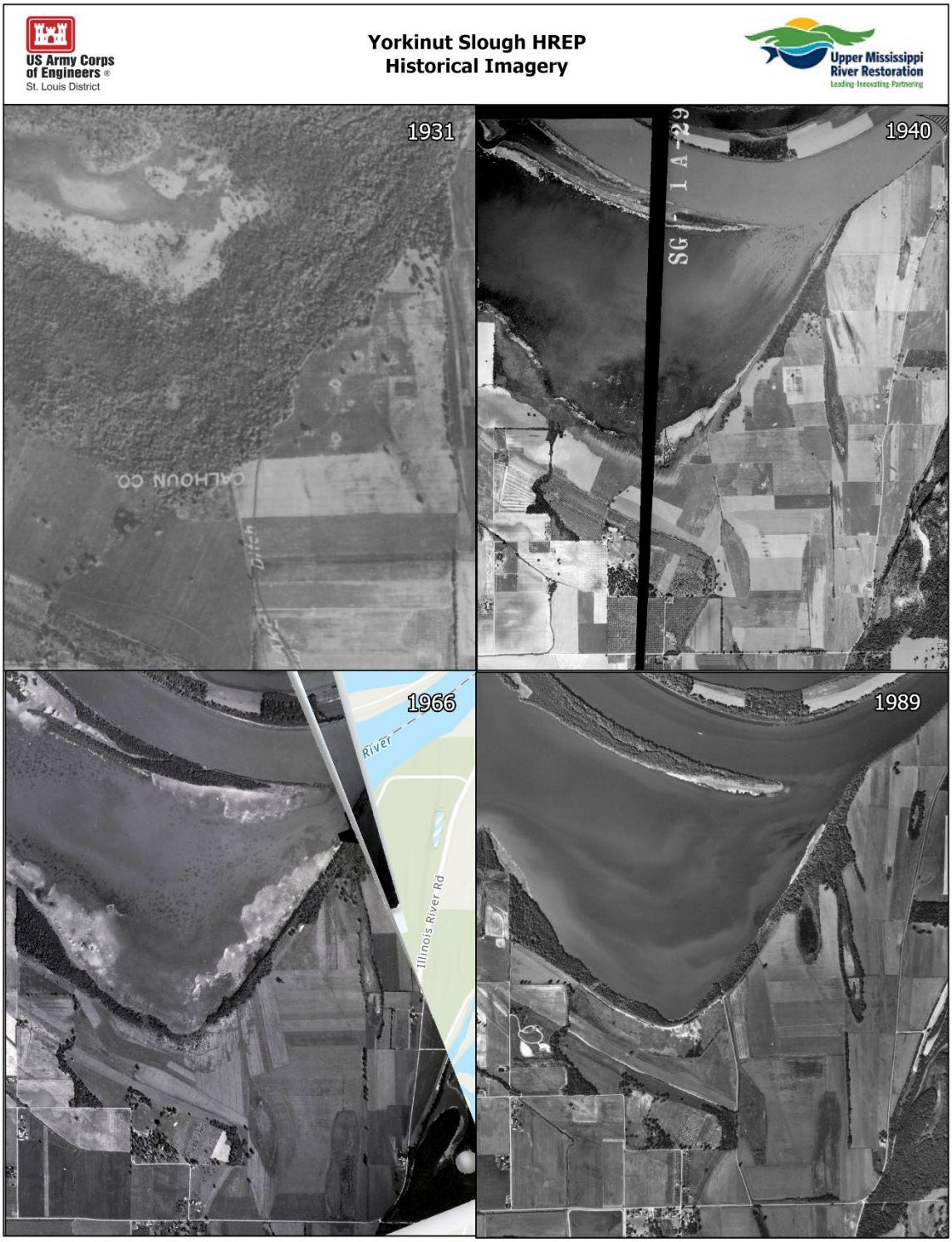

Figure 5. 1931 (a),1940 (b),1966 (c), and 1989 (d) Yorkinut Slough Area Imagery

C. Relevant Resources

The District evaluated relevant resources in the study area and assessed existing and FWOP conditions. Under the NEPA, the FWOP (considered to be the No Action alternative) is necessary to provide a reference point, enabling a comparison of environmental effects of the action alternatives. The District focused its evaluation on resources potentially affected by the alternatives. This section briefly describes the following resources' current condition:

- Hydrology
- Floodplains
- Navigation and Public Infrastructure
- Socio-economics
- Land Use
- Aquatic Resources (shorelines, vegetation and tributaries, invasive plant species, wetlands, and rare, unique, and imperiled vegetative communities)
- Fish and Wildlife Resources
- Threatened/Endangered Species and Other Protected Species of Concern
- Invasive Species
- Cultural, Historic, and Tribal Trust Resources
- Environmental Justice
- Aesthetics and Visual Resources
- Water Quality
- Air Quality
- Noise
- Hazardous, Toxic, & Radioactive Waste
- Sustainability, Greening, and Climate Change

Management & Land Use

a. Existing Conditions

Management of the Refuge's 4,280-acre Calhoun Division is guided by broad habitat goals and objectives developed for all Two Rivers National Wildlife Refuge lands in their Habitat Management Plan (HMP) (FWS, 2011). The Refuge is separated into six divisions. Each division has specific management strategies and prescriptions to guide on-the-ground management to achieve the overall Refuge goals. The Calhoun Division is divided into 25 management units based on habitat type. Management units in the study area are provided in **Figure 6**. The AG1-5 unit was formerly managed as agricultural fields; the F6 and F7 units are managed as forest. A range of target conditions exists for each management unit which relates to existing plant community type, flood frequency, and flood duration. The HMP emphasizes flooded habitat for migratory waterfowl, shorebirds, and other aquatic-dependent fauna; floodplain forest for migratory landbirds and other forest-dependent wildlife; and grassland habitat for migratory landbirds and other wildlife (FWS, 2011).

The nearly 2,350-acre Yorkinut Slough study area currently provides 323 acres of MSUs, 36 acres of bottomland woodland among 245 acres of grassland/annual herbaceous species, 672 acres floodplain forest plant communities, 231 acres of periodically mowed former agricultural fields (no longer farmed), 694 acres of open water, and levees or developed areas (**Figure 7**). MSUs are annually flooded in the fall for migratory waterfowl habitat. Primary management in

the Calhoun Division involves annual flooding and dewatering of MSUs for migratory waterbirds, and bottomland woodland restoration for terrestrial wildlife.

Recreational hunting opportunities were recently expanded to allow hunting and fishing on 854 acres in the Refuge. Hunting remains prohibited around the headquarters office, Duck Club, Upper Calhoun and Lower Calhoun MSUs; Swan Lake, and Six Mile Island to provide refuge for wildlife. Hunting activities permitted within season include migratory game birds, upland game and big game in areas east of and including Pump Station and Schoolhouse MSUs. Everything east of Calhoun Wetland road (N-S road) is open for hunting. Wildlife watching is a big segment of recreational users. Anglers use areas where fish are moving through structures to the river. Current management of the MSUs, floodplain forest, and floodplain woodland is provided in the following sections **Aquatic & Wetland Resources** and **Floodplain Forest** of this report.

Early Successional Fields

Approximately 269 acres were managed as agricultural units until 2011. This area is now managed as early successional habitat that consists primarily of moist-soil vegetation and other disturbance-dependent annual plants. Annual mowing is utilized as a management tool to reduce woody encroachment and annual weeds that germinate after floodwaters recede. Currently, water levels cannot be managed in these units due to placement of existing unit berms and lack of infrastructure that would allow water to move between units. The limited food resources produced in these units are largely inaccessible to migrating waterfowl. The inability to manage appropriate water levels in this area limits habitat quality in the former agricultural units.

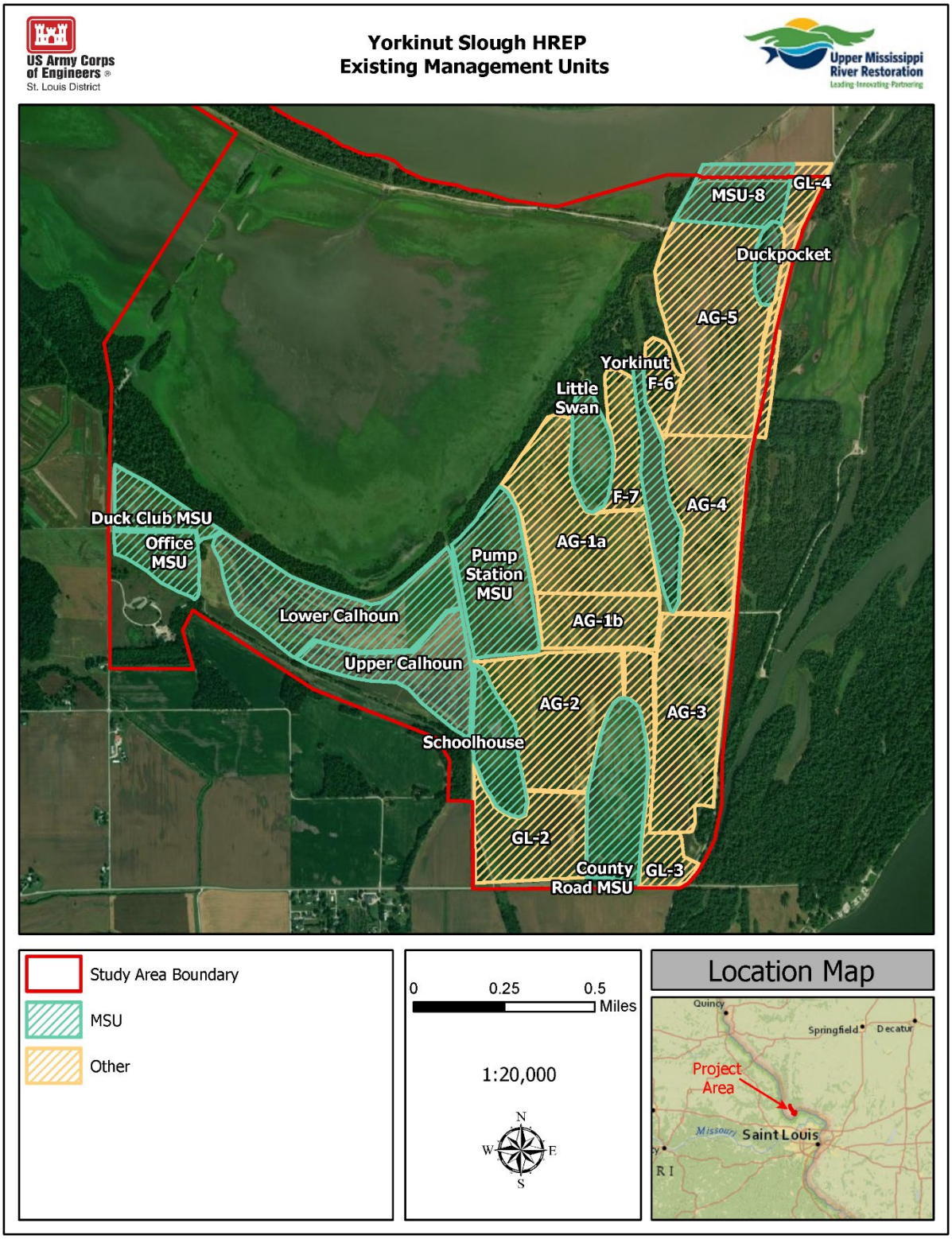

Figure 6. Existing Yorkinut Slough Management Units.

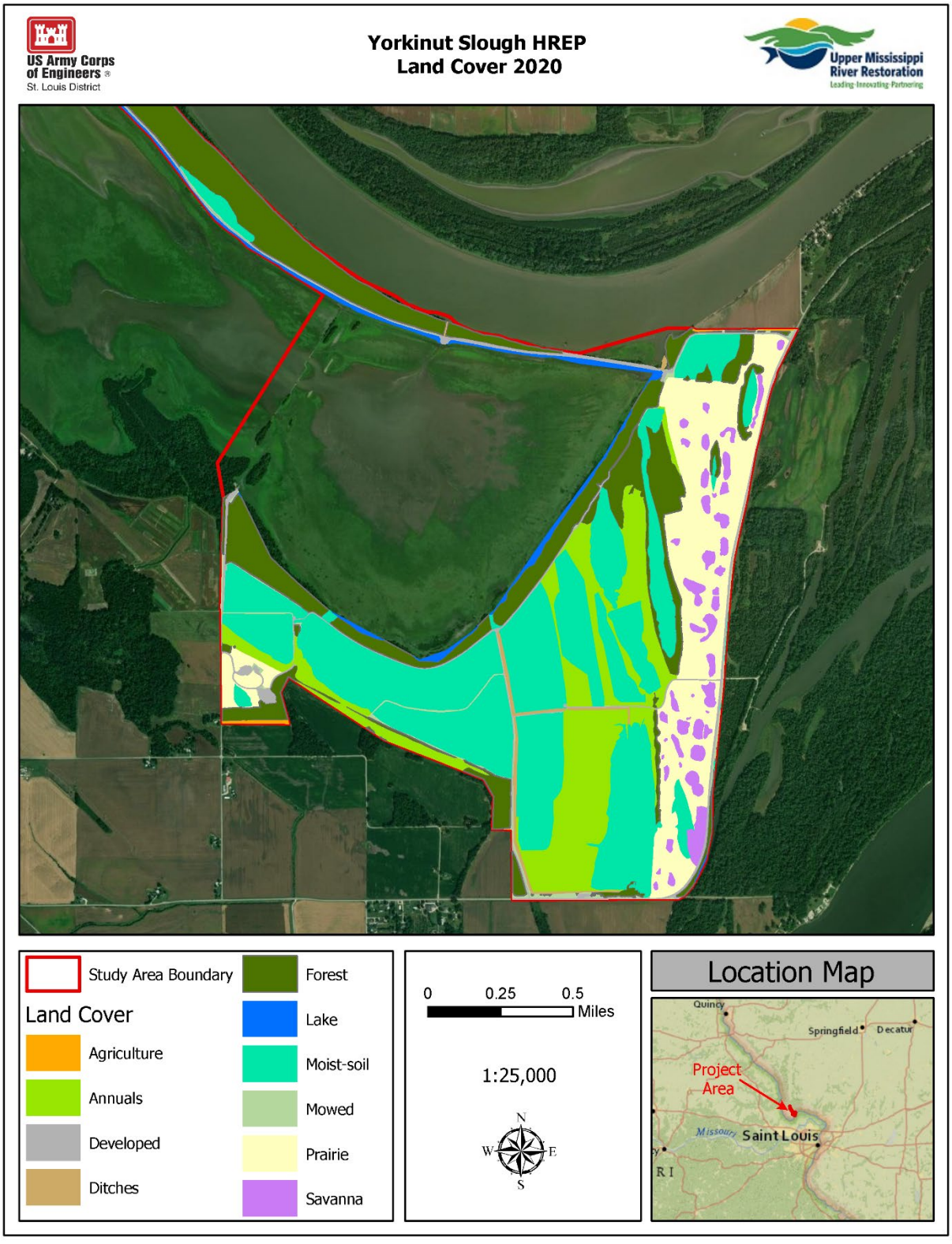

Figure 7. Landcover types in study area (2020)

b. No Action (FWOP Condition)

Existing water control structures would continue to degrade and limit transport of water between as well as into and out of units. Upland runoff and riverine flooding would continue to limit water management options for emergent wetlands in the study area due to frequent and sudden increases in water elevation. Within the study area, emergent wetlands would continue to degrade as a result of poor water management capabilities. Hard-mast resources would continue to be limited in extent due to a lack of seed sources and competition from aggressive, herbaceous species.

Hydrology & Hydraulics

a. Existing Conditions

Hydrologic conditions within the Illinois-Mississippi River confluence area were modified significantly by human alterations over approximately 200 years. Forest clearing was noted to occur as early as the mid-1830's to fuel increasing numbers of steamboats and growing populations of European settlers (Anfinson, 2003). Large patches of grassland and woodland were converted to agricultural production by the late 1800's. Land use change to agricultural production led to increasing rates and quantities of runoff and sediment being routed from upland sources to backwater lakes, wetlands, and the river (Havera & Bellrose, 1985).

Completion of the Chicago Sanitary and Ship Canal in 1900 connected the Illinois River with Lake Michigan and resulted in an increased volume of water being transported by the Illinois River, initially doubling the surface area of bottomland lakes, marshes, and sloughs in the Illinois River floodplain (Havera & Bellrose, 1985). Overall, the increased volume raised low water elevations 4.5 ft above previous levels. There was a temporary increase in resources for aquatic organisms utilizing the newly formed habitat, but this also resulted in bottomland forest degradation and loss. Sewage and industrial pollution flushed into the Illinois River from Chicago in the early to mid-1900s contributed to severe declines in aquatic resources along two-thirds of the Illinois River's length (Theiling, 1999); (Havera & Bellrose, 1985).

Between 1903 and 1930, drainage and levee districts were developed along the Illinois River that cut off nearly half of the floodplain from the river (i.e., 205,000 acres) (Havera, 1999). Reduced connectivity with the floodplain changed the hydrology of the river significantly and reduced the aquatic habitat extent influenced by the river (Havera & Bellrose, 1985).

In the 1930's, locks and dams were constructed along the Upper Mississippi and Illinois Rivers. The locks and dams reduced the speed of flow while maintaining the high-water elevations that began as a result of the Sanitary and Ship Canal (Havera, 1999). The six dams on the Illinois River and the Alton Lock and Dam on the Mississippi River raised low water on the Illinois River to ~5.5 ft. above pre-settlement levels (Nelson & Sparks, 1997). Historically, the low water elevation period coincided with the growing season which many floodplain tree species are adapted to in the region. This increase in low water elevation led to a decrease in bottomland forest diversity and continues to limit establishment of some species in the present floodplain (Nelson et al. 1994). River associated habitats along the Illinois River now have higher water elevations on average than pre-settlement levels, and experience more frequent and rapid

short-term fluctuations. These conditions place limits on the extent and composition of aquatic vegetation for floodplain habitats (Bellrose, 1941); (Bellrose, Paveglio Jr., & Steffeck, 1979); (Spink & Rogers, 1996) in favor of species that are more tolerant of fluctuating water levels and higher turbidity. Aquatic wetland plants requiring stable water levels have diminished along the Illinois River and are now confined to relatively small fragments.

Figure 8 and **Figure 9** show the average daily stages for three periods of record (1941-1960, 1961-1980, 1991-2020) on the Mississippi River at Grafton and Illinois River at Hardin. The plots for both gages show a general increase in stage during spring through early summer. Overall, average daily stages show a general increase with each period of record when considering the entire calendar year. The 1991-2020 period had higher average daily stages than both the 1941-1960 and 1961-1990 periods.

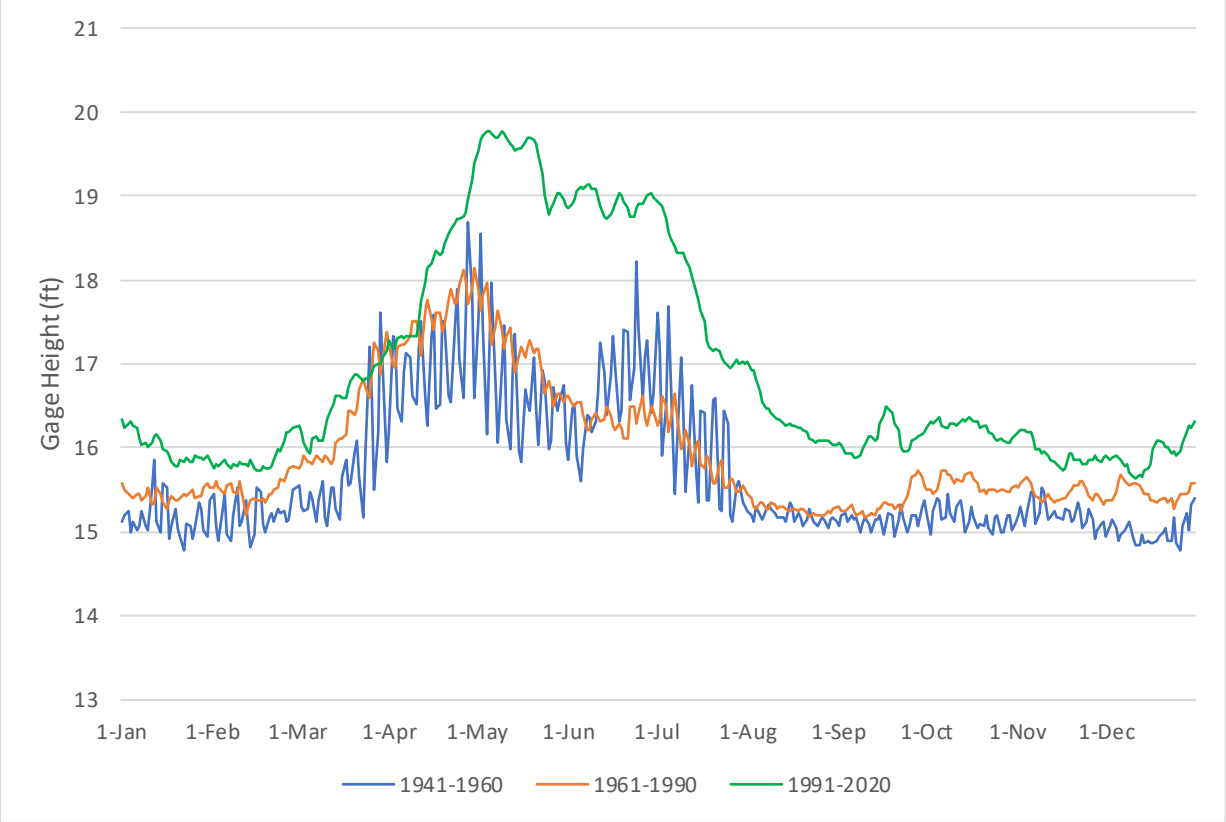

Figure 8. Daily Average Stage for the Mississippi River at Grafton, IL (RM 218) in increments from 1941-2020. Increments include: 1941-1960, 1961-1990, and 1991-2020.

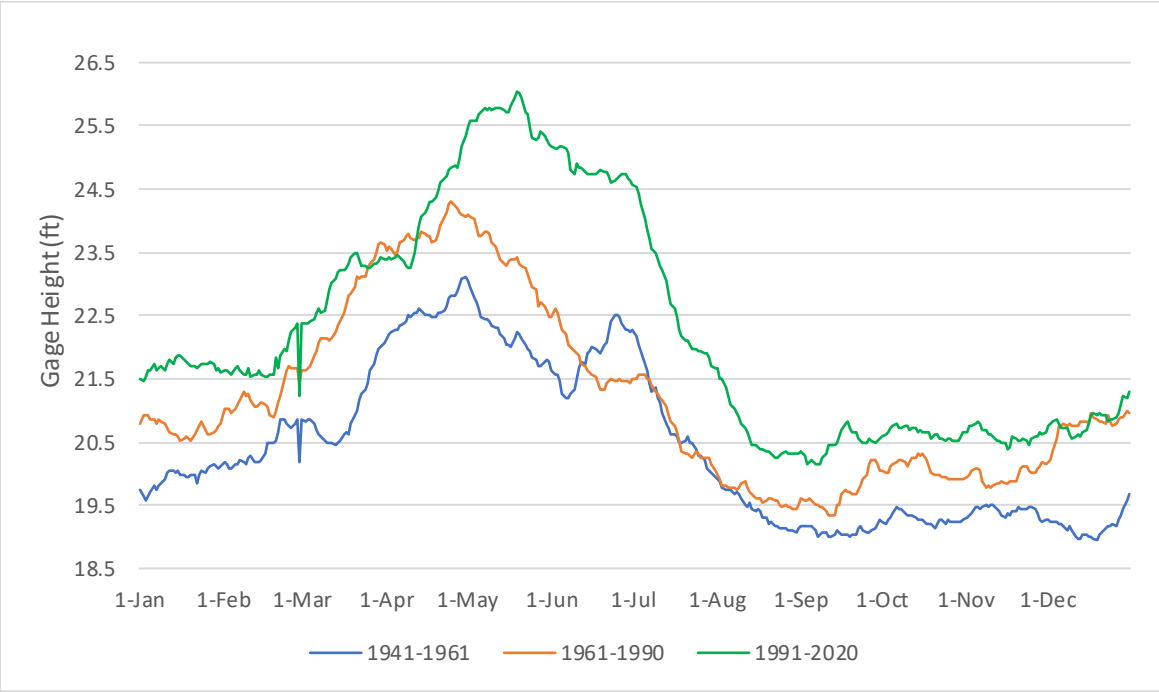

Figure 9. Daily Average Stage for the Illinois River at Hardin, IL (RM 21.5) in increments from 1941-2020. Increments include: 1941-1960, 1961-1990, and 1991-2020.

The Swan Lake (with a surface area of 2,400 ac) water-surface elevation has a major effect upon the management and operation of the Yorkinut Slough MSUs. Several of the Yorkinut Slough MSUs have water control structures that are directly connected to Swan Lake through the berm that separates the lake from the units. Gravity drainage of the Yorkinut Slough MSUs into Swan Lake is dependent on a Swan Lake water-surface elevation that is lower than Yorkinut Slough MSU water elevations. Without this condition, Yorkinut Slough MSUs cannot be drained.

Swan Lake's water surface elevation is directly influenced by water elevations in the adjacent Illinois River, inputs from several upland tributaries, inputs from Yorkinut Slough study area, and by management of features that were constructed as part of the Swan Lake Upper Mississippi River System Environmental Management Program (now Habitat Rehabilitation and Enhancement Program). A 16-foot-wide open channel stop log structure is utilized to gravity drain Swan Lake, the upland tributary inputs that flow into Swan Lake, and the Yorkinut Slough MSUs when Illinois River levels are lower than Swan Lake itself. Two pump stations are used to drain the lake to desired levels when gravity drainage cannot be achieved. Some large rain events have been noted to contribute enough upland runoff into Swan Lake to raise water elevations a foot or more and present a management challenge for both projects. Flooding from the Illinois and nearby Mississippi River present challenges for management of the area for waterfowl and wildlife.

Within the Yorkinut Slough moist-soil management area, structures and current berm configurations limit the ability to effectively fill the study area in the fall and drain the area at the start of the growing season. Water control structures and wells have degraded severely since

their installation in the 1990s and early 2000s. Culverts to several units are collapsed, wells are undersized and functioning at a reduced capacity, and berm seepage complicates and delays effective water management strategies. USFWS is responsible for the maintenance of this infrastructure.

A flood damage assessment is being conducted for the Swan Lake EMP project in response to damages resulting from several recent flood events. All Project measures will take into account the management needs and function of the Yorkinut Slough study area as well as proposed actions resulting from the Swan Lake flood damage assessment to avoid adverse impacts to the Swan Lake HREP project due to the strong interdependencies of the two projects.

b. No Action (FWOP Condition)

In the future, as in the present, drainage of the study area would be limited to times when Swan Lake and Illinois River water elevations are low and water control structures are open through the berm separating Swan Lake from the Yorkinut study area. Flooding of the study area would occur as a result of flow from the Illinois or Mississippi rivers as well as from upland runoff to Swan Lake and the management units after large rain events. Repair of the riverside berm at Swan and Fuller Lakes as proposed in the flood damage assessment would increase the resiliency of the berm to future floods and reduce the frequency of overtopping events that occur as a result of relatively common, minor flood events. Based on the interagency document entitled “Upper Mississippi River System Flow Frequency Study” (January 2004) and as-built elevations for the Swan Lake riverside berm, a reduction in river-caused flood frequency would occur for events having flows with a greater than 20% annual chance exceedance (ACE). The current riverside berm is near the level of a 50% ACE event. Restoration of the riverside berm to the original design elevation would not reduce flooding caused by upland runoff into Swan Lake which occurs on an annual basis.

The Mel Price Lock & Dam operations are not expected to change from the existing condition. Structures and current berm configuration in Yorkinut Slough would limit the ability to effectively fill the study area in the fall and drain the area at the start of the growing season. Water control structures and wells have degraded severely since their installation in the 1990s and early 2000s and would continue to degrade. Berm seepage complicates and delays effective water management practices. The structures and berms in the study area will continue to degrade until they are non-functional and water cannot be drained from the study area during essential life-history periods of desirable plant species. The new wells installed by Ducks Unlimited would function at an increased capacity from the existing condition. However, water movement within and between units will be further hampered as more structures and berms become unusable. As a result, the time needed to add to or remove water from the area during the fall and spring will be lengthened. It is anticipated that USFWS will be unable to maintain portions of the site as early successional emergent habitat as more structures cease to function, limiting water management capabilities throughout the study area.

The Ducks Unlimited NAWCA grant project installed two new wells. These wells are located at the existing Well 1 (Office MSU), and at a location along Illinois Route 1 (i.e., Deer Plain Well) (**Figure 10**). Additional wells were initially proposed but could not be funded. The new wells will increase water delivery and management capacity to portions of the Refuge.

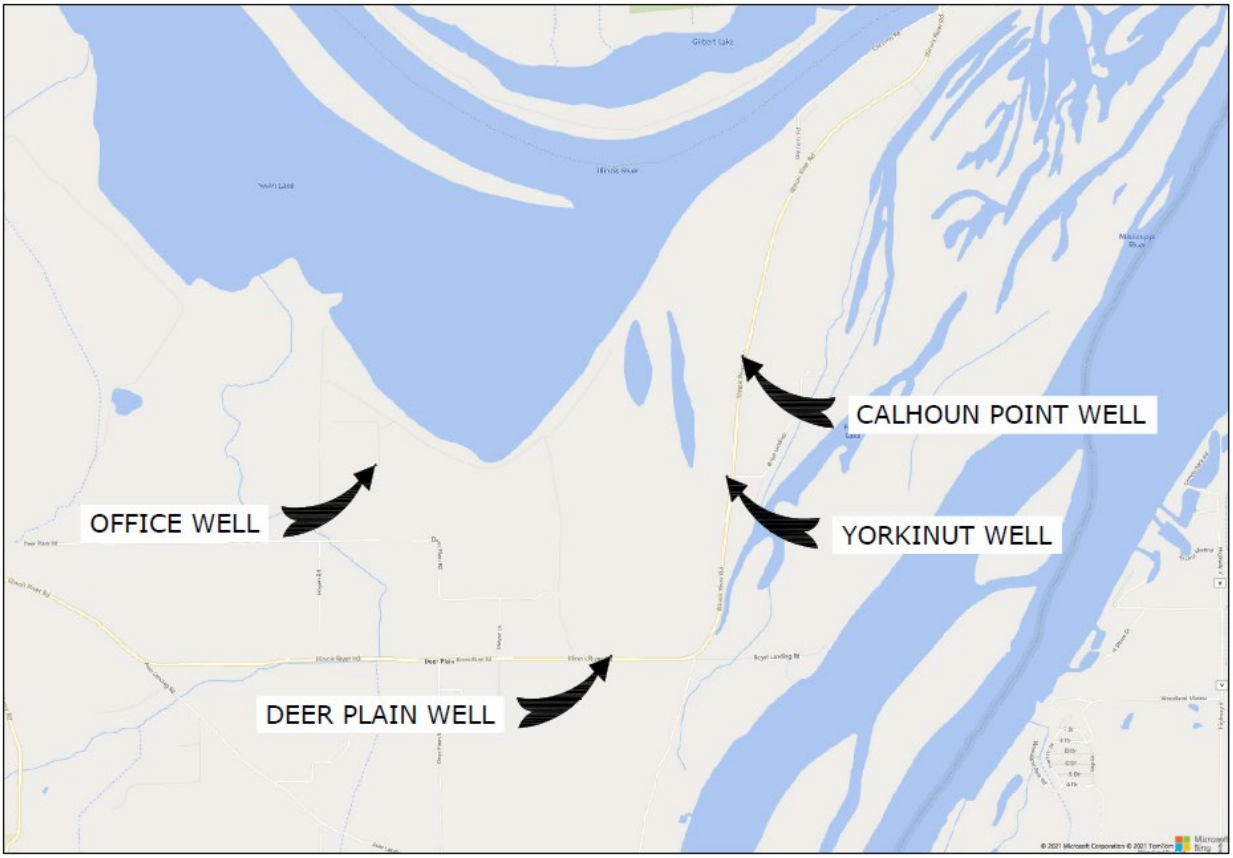

Figure 10. Proposed Ducks Unlimited Well Locations

Aquatic & Wetland Resources

a. Existing Conditions

Wetlands

Wetlands provide many ecological functions and services, and the scale of these services can range from local population effects up to the landscape level. Wetlands are often defined as having the presence of water at or near the surface for at least part of the year; possessing hydric soils; and supporting vegetation adapted to saturated soils (Havera, Suloway, & Hoffman, 1997). Some of the functions and services provided by wetlands include sediment retention and processing, flood control, groundwater recharge, wildlife corridors connecting other habitats, and support of wetland dependent plants and wildlife.

In the United States, between the 1780s and the 1980s, the lower 48 states lost an estimated 53% of the 221 million acres of original wetlands. The land within the current states of Illinois and Missouri both lost over 85% and 87% of wetlands during this period, respectively (Johnston, 1994); (Dahl & Johnson, 1991). Many of the remaining wetlands have been degraded by fragmentation, pollution, excess siltation, and invasion by non-native plant species (Molano-

Flores, et al., 2007). Together these factors have reduced the capacity of remaining wetlands to perform the previously mentioned ecological functions.

Illinois Riverine Wetlands

The Illinois-Mississippi River confluence region still provides critical wetland resources for migrating and resting waterbirds and has been designated an important bird area by the National Audubon Society. (Canada Ministry of the Environment, U.S. Department of Interior, & Mexico Secretariat of Environment and Natural Reso, 2012), (Soulliere, et al., 2017), and (Soulliere, et al., 2018) identified the Illinois, Mississippi, and Missouri Rivers as areas of high continental significance for North American waterbirds such as waterfowl, wading birds, and shorebirds but also other aquatic dependent taxa in lower numbers.

Study Area Wetlands

Moist soil management is a primary focus for USFWS to support waterbirds in the Yorkinut Slough study area. Eleven of the 25 management units have been developed into moist-soil management areas. Currently, USFWS manages over 380 acres of emergent wetlands in the study area. The majority of this included acreage occurs at elevations <425' elevation (NAVD 88) (**Figure 11**). The MSUs are managed to promote development of emergent wetland plant species, particularly species with high nutritional, energetic, or cover value for migratory waterfowl. Emergent plants are characterized by a lifecycle that requires alternating periods of inundation and drier conditions to maintain habitat suitability. A terrestrial, low water period during the growing season facilitates seed germination and plant maturation while a flooded period disperses seed, maintains wetland soils, and reduces competition from more upland species. Management includes manipulation of water levels to mimic components of the historical flood pulse and elevated water period as well as the summer low water period which promotes growth of natural herbaceous wetland flora. Mechanical disturbance and chemical applications are utilized as needed to promote a mix of native annual and perennial herbaceous species, control tree and shrub encroachment, and provide suitable foraging substrates and conditions for migrating waterbirds (i.e., waterfowl, wading birds, marshbirds, and shorebirds).

Gradual flooding of some units typically starts near the beginning of October and continues through December until units have reached capacity. Draining of units typically occurs after the spring flood pulse along the Illinois and Mississippi Rivers. This generally occurs between April and June with the latter half of this interval being more common. Overall, management in a particular MSU may deviate from the above description based on management needs (e.g., control of undesirable vegetation) and river flooding from the Illinois and/or Mississippi Rivers.

Water levels and vegetation are managed in these units to promote foraging and resting habitat for waterfowl. Native herbaceous plant species in these units provide forage for numerous dabbling ducks species, such as Mallard (*Anas platyrhynchos*), Northern Pintail (*A. acuta*), Green-winged Teal (*A. crecca*), Gadwall (*Mareca strepera*), and Northern Shoveler (*Spatula clypeata*).

Water depth and management has limited plant response in some units by not fully replicating the range of historic water and disturbance conditions. Elevated river elevations, turbidity, and nutrient levels; altered drainage rates; and altered disturbance frequency, intensity and duration

currently limit spatial extent and management capabilities for some historic plant communities (Yeager, 1949); (De Jager, 2012). In addition, high runoff from uplands , inefficient water conveyance through and out of units, and seepage from units further restrict management capabilities annually.

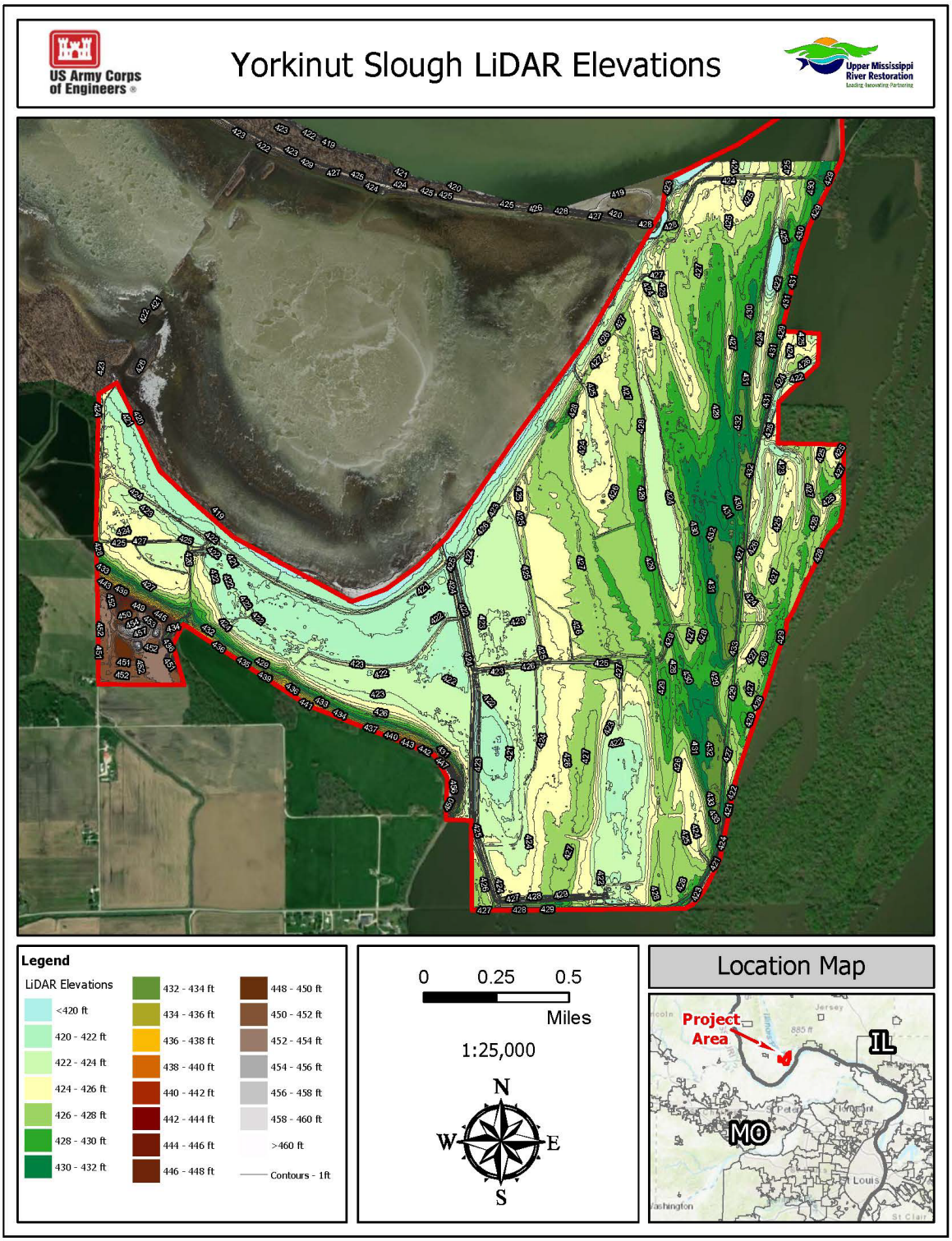

Figure 11. 2018 LiDAR Digital Elevation Model (DEM) of Yorkinut Slough Moist Soil Units

Moist Soil Species Composition

Existing conditions data were captured by Refuge staff utilizing the Integrated Waterbird Management and Monitoring (IWMM) sampling protocol during 2014-2018 (Loges, et al., 2021). Overall species composition of MSUs vary with year, management actions, and flood impacts. Vegetation is typical of MSUs in the region and comprised of a mixture of annual grasses, smartweeds, and other emergent forbs. *Echinochloa crus-galli, Leersia oryzoides, Polygonum coccineum, Polygonum lapathifolium*, *Polygonum pennsylvanicum, Symphyotrichum lateriflorum,* and *Xanthium strumarium* covered the largest area overall (**Figure 12**). *P. coccineum* provides moderate food values for migratory waterfowl*,* but *S. lateriflorum, and X. strumarium* provide no food value for waterfowl (Loges, et al., 2021). The remaining dominant species typically provide moderate to high food values for migratory waterfowl.

P. coccineum is a perennial which spreads by rhizomes, produces less seed than annual smartweeds, and creates large low-diversity patches which can be difficult to manage. This species has been particularly abundant in County Road, Little Swan, Lower Calhoun, and Pump Station MSUs which required more intensive management to improve diversity and seed production in those units. Multiple treatments are required to adequately control this species and therefore increased water management capabilities can aid management of this species. *X. strumarium* was abundant in County Road, Duck Club, Office MSUs, and Pump Station MSUs in some years. *X. strumarium* grows prolifically when water elevation drops quickly under high temperatures (Fredrickson, 1991). This weedy, annual produces an abundance of burry fruits which provide no food value for waterfowl. *S. lateriflorum* is a perennial, rhizomatous aster which forms dense colonies in a variety of floodplain habitats (i.e wetland transitions, forest edges, etc.). It can quickly form a monoculture in units and outcompete moist-soil vegetation, thus decreasing overall seed production for migrating waterfowl. Improved water management capabilities could help to control the extent of these species.

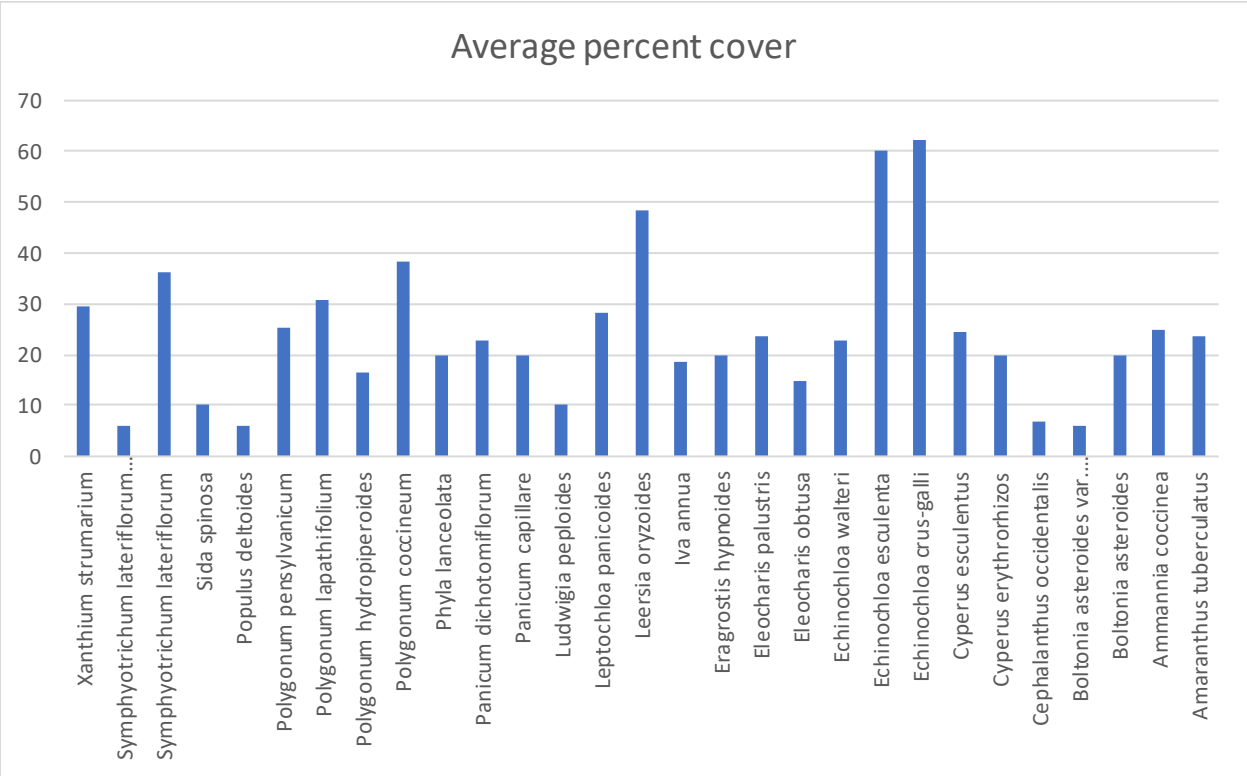

Figure 12. Moist-soil unit composition and overall average percent cover 2014-2018. IWMM methodology allows percent cover values to exceed 100 percent due to the layering of vegetation typical of moist-soil areas.

Richness and Diversity

Species richness and a diversity index (i.e., exponential index of Shannon entropy) varied across years and units (**Figure 13** and **Figure 14**) based on unit condition and disturbance frequency. Mid-summer floods in 2014, 2015, and 2018 impacted water level management in the study area and may account for some of the lower richness and diversity values in some units.

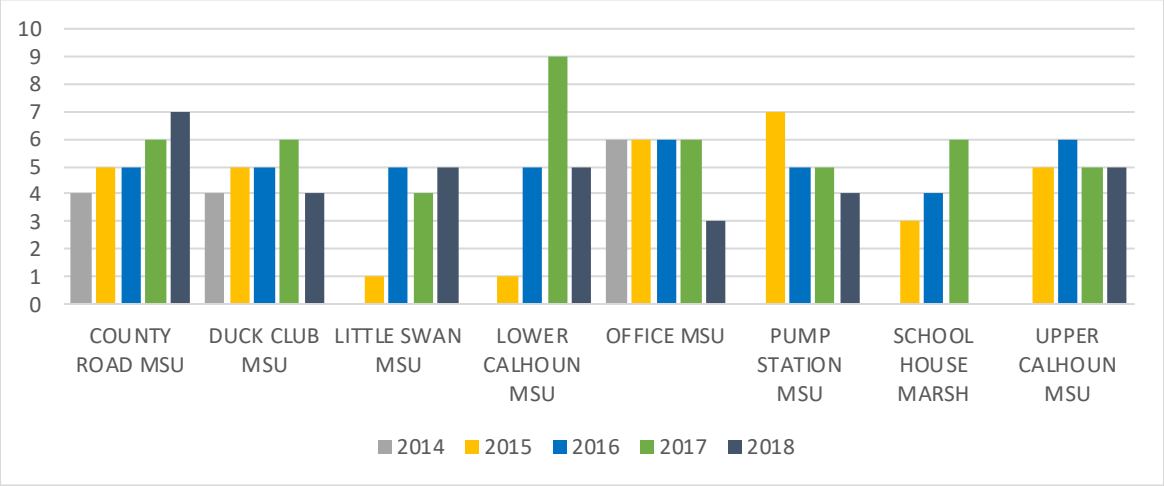

Figure 13. Species Richness per Unit

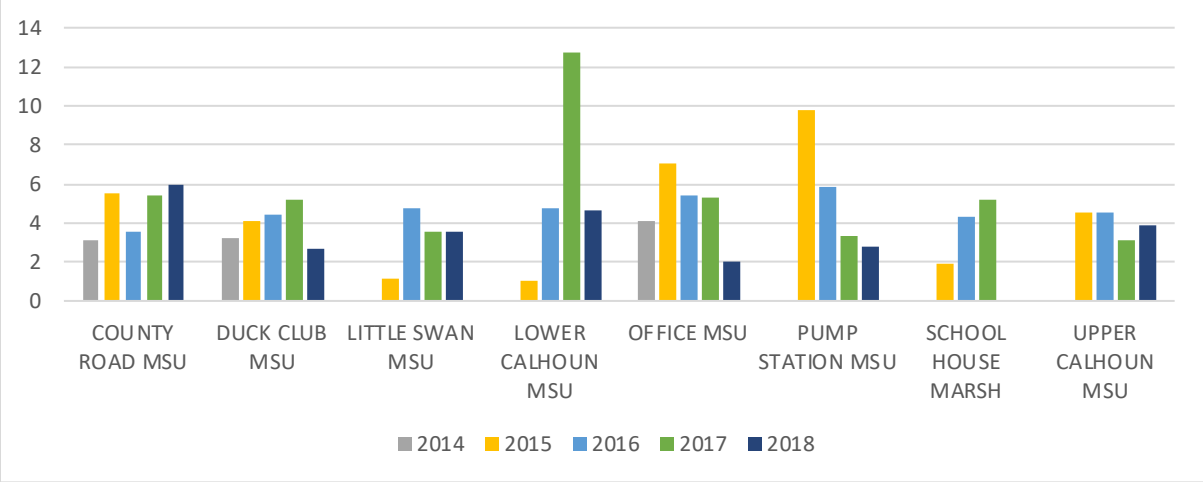

Figure 14. Species Diversity Index Per Unit

b. No Action (FWOP Condition)

Aquatic resources in the region would continue to decline due to altered hydrology, sedimentation rates, and disturbance frequency and intensity which impact depth of aquatic areas, species composition, and plant community resilience. Upland runoff and riverine flooding would continue to limit water management options for emergent wetlands in the study area due to frequent and sudden increases in water elevation. Within the study area, emergent wetland habitat within the study area would continue to degrade in extent and diversity due to a lack of effective water management. Frequent flooding deposits sediment within and between units reducing wetland capacity and water level management efficiency. Water level management ability will continue to decline as additional culverts collapse, and water control structures become non-functional. Two wells were constructed by Ducks Unlimited, located are illustrated

in **Figure 10**. Existing wells are expected to become non-functional within the next several years. Temporary piping is expected to be installed to allow some units to be filled. However, the two wells and piping will be insufficient to provide water for all existing MSUs. Reduced water management efficiency shortens the critical low-water growing season period by taking longer to drain areas in the spring and fill these same areas in the fall. Over time the wetlands would receive limited management due to reduced utilization and capabilities. The lack of management will encourage increased woody plant encroachment around the periphery of units which will increase sediment retention within units and further reduce the size and quality of the emergent wetlands. Areas with standing water would likely revert to an open water condition most like the current Duck Pocket, Yorkinut, and MSU 8 units. These units provide limited seed production and resources for migratory waterfowl. Overall, the emergent wetlands would convert into perennial wetlands, swamp shrubland, and be susceptible to invasion by perennial, wetland invasives such as Reed Canary Grass. It is anticipated that no major changes would occur to alter this land use and topography.

Floodplain Forest

a. Existing Conditions

Floodplain forest communities are highly productive, provide valuable habitat for many species of wildlife (support plants and animals adapted to alternating wet and dry periods), improve water quality, control erosion (capture and disperse sedimentation), reduce flood damage by holding water, and contribute to local and regional commerce (Wiener, et al., 1998); (Johnson & Hagerty, 2008) as well as carbon sequestration (Guyon, Sloan, Van Essen, & Corcoran, 2016).

Existing Forest Resources

The study area contains narrow corridors of forest resources primarily along Yorkinut berm and Six Mile Island. In all, 689 acres of forested habitats occur in the study area. The Yorkinut berm area contains portions of four inventoried stands, and Six Mile Island contains ten stands which utilize USACE's High Intensity Forest Inventory data collected from 2009-2010. Six Mile Island includes a series of shallow sloughs and a former side channel that has silted in and limits drainage (**Figure 15**). The average basal area for Yorkinut Slough study area is 81.4 ft^2/acre overall. Basal area for individual stands can be found in **Table 2**. The UMRS Forest Stewardship Plan (Guyon, Deutsch, Lundh, & Urich, 2012) identifies 90-160 ft^2/ac as the desired condition, so ten of seventeen stands in the study area are below this goal.

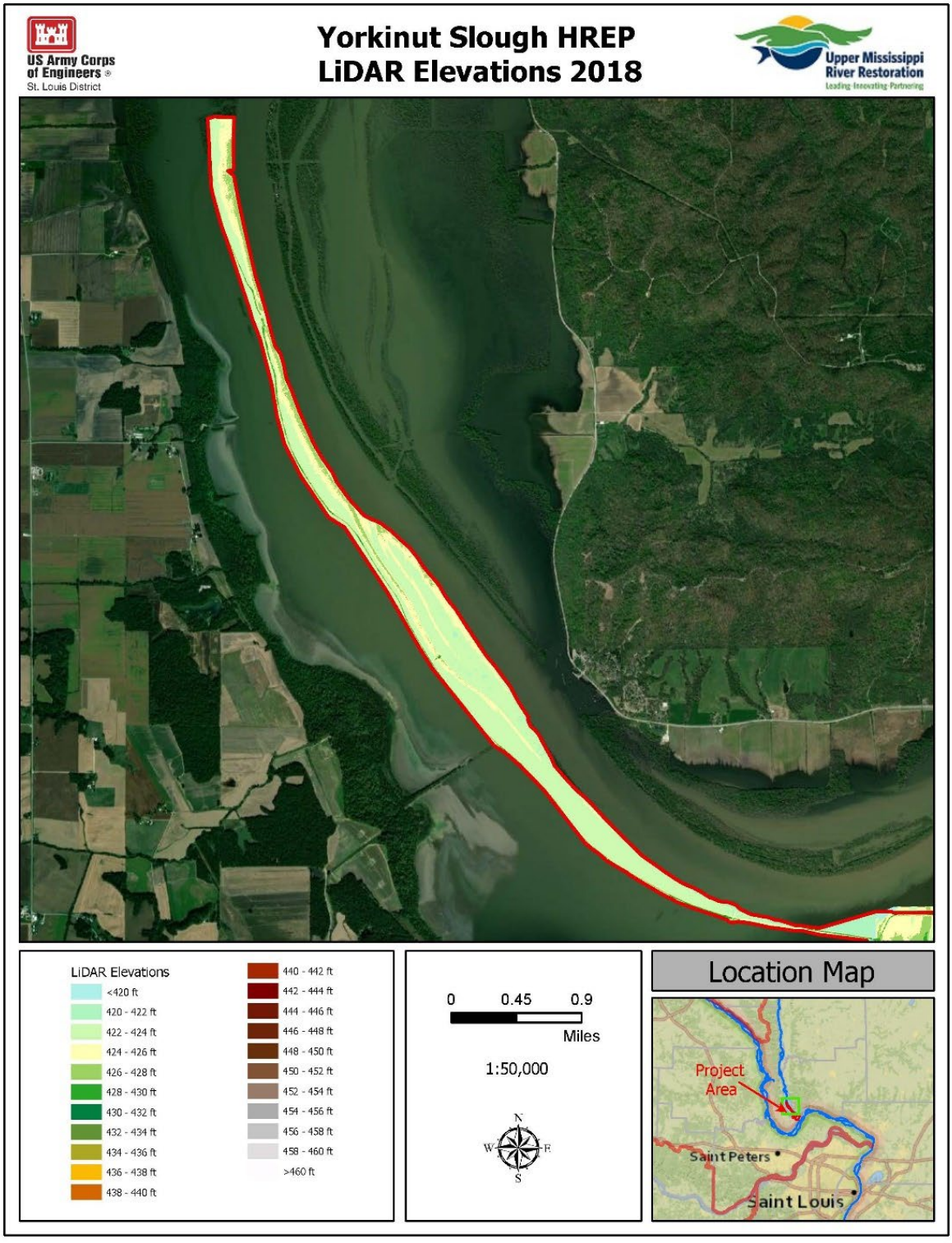

Figure 15. 2018 LiDAR DEM map of Yorkinut Slough Six Mile Island Area.

Importance values (IV) are used in forestry to measure how dominant a species is in an area. The importance value for a species in the USACE Forest Inventory data is based on three factors including relative species density, relative dominance and relative frequency of occurrence. The IV scores for all species combine to equal 300. Forest resources with the highest IV values include Silver Maple (*Acer saccharinum*) (IV = 145.2), Green Ash (*Fraxinus pennsylvanica*) (IV = 45.8), Cottonwood (*Populus deltoides*) (IV = 25.9), and Black Willow (*Salix nigra*) (IV = 22.2). Hard-mast trees have a combined IV of only (13.5). Remaining tree species combined have an IV of (47.4) (**Figure 16**). Pecan is the most dominant hard-mast species in the surveyed portions of the study area (IV = 10.8). Pin Oak (IV = 2.38) and Swamp White Oak (IV = 0.29) also occur in the study area to a lesser extent. Soft-mast species are comprised of Hackberry (IV = 5.28), Persimmon (IV = 1.88), Red Mulberry (IV = 1.36), and Swamp Privet (IV = 0.70).

Table 2. Basal area per stand for Yorkinut Slough HREP study area.

Forest Stand #	5	12	16	18	21	22	23	26	27	30	31	35	36	39	45	46	47
Basal Area	118.8	61.4	83.8	110.0	58.0	94.7	147.5	66.8	47.1	110.8	67.5	76.3	118.9	36.3	48.0	99.1	38.2

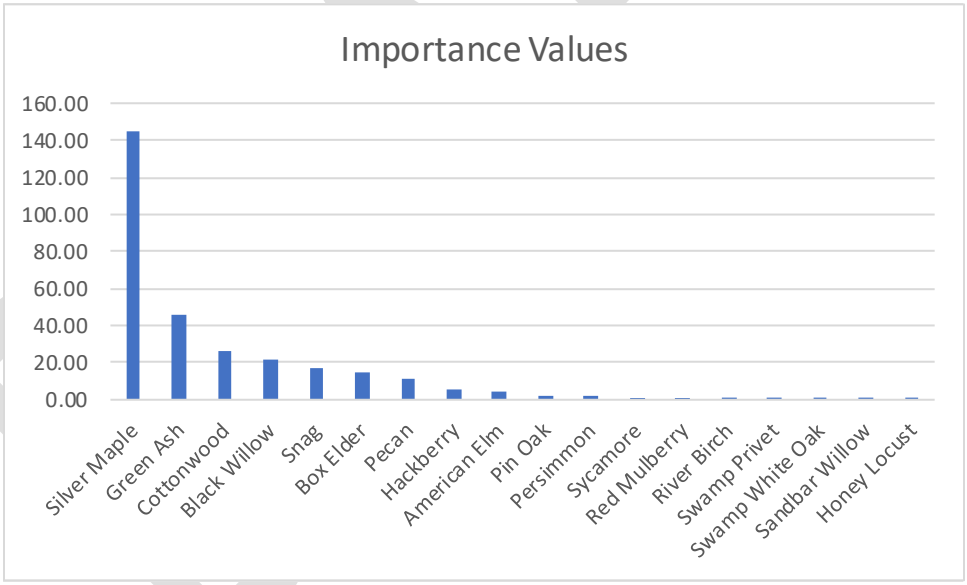

Figure 16. Yorkinut Slough Study Area Tree Species Importance Values, 2009-2010 forest inventory data.

Tree health was assessed as part of the forest inventory protocol (**Table 3**). Trees were identified as healthy if the tree had good growth form, free from significant vines, and showed little sign of decay. Trees were identified as stressed if an abiotic (flooding) or biotic (disease, shading, vines, mechanical) variable was causing a significant reduction in growth or health of the tree. Trees were identified as in significant decline if it appeared as if the tree would likely succumb to a stressor within the next couple of years. The final category included dead standing trees (snags).

Approximately 46% of the trees sampled within Yorkinut Slough study area in 2009-2010 were classified as healthy, and 36%, 12%, and 6% were classified as stressed, in significant decline, or dead, respectively. The desired ratio of healthy to stressed trees as outlined in the UMRS Forest Stewardship Plan is 60% healthy to 20% stressed. Therefore, the ratio of healthy to stressed trees in the study area is lower than desired. Widespread tree mortality occurred in the region after the historic 1993 flood event as a result of prolonged growing season flooding. Species composition and forest cover continues to be shaped by the impact of this flood and other significant flood events since then. The impact of flood events is exacerbated by reduced and altered drainage within forest stands which favors more flood tolerant species such as the already abundant Silver Maple.

Table 3**.** Assessment of Forest Health (USACE Forest Inventory 2009-2010)

Health	#	% of total
Healthy	1137	45.7
Stressed	901	36.2
Significant Decline	296	11.9
Dead	153	6.2

Overall, forest health and diversity is in significant decline. Silver Maple is more abundant than the historic condition due to its higher flood tolerance and ability to regenerate in a closed canopy forest. Cottonwood is mature and will senesce within the next couple decades without replacement. This species is dependent on disturbances that create bare soil in large open, sunny patches to regenerate. This type of disturbance is largely limited to relatively small sandbars or along transitional edges of islands. In addition, most hard mast species are not able to regenerate in the study area under current conditions. Pecan is the exception, naturally regenerating from the seedbank at low levels, but it is unable to reach maturity given the current forest structure. Historic sloughs that provided drainage after flood events have developed sediment plugs that reduce the rate and extent of draining. Poor drainage in combination with frequent flood events results in longer duration flooding that stresses less flood tolerant species, reduces hard mast regeneration, and decreases overall tree health, diversity, lifespan, and canopy cover.

Recent Forest and Woodland Restoration

The nearby Pohlman Slough area at Calhoun Point was planted with Swamp White Oak (*Quercus bicolor*), Overcup Oak (*Quercus lyrata*), Bur Oak (*Quercus macrocarpa*), Nuttall Oak (*Quercus nuttallii),* Pin Oak (*Quercus palustris*), and Pecan (*Carya illinoinensis*) in 2002. In 2006, a tree planting along the ridge in the study area near Route 1 also aimed to establish hard-mast trees. The goal of this planting was to create an open, bottomland woodland community with prominent herbaceous layer to reflect historical plant communities near the confluence of the Illinois and Mississippi Rivers. The trees were planted in patches among approximately 206 bottomland grassland/woodland grasses and forbs. Original composition was primarily *Panicum virgatum* varieties (i.e., “Nebraska 28” and “Cave in Rock”), Elymus

virginicus, and small inclusions of grassland forbs. Species composition of the herbaceous layer has largely converted to species with high flood/disturbance tolerance such as Giant Ragweed (*Ambrosia trifida),* Sumpweed *(Iva annua),* Cocklebur *(Xanthium strumarium),* and Calico Aster (*S. lateriflorum*) due to the altered hydrologic regime compared to historic conditions. Additionally, some willow (*Salix sp.*) and cottonwood (*P. deltoides)* encroachment has occurred as a result of recent floods and is managed at a low frequency of occurrence through mowing.

All planted trees have survived well at certain elevations, many are producing seed, and some are regenerating in the vicinity of the original planting areas. Flooding and competition from annual herbaceous weeds limit establishment from seed. Minimum planting elevation was 426 ft. Pecan has survived at elevations as low as 427 ft. Swamp White Oak and Overcup Oak have survived at some elevations above 427 ft., and all individuals have survived at 430 ft and above. In addition, all hard-mast species planted survived at elevations greater than 430 ft. (pers. comm. Ken Dahlrymple, 2020).

Management of Bottomland Forest and Woodland

Management goals from the HMP for forest resources in Calhoun Division were/are designed to maintain reforested units (78 acres), to maintain overall health and extent of forest resources, and to plant and maintain hard mast trees on suitable sites. Bottomland woodland is defined here as an area that will be managed as a two dominant layer plant community, including an open canopy of widely spaced trees and an understory comprised of primarily herbaceous vegetation. Historically this would encompass plant communities such as floodplain savanna, wet bottomland woodland, and mesic bottomland woodland plant communities. Currently woodland is limited to a ridge of plantings that were established in approximately one-acre pods on the eastern side of the study area. Floodplain forests include the remaining forested resources that are two- or three-layered with woody species dominating the canopy, mid-story, and understory layers. However, herbaceous vegetation may dominate the understory seasonally and in canopy gaps or less densely canopied areas of floodplain forests. Management has included natural succession and planting of container-stock trees in moderate to higher elevation locations in the study area. Growing season floods and loss of summer low water period limit the species distribution, abundance, and overall health of bottomland forest and woodland communities in the region.

An additional 664 acres of floodplain forest are in a General Plans/Cooperative Agreement that authorizes the USFWS to manage USACE lands for the enhancement of fish and wildlife resources. With that agreement, USACE retained the responsibility to manage the forest resources on those lands. The current forest management objectives include the following:

- A functional, sustainable floodplain ecosystem that includes a mosaic of native vegetation communities sufficient to support important wildlife species of concern.
- Restore and maintain forest diversity, health, and sustainability on federal lands.
- Adaptive management: science-based decision-making.

Table 4 provides a standard set of desired conditions that are managed for on all USACE forest management areas (taken from the UMR Systemic Forest Stewardship Plan). This is a very generalized set of conditions and as forest management plans (FMPs) are developed, more specific prescriptions are developed and synchronized to meet habitat requirements of wildlife

species of concern. FMPs are synchronized with habitat management goals of GP partners to ensure comprehensive management objectives.

Table 4. Desired stand conditions for bottomland forest within the UMRS

Forest Variables[1]	Desired UMRS Stand Structure	Conditions that may warrant active management
Overstory canopy cover	70 – 80%	>80%
Overstory Species	2 species or more	large blocks of single species
Basal area	90-160 ft^2 / acre with ≥25% in older age classes[2]	>160 ft^2 / acre
Tree stocking	NA	< 50% or > 90%
Emergent trees[3]	> 2 / acre	< 1 / acre
Understory cover	> 10 %	< 10%
Regeneration[4]	> 10% of area	< 10% of area
Coarse woody debris	---	---
Small cavities (< 10 inch diameter)	≥ 2 visible holes/acre	< 2 visible holes/acre
Den trees/large cavities (> 10 inch diameter)	≥ 1 visible hole / 10 acres mature timber	< 1 visible holes / 10 acres
Standing dead and/or stressed trees	≥ 2 large trees / acre	< 2 large trees / acre
Invasive herbaceous	< 10%	> 10% of herbaceous layer
Invasive woody	< 10%	> 10% of any canopy layer

[1] Promotion of species and structural diversity within stands is the underlying principle of management.
[2] "Older age class" stems are those approaching biological maturity (i.e., senescence).
[3] Emergent trees make good perch/nesting sites and should have stronger consideration on diverse sites.
[4] Advanced regeneration of trees in sufficient numbers (e.g., 400/acre) to ensure their succession to forest canopy.

b. No Action (FWOP Condition)

Overall, low natural regeneration is occurring from the seed bank in the existing forest resources. The regeneration that is occurring is limited to maples, green ash and American elm which is the most widespread and abundant forest community in the UMRS floodplain. Even these species regenerate at low rates due to current stand conditions. Existing stands have lower species and structural diversity than desired and are not expected to improve based on the existing disturbance regime. Less prevalent and declining forest community types such as oak-hickory forest and early successional Cottonwood/Willow forest are not expected to reestablish under the current and projected disturbance regime. Both these communities require a reduction in forest canopy that increases light levels that support establishment and regeneration. When these types of disturbances do occur now, they either occur at unsuitable elevations to establish the desired species and/or result in colonization by invasive species which impedes forest regeneration.

Mature hard mast resources in the study area are distributed across nine stands. Currently, pecan is the only hard-mast component in eight of the nine stands; in the ninth stand, located along Yorkinut berm, Pecan, Pin Oak, and Swamp White Oak are the hard mast species present. The overstory trees are 50-80 years old. Hard-mast resources would continue to be limited in extent due to a lack of seed sources and competition from aggressive, herbaceous species in open areas. Extent of hard-mast resources would continue to decline as a result of age-related factors, decreased drainage capacity, lack of appropriate disturbance regime and habitat conditions, and lack of suitable seed-sources in the study area. Species and structural diversity would decline due to a lack of hydrologic diversity, disturbance regime diversity, and canopy conditions. Hard-mast species historically depended on periodic disturbance, such as windthrow or fire, to increase light levels at higher elevation areas that supported establishment and development of bottomland oaks and hickories. Flood and windthrow disturbance still occurs in floodplain forests, but now the gaps are quickly colonized by invasive species such as Japanese Hops (*Humulus japonica*), woody vines (*Vitis* spp.*),* and others which impede regeneration of desired forest species.

Floods of long duration and intensity such as the flood of 1993 and 2019 are particularly damaging to less flood-tolerant species. High mortality across a range of species was documented as a result of the 1993 and 1995 floods (Cosgriff, Nelson, & Yin, Forest response to high duration and intensity flooding along Pool 26 of the Upper Mississippi River. Illinois Natural History Survey Alton LTRMP REach 26 Field Station. , 1999); (Cosgriff, Nelson, & Yin, 2007), and are yet to be fully evaluated for the 2019 flood. The St. Louis area was at flood levels for over 100 days during the flood of 1993, and the peak water elevation reached the highest on record. Similarly, the area was at flood levels for 126 days during the 2019 flood, and the peak water elevation reached the second highest on record. Any long duration flood events that occur during the period of analysis would increase the rate of decline for bottomland forest resources. It is anticipated that USFWS would continue to manage forest resources in the Yorkinut Slough study area as referenced in the Two Rivers HMP (FWS, 2011).

Cottonwood and Green Ash comprise nearly 25% of overstory trees in the study area and will likely have high rates of mortality over the period of analysis. High rates of mortality are expected for cottonwood due to current maturity/age class, relatively short lifespan, and growth habitat; and for green ash, due to the presence of Emerald Ash Borer (*Agrilus planipennis*) (EAB) in the study area. Green Ash is expected to undergo widespread mortality due to expanding EAB populations in the region. Once that occurs, Green Ash may be reduced to an understory tree in the study area. Overall canopy cover is expected to decline slightly over the period of analysis. Together, the trajectories of several of the most dominant species in the study area present a significant problem for long-term forest management. Forest resources are likely to be replaced by non-desirable species within the next 50 years as hard-mast, Cottonwood, and Green Ash overstory trees decline in abundance. More flood and shade tolerant species will continue to dominate at the site and there will be an overall decline in species and forest community diversity. Japanese Hops is likely to establish and delay or prevent regeneration of forest where large canopy gaps form due to tree mortality. Reed Canary Grass and Common Reed, invasive grasses which have established at other sites, also have potential to establish and delay or halt forest regeneration.

Geology & Soils

a. Existing Conditions

Geology

The Mississippi River once flowed through the Ancient Mississippi Valley (present-day Illinois River Valley) creating a broad, low slope valley floor. The advancing Wisconsin glacier about 21,000 years ago shifted the Mississippi River west into its current river valley (Willman & Frye, 1970). Meltwater from the Wisconsin glacier formed a series of glacial lakes and contributed a small volume of water to form the Illinois River (Havera & Bellrose, 1985). The low volume (relative to floodplain width) and shallow slope of the Illinois River created unique conditions for habitat development (Mills, Starrett, & Bellrose, 1966). In the centuries after the Wisconsin glacier, over 300 bottomland lakes and sloughs formed along the river channel as a result of sediment deposition patterns during high flow conditions (Havera and Bellrose, 1985). Over time these bottomland lakes and sloughs have partially filled in with sediment and have become more homogenous in their water depth profiles.

Soils

The soil in the study area consists of silty loams on ridges and silty clays in the swales. The soil in the study area has been characterized by the Natural Resource Conservation Service as primarily Beaucoup silty clay loam, undrained; Beaucoup silty clay loam, cool mesic; Tice silt loam; Darwin silty clay, Hurst silt loam, and Wakeland silt loam found on 0 to 2 percent slope and frequently flooded for long durations (**Figure 17**). The above soil types have a slow or very slow infiltration rate (high runoff potential) when thoroughly wet. Oakville loamy fine sand, located near the visitor center and office, is found on 7 to 15 percent slopes and has a high infiltration rate (low runoff potential) when thoroughly wet. Channel meandering at the confluence of the Mississippi and Illinois River over thousands of years has resulted in varying soil conditions with high amounts of sand deposition occurring in some areas. Areas with high sand content will need to be considered when evaluating modifications to existing MSUs as well as development of other Project measures due to the high water infiltration rates and seepage capabilities found in these areas.

Prime Farmland (Farmland Protection Policy Act, 7 CFR Part 658).

Prime farmland is land considered to have the best combination of physical and chemical characteristics for crop production. Tice silt loam is considered to have prime farmland characteristics. These soils tend to be slightly acidic to alkaline, with pH ranging from 5.6 to 7.8 respectively (USDA Web Soil Survey, 2021). The areas classified as prime farmland in the study area are not currently in agricultural production. Oakville loamy sand is considered farmland of statewide importance as determined by the state of Illinois. In general, this category includes lands that nearly meet the criteria for prime farmland, and that economically produce high yields of crops when treated and managed with acceptable farming methods.

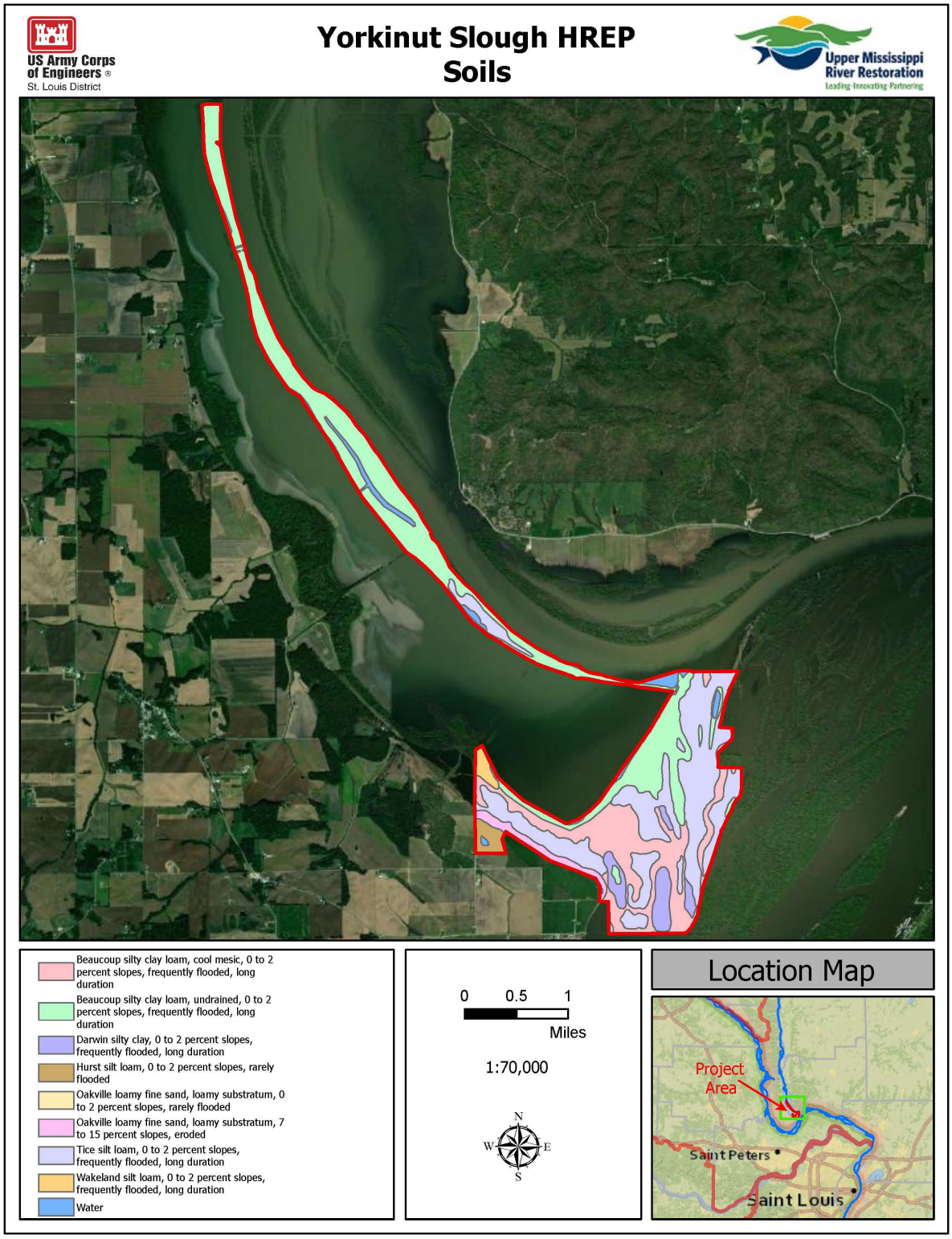

Figure 17. Yorkinut Slough soil classification.

b. No Action (FWOP Condition)

No major impacts to geology and soils would be expected in the FWOP condition. No impacts to acres that qualify as prime farmland within the study area would be expected because no prime farmland is currently used for agriculture within the study area; therefore, no farmland in the study area would be converted to nonagricultural uses.

Wildlife & Birds

a. Existing Conditions

Wildlife

Large river floodplains, such as the UMRS, provide a mosaic of forest, grassland, islands, backwaters, side channels, and wetlands that support a wide diversity of wildlife. In all, the UMRS supports over 550 vertebrate species, and nearly 50 species of mussels (Guyon, Deutsch, Lundh, & Urich, 2012). There are over 300 species of bird that migrate along the Mississippi Flyway each year. The Yorkinut Slough study area is uniquely located at the confluence of the Mississippi and Illinois Rivers and is an important link along this migratory corridor. The USFWS manages the study area primarily as a refuge for migratory birds that rest, feed, and winter along the Mississippi Flyway. Recreational hunting opportunities are provided in portions of the study area for waterfowl, whitetail deer, and furbearing animals.

Migratory Birds

The Migratory Bird Treaty Act (MBTA) of 1918 regulates and protects most aspects of the taking, possession, transportation, sale, purchase, barter, exportation, and importation of migratory birds. As of December 2, 2013, the MBTA regulates and protects 1,026 species.

The Two Rivers NWR has been designated a state important bird area for waterfowl, wading birds, and its breeding population of Prothonotary Warbler; and by the Upper Mississippi River/Great Lakes Joint Venture as a wetland focus area for waterbirds and waterfowl.

Waterfowl

A wide diversity of waterfowl utilizes the critical overwintering and migration habitats that are present along the Illinois River (Havera, 1999). Swan Lake has supported an annual average of 3.8 million waterfowl fall use days between the years of 1995-2019 (INHS, 2019). In addition, the study area has recorded an average of 29,500 waterbirds during the migratory and winter seasons (2012-2018) ((USFWS, 2019); unpublished data). Resources for spring migrating waterfowl in the region are more limiting, and currently the Refuge is unable to effectively stagger flooding of units to provide reliable spring migratory habitat.

Shorebirds

Shorebirds are predominantly long-distance migrant species with diverse migration strategies. Many of the species have declining populations and are of conservation concern (Hamer, Heske, Brawn, & Brown, 2006). Adequate refueling stopover sites are crucial to migration success for many of the shorebird species that migrate through the interior portions of North

America (Skagen, 2006). The Illinois River Valley can produce functional, high quality habitat when shorebird foraging habitat is available (Smith, et al., 2012). Suitable foraging habitat for shorebirds includes mudflats and shallowly flooded areas that are sparsely vegetated or bare. Due to these habitat requirements, suitable habitat may not be available each year or may only be available for a small portion of the spring or fall migration in the Refuge and along the Illinois River Valley. These relatively narrow habitat conditions require management flexibility to support suitable habitat. Over 30 species of shorebird have been recorded in the Two Rivers NWR.

Landbirds

Despite extensive changes to UMRS floodplain landcover, remaining floodplain forests represent some of the largest contiguous tracts of forest in the region. These remaining tracts of forest provide valuable resources on the landscape for migrating and resident landbirds, many of which have undergone population declines over the past 50 years (Rosenberg, et al., 2019). On the Upper Mississippi River, studies within the Driftless Area suggest that these floodplain habitats provide migratory habitat (Kirsch, Heglund, Gray, & McKann, 2013) and breeding habitat (Knutson, 1995) for a high diversity of birds, including some nearctic-neoptropical migrant species of concern. Studies of avian use of bottomland forest habitats in other areas of the U.S. have also found that they are important breeding areas for migratory species (Sallabanks, Walters, & Collazo, 2000); (Buffington, Kilgo, Sargent, & Chapman, 1997); (Miller, Dixon, & Turner, 2004); (Bub, Flaspohler, & Huckins, 2004); (Hopps, 2012). Bottomland habitats often support higher avifauna diversity compared to upland sites, and these bottomland habitats may act as source populations for birds in highly fragmented landscapes (Guifoyle, 2001). The natural edges and complex vegetation structure created by regular disturbances is thought to enhance bird community diversity and nesting success in other similar bottomland and floodplain habitats (Sallabanks, Walters, & Collazo, 2000); (Knutson, Gureuter, & Klaas, 2000).

Wading Birds

The IRV historically provided extensive habitat for wading birds. This group of birds is dependent on shallow areas with abundant food resources (i.e., amphibians, crustaceans, small fish, etc.) for foraging, and large, mature trees for nesting and roosting. Emergent cottonwood trees that extend above surrounding canopy trees are particularly valuable as nesting habitat in the floodplain of the UMR and IRV. The moist-soil and river edge habitats within the Two Rivers NWR still provide important food resources for a range of wading birds, primarily herons and egrets during the breeding and migratory seasons. However, foraging, roosting, and nesting habitat quality for wading birds could be improved with improved management capabilities and increased forest health and structural diversity.

USFWS provided a species list for migratory birds of concern that may be affected by Project measures implemented in the study area (**Table 5**) (IPAC Report dated 02 February 2023; *Appendix A – Coordination*). The majority of species included in the list below fall into one of the bird taxa categories described in the previous paragraphs. Exceptions include Bald Eagle, Red-headed Woodpecker, and Rusty Blackbird. The Bald Eagle will be discussed in the Endangered Species section. The Red-headed Woodpecker is a resident or short-distance migrant species in decline that is dependent on forested habitats and concentrates in savanna and open woodland habitats often dominated by oak species. The Rusty Blackbird is a boreal breeder that

migrates south to overwinter in swamps and floodplain forests throughout much of the eastern U.S.

Table 5**.** Migratory birds from USFWS Information for Planning Consultation (IPAC)

Common Name	Scientific Name	Breeding Season
American Golden-plover	*Pluvialis dominica*	Breeds elsewhere
Bald Eagle	*Haliaeetus leucocephalus*	October 15 to August 31
Bobolink	*Dolichonyx oryzivorus*	May 20 to July 31
Chimney Swift	*Chaetura pelagica*	Breeds March 15 to August 25
Eastern Whip-poor-will	*Anstrostomus vociferus*	Breeds May 1 to August 20
Golden Eagle	*Aquila chrysaetos*	Breeds elsewhere
Hudsonian Godwit	*Limosa haemastica*	Breeds elsewhere
Kentucky Warbler	*Oporornis formosus*	April 20 to August 20
Lesser Yellowlegs	*Tringa flavipes*	Breeds elsewhere
Prothonotary Warbler	*Prothonotaria citrea*	April 1 to July 31
Red-headed Woodpecker	*Melanerpes erythrocephalus*	May 10 to September 10
Ruddy Turnstone	Arennaria interpres morinella	Breeds elsewhere
Rusty Blackbird	*Euphagus carolinus*	Breeds elsewhere
Semipalmated Sandpiper	*Calidris pusilla*	Breeds elsewhere
Short-billed Dowitcher	*Limnodromus griseus*	Breeds elsewhere
Wood Thrush	*Hylocichla mustelina*	May 10 to August 31

b. No Action (FWOP Condition)

Migratory Birds

Migratory and resident birds would be negatively impacted by continued degradation of habitat within the study area. Migratory waterfowl would be negatively impacted through a reduction in suitable food production within the study area that is utilized to fuel their spring and fall migrations. In addition, forest species and structural diversity would decline and overall would become more homogenous in resources. As a result, prey diversity and abundance is expected to decline for neotropical migrants, and limit habitat suitability.

Other Wildlife

Fur-bearing animals dependent on wetland habitats would be negatively impacted by the continued loss of aquatic habitat diversity. Edge-dependent species in the study area would be expected to increase as a result of high tree mortality rates in the study area, but overall food quality would be expected to decrease under the FWOP condition as aggressive species of low quality colonize areas with high tree mortality or wetlands that have converted to open water as a result of infrastructure failures. As a result, it is expected that habitats will provide less suitable food, cover, and shelter overall for wildlife under the FWOP.

Endangered Species

a. Existing Conditions

Federal Threatened and Endangered Species

In compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, the USFWS provided a list of three federally threatened and endangered species and two candidate species that could potentially be found in the area (Calhoun County, Illinois) via a letter dated 30 October2019 (IPAC report) (updated 02 February 2023; *Appendix C – Biological Assessment).* The five species, federal protection status, and habitat can be found in **Table 6**. No critical habitat is located in the study area. USFWS Ecological Services Office provided a Draft Fish and Wildlife Coordination Act Report (FWCAR) for the Project that was reviewed and concurred with by the U.S. Fish and Wildlife Service Two Rivers NWR and the IDNR (see *Appendix A - Coordination*).

Table 6**.** Federally listed threatened and endangered species potentially occurring in the Study Area

Species	Status	Habitat
Indiana bat (*Myotis sodalis*)	Endangered	Hibernates in caves and mines. Maternity & foraging habitat includes small stream corridors with well-developed riparian woods, upland & bottomland forests
Northern Long-eared Bat *(Myotis septentrionalis*)	Endangered	Hibernates in caves and mines. Swarming in surrounding wooded areas occurs in autumn. Roosts and forages in understory of a wide range of forested habitats during spring and summer.
Tricolored Bat (*Perimyotis subflavus*)	Proposed Endangered	Hibernates in caves and mines in our region; found in forested habitats in spring, summer, and fall; generally roost in canopy among leave clumps/clusters.
Monarch Butterfly (*Danaus plexippus*)	Candidate	Breeding and migratory habitat found in a variety of habitats where suitable host (*Asclepias* spp.) and diverse nectar plants occur. Suitable sites are often found along riparian corridors.
Decurrent False Aster (*Boltonia decurrens*)	Threatened	Disturbed alluvial soils. Moist, sandy floodplains and prairie wetlands along the Illinois River and a small portion of the Mississippi River primarily above the Missouri-Mississippi River confluence.

b. No Action (FWOP Condition)

Habitat conditions would continue to degrade within the study area in the FWOP condition, but some available habitat in the study area as well as surrounding public land would be anticipated to persist. Additional details can be found in *Appendix C – Biological Assessment*.

Bald Eagle

a. Existing Conditions

Although the Bald Eagle (*Haliaeetus leucocephalus*) was removed from the federal list of threatened and endangered species in 2007, it continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA). The BGEPA prohibits unregulated take of Bald Eagles, including disturbance. The U.S. Fish and Wildlife Service developed the National Bald Eagle Management Guidelines (USFWS, 2007) to provide land managers, landowners, and others with information and recommendations regarding how to minimize potential Project impacts to Bald Eagles, particularly where such impacts may constitute disturbance.

Bald eagles generally nest near coastlines, rivers, large lakes or streams that support an adequate food supply. They often nest in mature or old-growth trees, snags (dead trees), cliffs, and rock promontories. They rarely nest on the ground, and nest with increasing frequency on anthropogenic structures such as power poles and communication towers. In forested areas, bald eagles often select the tallest trees with limbs strong enough to support a nest that can weigh more than 1,000 pounds (USFWS 2007). There are mature trees fitting this description within the forested portions of the Refuge. In addition, there is currently one known bald eagle nest that was constructed and occupied during a recent breeding season.

b. No Action (FWOP Condition)

There is currently one known Bald Eagle nest in the study area. Bald Eagles reuse nesting sites across multiple years until they are damaged. Under the No Action Alternative, potential Bald Eagle habitat would be expected to persist within and outside of the study area. However, a decline in the total number of suitable sites would be expected to occur within the study area as Cottonwood and existing hard-mast trees experience increased mortality without the Project. Overall, due to the presence of nearby forests with potentially suitable trees, no impacts to the Bald Eagle are expected with the No Action Alternative.

Illinois Resources of Concern

a. Existing conditions

The IDNR Ecological Compliance Assessment Tool (EcoCAT) Natural Heritage Database that was accessed on 30 October 2019 and updated 9 January 2023, lists four Illinois Natural Area Inventory (INAI) Sites, two land and water reserves, and seven protected plant and or animal species in the vicinity (i.e., Calhoun County, Illinois) of the study area (**Table 7**). The INAI sites are located north of the study area and north of the Illinois River.

Table 7. Illinois Natural Area Inventory Sites located within the Project vicinity. Category I sites includes high quality natural community and natural community restorations; Category III sites include state dedicated Nature Preserves, Land and Water Reserves, and Natural Heritage Landmarks, and Category IV sites include Outstanding geological feature.

INAI Site	Category	Location/County
Gilbert Lake	IV	Jersey
Brainerd Cave	I, III	Jersey
Deer Lick Hollow Geological Area	IV	Jersey
Mcadams Peak Hill Prairie	I, III, IV	Jersey

The individual species of concern are shown in **Table 8** below.

Table 8. Illinois species of concern potentially occurring within the Study Area.

Species	**State Status**
American Eel *(Anguilla rostrata*)	Threatened
Bigeye Shiner (*Notropis boops)*	Endangered
Black Sandshell *(Ligumia recta*)	Threatened
Indiana bat (*Myotis sodalis)*	Endangered
Northern long-eared bat (*Myotis septentrionalis*)	Threatened
Western Sand Darter *(Ammocrypta clara*)	Endangered
Smooth Softshell *(Apalone mutica*)	Endangered

b. No Action (FWOP Condition)

Nearby Illinois Natural Area Inventory (INAI) sites would be expected to persist and no impacts are anticipated to Illinois listed species in the FWOP condition. Therefore, no impacts to Illinois state resources of concern are anticipated.

Invasive Species

a. Existing Conditions

Invasive Species Executive Order 13112 aims “to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause”. To abide by this Executive Order, construction best management practices, such as cleaning equipment, would be in place and enforced to prevent the introduction of additional species to and from the study area by this Project.

In addition, Refuge management aims to prevent invasion of new invasive species, eradicate new or small infestations, and control or contain large established infestations as outlined by the USFWS’s Invasive Species Management Strategy Team (USFWS, 2003). Currently, the number of invasive species found within the Refuge is limited and has been managed with integrated approaches. Independent of field surveys, the potential of invasive species to exist as well as become a future problem within the study area is understood.

Common invasive plant species likely to be present within the study area include: Reed Canary Grass (*Phalaris arundinacea*) and Japanese Hops (*Humulus japonicus*). Reed Canary Grass is a variable species with circumpolar distribution (Yatskievych, 1999). The Eurasian ecotype, originally planted for forage and erosion control, has spread throughout much of the United States and invades wetland communities and wet prairies (MDC, 2010). This cool-season grass forms dense clumps once established, and spreads aggressively through creeping rhizomes and an abundance of seed. Stems lodge by mid to late summer to form a dense mat that prevents other species from establishing. Seeds are primarily dispersed within and between sites by waterways, animals, and on machinery. Japanese Hops is an herbaceous annual native to East Asia. The species is well adapted to disturbed, open floodplain habitats (MDC, 2012). The seed is dispersed primarily by water, wind, and machinery. Seed germinates in early spring but can also occur later in the season when suitable moisture and light are available. Frequent floods in floodplain habitats create ideal conditions for the spread and establishment of this species. Once established, this twining vine can quickly overtop, blanket, and outcompete surrounding herbaceous vegetation, woody shrubs, and trees up to about 10 ft in height.

Invasive Carps, including Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*Hypophthalmichthys molitrix*), Common Carp (*Cyprinus carpio*) and Grass Carp (*Ctenopharyngodon idella*), are found throughout the region and utilize habitats with low water velocity such as those found in the 2,400 ac Swan Lake. Bighead and Silver Carp, species of particular management concern, were first documented in the UMRS in 1982 (Koel, Irons, & Ratcliff, 2000). Since then, populations have increased dramatically in the Upper Mississippi River (Koel, Irons, & Ratcliff, 2000) and Illinois River reaches (Irons, Sass, McClelland, & O'Hara, 2011). In 2017, Swan Lake was drained and evaluated as a potential invasive carp management lake due to the large number of invasive carps that enter the lake and are thus removed from the system as the lake is drained further (pers. comm. Kevin Haupt, 2021). It was found that this type of management had minimal impacts on native fishes and therefore it provides an opportunity to reduce invasive carp impacts to the Illinois River. As a result, consideration will be given to how Project measures support Project objectives along with Swan Lake's current moist-soil vegetation management and invasive carp management efforts.

b. No Action (FWOP Condition)

Overall, it is likely that invasive species would increase in occurrence and extent under the FWOP scenario as a result of altered hydrology, increased sediment deposition, widespread tree mortality in the study area, and more limited management capabilities.

Water Quality

a. Existing Conditions

Section 303(d) of the Clean Water Act requires that each state identify waters not meeting water quality standards related to beneficial uses of water including whole body contact (e.g., swimming), support aquatic life, and provide drinking water for people, livestock, and wildlife. The Illinois River within the vicinity of the study area (Assessment ID #: IL D-01, a 48-mile reach) is listed in the Illinois 2018 303(d) list for impairment for mercury and polychlorinated biphenyls (PCBs) (based on fish consumption). These impairments were also listed in the 2016,

2014, 2012, 2010 assessments. Fecal coliform was also listed for this reach in the 2012 and 2010 assessments (based on primary contact recreation).

b. No Action (FWOP Condition)

Water quality would not be expected to change under the FWOP scenario. Land use and disturbance patterns in and around the study area are not anticipated to change significantly during the period of analysis. The Illinois River adjacent to the study area would likely continue to be impaired for some uses as water quality is influenced by a number of widespread inputs from the floodplain.

III.C.10. Air Quality

a. Existing Conditions

The Clean Air Act of 1963 requires the U.S. Environmental Protection Agency (EPA) to designate National Ambient Air Quality Standards (NAAQS). The EPA has identified standards for six pollutants: lead, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, and particulate matter (at less than 10 microns and at less than 2.5 microns in diameter), along with some heavy metals, nitrates, sulfates, volatile organic and toxic compounds. EPA regulates these pollutants by developing human health-based or environmentally-based permissible pollutant concentrations. EPA then publishes the results of air quality monitoring, designating areas as meeting (attainment) or not meeting (nonattainment) the standards or as being maintenance areas. Maintenance areas are those areas that have been re-designated as in attainment from a previous nonattainment status. A maintenance plan establishes measures to control emissions to ensure the air quality standard is maintained in these areas.

The region of Calhoun County, Illinois currently meets all USEPA air quality standards and is not a designated maintenance area (USEPA, 2021).

b. No Action (FWOP Condition)

Air quality within the study area would likely remain similar to current conditions in the FWOP condition as current sources of air pollution are assumed to continue into the future.

Greenhouse Gas Emissions and Climate Change

a. Existing Conditions

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 emissions (GHG) 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). Since 1970, the concentration of atmospheric carbon dioxide has increased at a rate of about 1.67 ppm per year (1970-2019) to approximately 407 ppm as of September 2019 (current globally averaged value). 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 (IPCC, 2020). A large body of scientific evidence indicates that increases in GHG in the Earth's atmosphere are contributing to changes in national and global climatic conditions (Melillo, Richmond, & Yohe, 2014). These changes include such things as average temperature, changes in precipitation patterns, and increases in the frequency and intensity of severe weather events. These changes have the potential to impact a wide sector of the human environment including water resources, agriculture, transportation, human health, energy, and aquatic and terrestrial ecosystems. Therefore, it is important to understand the potential impacts of federal actions on GHG emissions and climate change as well as the potential changes that may occur to the human environment that could affect the assumptions made with respect to determining the impacts and efficacy of the federal action in question.

Upper Mississippi River Region Climate Trends

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

Summary of Observed Climate Findings:

> *The general consensus in the recent literature points toward moderate increases in temperature and precipitation, and streamflow in the Upper Mississippi Region over the past century. In some studies, and some locations, statistically significant trends have been quantified. In other studies and locales within the Upper Mississippi Region, apparent trends are merely observed graphically but not statistically quantified. There has also been some evidence presented of increased frequency in the occurrence of extreme storm events (Villarini et al., 2013). Lastly, a transition point in climate data trends, where rates of increase changed significantly, at approximately 1970 was identified by multiple authors.*

Study Area Climate Trends & Greenhouse Gas Emissions

In terms of climate change, changes in the annual and long-term hydrologic cycles of the Mississippi River influence the study area. The two primary 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 St. Louis, Missouri, and (2) local and regional precipitation. In general, there is a seasonal pattern to the river's hydrology with peak flows typically occurring in the spring and early summer associated with rain and snowmelt followed by declining flows from early summer through early fall. In addition to the annual seasonal pattern of the river's hydrology, historical data shows an 11 to 15 year cycle of

increasing discharge and flooding followed by declining flows and drought (Knox 1984; Franklin et al. 2003). Changes in hydrology (e.g., wet vs. dry periods) ultimately influence what floodplain habitats establish and are able to persist.

b. No Action (FWOP Condition)

Summary of future climate projection findings:

> *There is strong consensus in the literature that air temperatures will increase in the study region, and throughout the country, over the next century. The studies reviewed here generally agree on an increase in mean annual air temperature of approximately 2 to 6 ºC (3.6 to 10.8 ºF) by the latter half of the 21st century in the Upper Mississippi Region. Reasonable consensus is also seen in the literature with respect to projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves in the long-term future compared to the recent past.*
>
> *Projections of precipitation found in a majority of the studies forecast an increase in annual precipitation and in the frequency of large storm events. However, there is some evidence presented that the northern portion of the Upper Mississippi Region will experience a slight decrease in annual precipitation. Additionally, seasonal deviations from the general projection pattern have been presented, with some studies indicating a potential for drier summers. Lastly, despite projected precipitation increases, droughts are also projected to increase in the basin as a result of increased temperature and* [evapotranspiration] *rates.*
>
> *A clear consensus is lacking in the hydrologic projection literature. Projections generated by coupling* [Global Climate Models] *with macro scale hydrologic models in some cases indicate a reduction in future streamflow but in other cases indicate a potential increase in streamflow. Of the limited number of studies reviewed here, more results point toward the latter than the former, particularly during the critical summer months.*

Given the high degree of variability and uncertainty in weather patterns in general and in predictions of future weather patterns, quantifying future project impacts is inexact.

Greenhouse gas emissions for the study area are expected to be similar to current conditions. In the FWOP condition, flood frequency may increase related to increased storm intensity and precipitation. An increase in flood frequency could lead to more high-water events capable of overtopping the Six Mile/IL River berm and/or Yorkinut Slough berm.

Hazardous, Toxic, and Radioactive Waste

a. Existing Conditions

USACE regulations (ER-1165-2-132, ER 200-2-3) and Division policy requires procedures be established to facilitate early identification and appropriate consideration of potential Hazardous Toxic Radioactive Waste (HTRW) in reconnaissance, feasibility, preconstruction engineering and design, land acquisition, construction, operations and maintenance, repairs, replacement, and rehabilitation phases of water resource studies or projects by conducting a Phase I Environmental Site Assessment (ESA). USACE specifies that these assessments follow the

process/standard practices for conducting Phase I ESA's published by the American Society for Testing and Materials (ASTM) E2247-16.

The purpose of a Phase I ESA is to identify the range of contaminants (i.e., Recognized Environmental Conditions, RECs) within the scope of the U.S. Environmental Protection Agency's (EPA) Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and petroleum products to the extent feasible in the absence of sampling and analysis. Current policy is to avoid known HTRW and RECs to the extent practicable or until hazard risks and potential liability are mitigated.

A Phase I ESA following ASTM E2247-16 was performed for the Yorkinut Slough Habitat Rehabilitation and Enhancement Project (HREP), located in Brussels, IL 62013. Based on the information available for this assessment, it was concluded that the Yorkinut HREP contains no RECs that would have a major impact to the project's cost and/or schedule. The environmental impact for the migration of off-site hazardous material onto the study area is negligible. A Phase II ESA is not recommended at this time. A completed Phase I ESA report for this project can be reviewed in *Appendix F – Hazardous, Toxic, and Radioactive Waste*.

b. No Action (FWOP Condition)

No HTRW impacts would be expected in the FWOP condition. If any HTRW matter is encountered during construction of this project, USACE would be contacted to coordinate the handling and disposal of the material. However, no project measures are located near any known HTRW concerns. Therefore, HTRW would not be affected in the FWOP condition.

Historical and Cultural Resources

a. Existing Conditions

Historic plat maps indicate that portions of the study area were inhabited in the mid-20th century. The 1926 plat map identifies a school potentially within the southern portion of the study area (**Figure 18**). The 1948 plat map shows a residence located in the northwestern portion of the study area, and two residences within the northeastern portion of the study area, adjacent to Illinois River Road/Highway 1 (**Figure 19**).

Figure 18. Calhoun County 1926 Atlas.

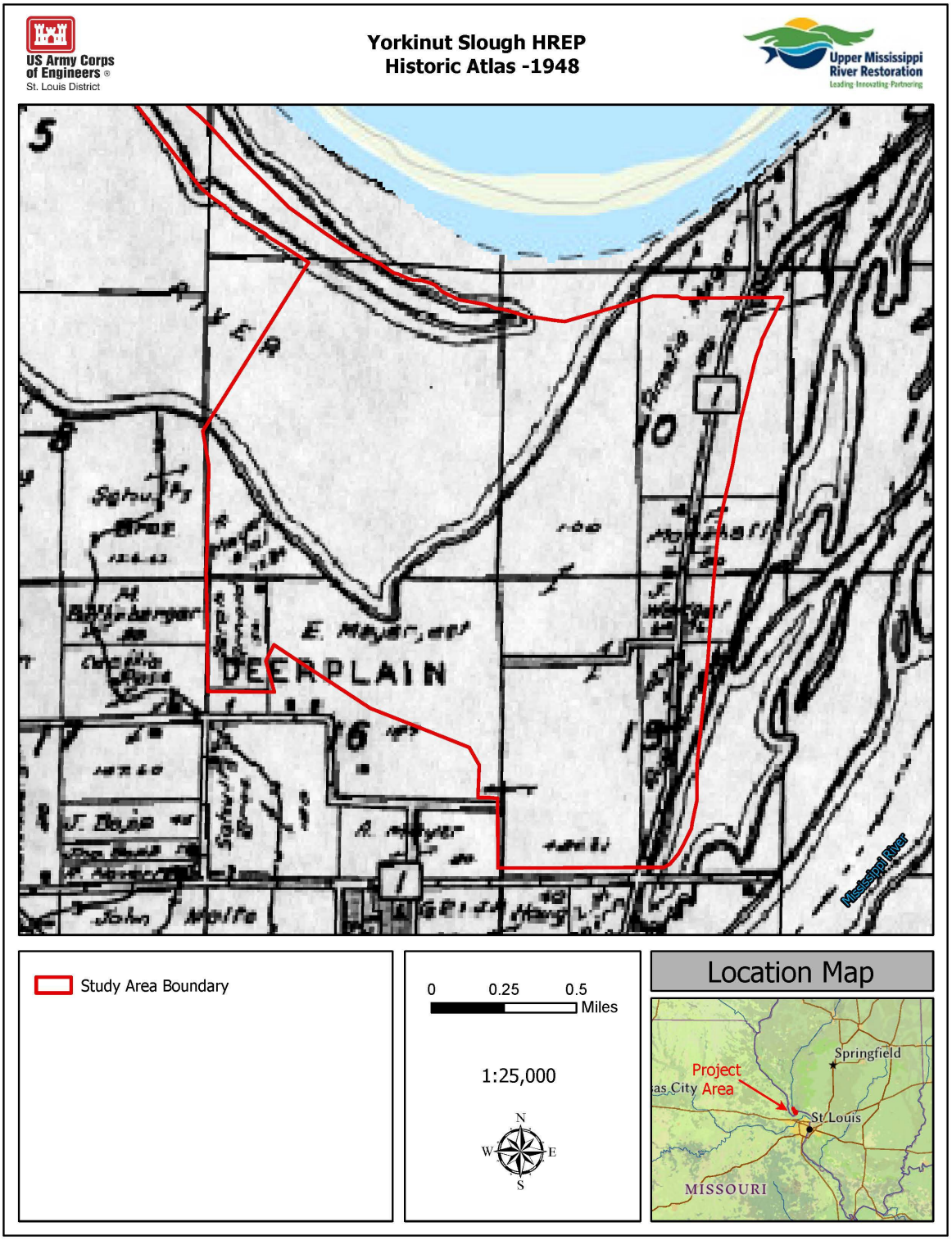

Figure 19. Calhoun County 1948 Atlas.

Three archaeological sites have been previously identified within the study area. Site 11C152 was identified by Northwestern University in 1975 (Farnsworth, 1976) as a historic Native American campsite. American Resources Group (ARG) conducted a Phase I survey in 1994 and determined the site had Early Woodland, Late Woodland, and Mississippian components (Snyder, 1994). ARG conducted Phase III mitigation efforts of the site in 1995 (Titus, Neal, Anderson, & Howe, 1995) . In 2010, Bear Creek Archaeology (BCA) conducted a survey of 11C152 and determined that a Middle Woodland and Protohistoric component also was present. BCA identified two features eroding from the bank, which were subsequently excavated. The site was determined to be mitigated through Phase III excavations (Benn, 2011).

Site 11C159 was identified in 1979 by American Resources Group as possibly a Middle Archaic lithic scatter and 19th century historic ceramic scatter (McNerney, 1979). The Illinois State Historic Preservation Office has determined it ineligible to the National Register of Historic Places (NRHP). Finally, site 11C388 is a prehistoric lithic scatter identified in 1981 by Center for American Archaeology (Hassen, 1981). This site has not been evaluated for NRHP eligibility.

b. No Action (FWOP Condition)

No impacts to cultural or historical resources are anticipated in the FWOP condition. No known historic properties exist within the study area. Site 11C152 has been mitigated through Phase III excavations, site 11C159 was determined ineligible, and site 11C388 is unevaluated for the NRHP. If unknown historic properties are within the study area, the continuous sedimentation caused by the frequent flooding would bury them deeper and thus preserve the property.

Socioeconomic Resources

a. Existing Conditions

Recreational use within the study area is characterized by numerous outdoor activities including bird watching, hiking, nature viewing and some limited forms of hunting. The nearby Illinois River, Mississippi River, and Calhoun Point Wildlife Management Area offer river fishing, hunting, boating, and kayak/canoeing opportunities. The state and federal public lands throughout Calhoun County and nearby counties offer numerous outdoor experiences for various recreational user groups.

The study area is located in Calhoun County, Illinois. Calhoun County has a population of 4,830 based on the 2019 U.S. Census Bureau American Community Survey (ACS) 5-year estimate (US Census Bureau, 2021). During this period, 49.9% were female, 97.7% were white, and 11.6% of all individuals had income in the past 12 months below the poverty level. Based on the 2019 American Community Survey, the median household income in Calhoun County is $63,009 with an average household size of 2.83. The main industries providing employment in Calhoun County include educational services and health care and social services (27.6% of workforce), construction (10.8%), arts, entertainment, recreation, accommodation, and food services (10.1% of workforce), retail trade (7.9% of workforce), finance and insurance, real

estate, and rental and leasing (7.5%) and manufacturing (6.9%). The unemployment rate for Calhoun County is 3.1%.

b. No Action (FWOP Condition)

No impact to socioeconomic resources would be expected in the FWOP condition. Human use of the study area may gradually decline as the ecosystem resources continue to degrade.

Aesthetic Resources

a. Existing Conditions

Aesthetic resources of the study area consist primarily of natural habitats. These include wetlands, early successional, woodland, and forest habitats that serve as scenery for visitors.

b. No Action (FWOP Condition)

A decline in aesthetics may occur due to degrading emergent wetland and floodplain forest habitat. Some emergent wetland areas will convert to open water systems with little resources to support wildlife, while other areas will convert to shrubland systems. Floodplain forests are expected to lose species and structural diversity and undergo greater rates of mortality in the coming decades. Overall, this decline would be gradual and result in a change of plant community type. Therefore, there would be no major effect on aesthetic resources in the FWOP condition.

Noise Levels

a. Existing Conditions

Noise levels surrounding the study area are varied depending on the time of day and season. The current human activities causing elevated noise levels in the vicinity of the study area include cars and trucks road traffic. The Illinois River Road is located along the entire eastern boundary and part of the southern boundary of the study area. This road sees on average 900 vehicles per day near the study area. The sound of firearms during hunting seasons within the study area is also prevalent

A typical vehicle can produce 60-90 decibels (dB) at a distance of 50 ft (USEPA, 1974). A public boat ramp is located near the study area introduces a source of noise from recreational boat traffic. A pleasure boat's noise range can typically be between 65-115 dB (USEPA 1974). Although the Two Rivers National Wildlife Refuge is designated as a refuge, adjacent lands are open for hunting and part of the study area is also open for limited hunting opportunities. Waterfowl hunting is the primary public use and shotguns are used to harvest ducks. The noise from a typical 12-gauge shotgun is 130 dB. All of these sources may contribute to noise levels within the study area.

b. No Action (FWOP Condition)

Current sources of noise associated with traffic, agriculture, and recreation are expected to continue into the future. Therefore, no change in noise levels would be expected in the FWOP condition.

Environmental Justice (Executive Order 12898)

An evaluation of environmental justice impacts is mandated by Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 11, 1994). This Executive Order directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse health or environmental effects of its programs, policies, and activities on minority and low-income populations.

a. Existing Conditions

The U.S. Environmental Protection Agency (USEPA) on-line EJScreen mapping tool (Version 2.1, https://www.epa.gov/ejscreen) and the Council of Environmental Quality's Climate and Economic Justice Screen Tool (Version 1.0) (CEQ, 2022) was used to characterize existing conditions for communities of color and underserved populations. The area used in the analysis applied a 2-mile buffer to the study area boundary to determine the population most affected by the Project. The community of comparison for this area is the Illinois counties of Calhoun and Jersey, respectively (**Table 9**). State and national values are provided for further context. The EJScreen tool estimated an approximate population of 405 in the analysis area. Neither the people of color nor the underserved populations is fifty percent or greater in the analysis area. The area of analysis was then assessed to determine if the people of color population or underserved population is meaningfully greater than that of the community of comparison. Both the underserved and people of color populations are below values found in Calhoun and Jersey counties as well as state and national averages. Additionally, the limited English-speaking population is the same in the study area, Calhoun County, and Jersey County, and less than state and national averages. The CEQ Version 1.0 evaluates the proportion of the population that is disadvantaged within a census tract relative to eight categories of burden. The broad categories include metrics that are categorized under climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development factors. The tool did not identify disadvantaged communities.

Table 9. Population and environmental justice characteristics within the study area

	*Analysis area	Calhoun County, IL	Jersey County, IL	State of Illinois	USA
Population	405	4,782	21,776	-	-
Demographic Index	9%	13%	13%	34%	35%
People of Color	1%	4%	5%	39%	40%
Underserved	17%	21%	21%	27%	30%
Unemployment Rate	7%	4%	4%	6%	5%
Limited English Speaking	0%	0%	0%	4%	5%

Less than High School Education	7%	6%	7%	10%	12%
Under Age 5	2%	5%	5%	6%	6%
Over Age 65	29%	24%	19%	16%	16%

***Environmental Justice analysis area included a two mile buffer surrounding the study area.**

b. No Action (FWOP Condition)

As described in the previous section, the analysis of existing conditions found that the population within the area of analysis was not significantly different than the community of comparison. No change in environmental justice would be expected in the FWOP condition. Therefore, the No Action alternative would have no effect on environmental justice.

CHAPTER 4- PLAN FORMULATION*

Plan formulation is the process of creating plans that meet objectives and, thereby, solve problems and realize opportunities for gain. Formulation was consistent with protecting the Nation's environment, pursuant to national environmental statues, applicable executive orders, and other federal planning requirements. Plan formulation also considered all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines (1983), which are National Ecosystem Restoration (NER) development, Environmental Quality, Regional Economic Development, and Other Social Effects.

This section describes the plan formulation process, a process of determining appropriate future actions through a sequence of structured rational choices to achieving desired ends, for Yorkinut Slough HREP. For planning purposes, the period of analysis (planning horizon) was established at 50 years. The Project first year is anticipated to be **2025,** therefore the period of analysis extends to **2075.**

Initial measures were identified based on previous utilization and lessons learned by the UMRR HREP program documents (USACE, 2012). A measure may be considered for action if it:

- Meets at least one study objective;
- Another measure cannot achieve the same or more benefit for less cost:
- Does not violate a constraint;
- Does not negatively impact other study objectives; and
- Is sustainable over the 50-year period of analysis functionality.

Measures were evaluated on the Principles and Guideline criteria:

- *Completeness* is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned effects.
- *Effectiveness* is the extent to which an alternative plan alleviates the specified problems and achieves the specified objectives.
- *Efficiency* is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and achieving the specified objectives.
- *Acceptability* refers to the workability and viability of the alternative with respect to acceptance by state and local entities and the public compatibility with existing laws.

Measures initially identified are described in **Table 10**. Measures screened from further analysis and the rationale for screening are listed in **Table 11**. Measures retained and listed in the final array of measures are shown in **Table 12**. The alignment of the final array of measures with the problems, opportunities, goal, objectives, and resource significance are shown in **Table 13**.

Table 10. Measures initially identified.

Measure #	Structural (S), Nonstructural (NS), or Natural/Nature Based (NS/NB)	Objective(s) addressed	Measure description
1	**S**	1, 3	**Modify MSUs (reconfigure, consolidate, expand, add).** A structural method, utilizing berms to create/increase the size of shallow-water management (MSUs).The existing MSUs (Figure 6) contain structures that allow flooding during fall and winter and dewatering during spring and summer to mimic historic hydrologic conditions. Locations were identified based on sites with elevations < 425 ft NGVD and suitable soils based on preliminary soils data. This group of measures was proposed and evaluated for ability to increase and improve emergent wetland habitat within the study area.
2	**S**	1, 3	**Channel excavation, modify channels between MSUs.** Locations of modified and constructed drainage channels would vary by MSU layout and proximity to other features. This measure would reduce the number of inefficient channels distributing water in the project area and replace them with conveyance channels that better mimic historic swale and sheet flow water distribution and draining. This would support a more natural moisture gradient within units which should support a greater diversity of aquatic species.
3	**S**	1, 3	**Enhance drainage to Illinois/Mississippi rivers through Calhoun Point.** This measure would alter the drainage of County Road MSU eastward from the study area to improve water level management. Two configurations were considered. The existing 5' diameter concrete culvert passes under the Illinois Route 1 into Calhoun Point to the Illinois River and/or Mississippi River along existing drainage pathways. Two configurations were considered. The first configuration (measure 3a) modified the existing county ditch and routed it around the Royal Landing Access lot to the Mississippi River. The second configuration (measure 3b) followed the existing county drainage channel and then routed the water into Royal Lake within Calhoun Point Area. The study team estimated the flow increase under different storm scenarios; only a small amount of drainage from small watersheds (combined area 0.18 miles; 116.9 acres representing 0.44% of the study area watershed) would be directed to Calhoun Point. The redirection of this flow would only cause a 4.3% increase in water directed to Calhoun Point. Calhoun Point lands are federally owned lands managed for conservation by IDNR. USFWS has not observed Route 1 road being flooded or overtopped.
4	**S/NB**	1, 2, 3	**Ridge and swale construction.** This measure aims to mimic ridges alternating with wetland depressions found historically in the floodplain. Potential for enhancing ridge and swale construction was limited at the site due to the relatively prominent ridges and swales already present and utilized. As a result, the measure focuses on ways to enhance sheet flow with low-profile meandering swales in units where drainage times exceed two weeks, and sites where existing ridges could be expanded with material derived from berm modifications.
5	**S**	3	**Modify berms.** Existing and proposed berms were assessed for their impacts to water level management efficiency within units such as alignment along contours and seepage issues. The berm between Yorkinut Slough and Swan Lake was identified for modification due to inconsistencies in height causing flow into and out of Yorkinut Slough at inappropriate/unmanaged locations; this measure would make the berm a consistent height so that flow can be managed
6	**S**	3	**New water control structures (WCSs).** Structures placed in a berm or ditch to provide increased control of water stage and discharge of surface or subsurface water. This measure would result in structures that are sized appropriately for reconfigured MSUs and anticipated riverine flood events.

7	**S/NB**	3	**Tiered wetland units.** Wetland units created on elevations higher than 425 ft NGVD, increasing total shallow water acreage (i.e., < 2 ft depth) within and adjacent to existing MSUs.
8	**S**	3	**Units drain north and south**. This measure considered multiple drainage routes from County Road MSU to increase flexibility for water drainage dependent on Illinois and Mississippi River water elevations.
9	**S**	3	**Wells (well pumps) & supporting pipe work for Ducks Unlimited wells**. Ducks Unlimited has installed two wells on site in coordination with the study team; pipe work supporting these wells and additional wells were considered to support filling for MSU configurations.
10	**S**	3	**Low Water Crossings.** Replacement of culvert pipes with shallow, graded low water crossings to convey water between units while maintaining access along roads when units are not flooded (typically summer through mid-fall).
11	**S**	3	**Circumferential berm around Yorkinut Slough.** Raising the berm around the Yorkinut Slough area to one consistent elevation to reduce the influence of the Illinois River during minor floods and reduce sedimentation within the Yorkinut Slough area.
12	**S**	1, 3	**Raise Yorkinut Slough berm.** Raising the berm along Yorkinut Slough between Duck Club MSU and Little Swan MSU to one consistent elevation. This would reduce the influence of exterior water levels in Yorkinut Slough during minor floods.
13	**S**	3	**New pump station to Illinois River.** Pumps and equipment for pumping water across Six Mile Island, to improve management of water levels in Yorkinut Slough.
14	**S**	3	**New/Larger drainage structure to Illinois River.** Drainage structure carrying flow to the Illinois River would increase capability to reach drawdown target elevations after flood events in support of emergent vegetation habitat development.
15	**S**	3	**Channel and berm routing upland flow to the Illinois River.** A new berm and channel routing drainage from Yorkinut Slough to the Illinois River under the access road near the northwest corner of MSU-8. Measure conceptualized to increase independent water level management in Yorkinut Slough from Swan Lake management conditions.
16	**S**	3	**Reroute upland flow.** Upland flow from tributaries to Yorkinut Slough and Swan Lake compounds drainage problems in the study area. Three configurations for rerouting upland flow were considered, including berms, new water control structures, and a new spillway on Six Mile Island. The primary difference between the configurations is the berm alignment: meandering west of stoplog structure (16a), meandering east of stoplog structure (16b), and straight west of stoplog structure.
17	**S**	3	**Cross dike with drainage directly to Illinois River.** Dike across lake allowing upland flow across to the Illinois River while allowing flow within the lake. Measure conceptualized to improve drainage of large, sporadic water inputs that affect management of water levels in Yorkinut Slough.
18	**S**	3	**Portable pump station.** A portable pump station designed to provide water input to tiered MSUs.
19	**S**	2, 3	**Channel improvements on Six Mile Island**. Reconnection of several drainage ditches on Six Mile Island to the Illinois River via excavation and regrading, to reduce forest inundation after floods.
20	**S**	2, 3	**Side channel restoration on Six Mile Island.** Dredging and excavation of the historic channel on the riverward side of Six Mile Island from approximately RM 6.8 to RM 8. 4.
21	**S**	3	**Raise spillway on Six Mile Island/Illinois River berm.** Two scenarios were investigated: raising the existing spillway to design height or the height of the berm and returning the spillway elevation to the originally constructed elevation of 428 NGVD.

22	**NB**	2, 3	**Removal of woody debris from MSUs**. Removal of accumulated woody biomass from semi-wooded MSUs to increase herbaceous annual emergent cover.
23	**S/NB**	2, 3	**Wetland excavation.** Excavation of MSUs to support wetland function and drainage.
24	**N/NB**	2	**Tree planting.** Planting of trees to establish a desired forest community, selecting appropriate tree species, spacing, and management.
25	**N/NB**	2	**Timber Stand Improvement (TSI).** Management actions to improve the composition structure, condition, health, and growth of even-age or uneven-age stands. Actions may include removing diseased or dying trees, thinning or pruning less desirable trees, and thinning vines where tree recruitment and regeneration is being impacted on Six Mile Island.
26	**S**	3	**Sediment deflection berm.** Berm constructed to reduce sediment deposition at specified location.
27	**S**	3	**Sediment detention basins.** Basins designed to manage upland runoff, collect sediment, and reduce sediment inputs into moist soil units.
28	**S**	3	**Borrow site.** Use of sediment from Swan Lake area to construct other Project measures such as berms or ridge and swale features.
29	**N/NB**	2	**Prescribed fire.** Controlled application of fire for the purpose of restoring forested habitat.
30	**NS**	3	**Revised water management plan.** Modification of the existing water management plan to change current operations of infrastructure in the study area.
31	**S**	3	**Grade control structures.** A variety of structures reducing erosion and scour.
32	**N/NB**	1	**Aquatic Plantings.** Planting and establishing a desired aquatic vegetation community with appropriate vegetative species, spacing, and management to increase aquatic plant diversity. Areas with appropriate hydrology and/or management objectives include shrub-scrub wetlands of Six Mile Island, Yorkinut MSU, and Duck Pocket MSU. Areas managed to promote predominately annual, emergent vegetation for migratory waterfowl were excluded from consideration due to conflicting management methods.
33	**N/NB**	1, 2	**Invasive species management.** Removal and management of invasive species, particularly in forested areas, in the study area.

Table 11. Measures Screened from Further Analysis

#	Measure	Objective	Structural (S), Nonstructural (NS), or Natural/Nature Based (NS/NB)	Rationale for Screening
2	Channel excavation, modify channels between Moist Soil Units (MSUs)	1, 3	S	Not complete. Measure combined with Modify Moist Soil Units (MSUs) (measure 1, retained) to achieve Project objectives.

#	Measure	Objective	Structural (S), Nonstructural (NS), or Natural/Nature Based (NS/NB)	Rationale for Screening
3a	Enhance drainage to Mississippi River via Royal Landing Rd. ditch	3	S	Not effective. There are concerns with sedimentation deposition and O&M along the road, as well as how flow along this route would affect the boat ramp/access area on the Mississippi River; the measure that was retained that would drain the existing County Road MSU through Calhoun Point does not have these concerns.
8	Units drain north and south	3	S	Not complete. Measure combined with Modify MSUs (measure 1, retained) to achieve Project objectives.
10	Low water crossings	3	S	Not complete. Measure combined with Modify MSUs (Measure 1, retained) to achieve Project objectives.
11	Circumferential berm around Yorkinut Slough	3	S	Not efficient when compared to measures modifying significantly less berms to achieve the same benefits. Acceptability criteria was not achieved given the likelihood for new berm construction impacts on neighboring land flooding, anticipated cost, and negative impacts to transitional habitats and tree planting areas.
15	Channel and berm routing upland flow to the Illinois River	3	S	Not as effective as Reroute upland flow (measure 16) options; would likely cost more due to more WCSs, need more O&M, and cause more issues in backing up to Yorkinut Slough
16	Reroute upland flow – meandering berm (Option 16b)	3	S	Not acceptable and less effective than other upland flow management configurations. Berm configuration would give less control over water management than in configuration 16a (meandering berm west of stoplog structure). Potential impacts to adjacent landowner(s).
17	Cross dike with drainage directly to Illinois River	3	S	Not acceptable. Added drainage from upland directly into the Illinois River would have greater water quality impacts than is acceptable due to increased sediment and nutrient inputs. Potential for water quality issues from flow draining directly to river.
18	Portable pump station	3	S	Not efficient when compared to stationary pump station (measure 16a or 16c) on site due to increase in O&M.
22	Removal of woody debris from MSUs	2, 3	NS	Not effective. Woody debris not identified as a management issue
23	Wetland excavation	2, 3	S	Not complete. Consider as part of measure 1, Modify MSU units (retained).
26	Sediment deflection berm	3	S	Not effective. Beneficial location not identified

#	Measure	Objective	Structural (S), Nonstructural (NS), or Natural/Nature Based (NS/NB)	Rationale for Screening
27	Sediment detention basins	3	S	Not effective. There is limited area and ability to apply such a measure outside the existing MSUs or lake. Applying this measure closer to the runoff and sediment sources would provide the greatest benefit but is outside agency authorization since that would occur on private land.
28	Borrow site	3	S	Not complete. Measure is screened as a standalone; is included as part of measures using fill (measure 4, 5, 7, 12, and 21)
29	Prescribed fire	2	NS, NB	Not complete. Invasive species management dependent on Timber Stand Improvement (TSI) (measure 25) to address site problem and achieve desired objectives.
30	Revised water level management plan	3	NS	Not complete or effective. Change in water level management plan would likely not provide significant habitat benefits if implemented independently due to limitations in water level management ability under current unit configuration and infrastructure.
31	Grade Control Structures	3	S	Not complete. Grade control structures are dependent measures and cannot achieve Project objectives if implemented separately. Combined with Modify MSUs (measure 1, retained).
32	Aquatic plantings	1	NS, NB	Not complete. Lack of suitable sites due to altered hydrology prevents establishment.
33	Invasive species management	1, 2	NS, NB	Not complete. Invasive species management dependent on TSI (measure 25) to address site problem and achieve desired objectives.

Table 12. Final Array of Measures

Measure #	Measure	Project Objective Alignment	Structural (S)/ Non-Structural (NS), or Natural/Nature-Based (NB)	Retained
1	Modify Moist Soil Units (MSUs) (reconfigure, consolidate, expand, add)	1, 3	S	Yes
3	Enhance drainage to Illinois/Mississippi rivers through Calhoun Point	1, 3	S	Yes
4	Ridge and swale construction	1, 2, 3	S	Yes
5	Modify berms	3	S	Yes
6	New Water Control Structures (WCSs)	3	S	Yes
7	Tiered wetland units	3	S	Yes
9	Wells (well pumps) & supporting pipe work for Ducks Unlimited wells	3	S	Yes
12	Raise Yorkinut Slough berm	1, 3	S	Yes
13	New pump station to Illinois River	3	S	Yes
14	New/larger drainage structure to Illinois River	3	S	Yes
16	Reroute upland flow	3	S	Yes
19	Channel improvements on Six Mile Island	2, 3	S	Yes
20	Side channel on Six Mile Island	2, 3	S	Yes
21	Raise spillway on Six Mile Island/Illinois River berm	3	S	Yes
24	Tree planting	2	NS, NB	Yes
25	Timber Stand Improvement (TSI)	2	NS, NB	Yes

Table 13. Alignment of Final Array of Measures with Problems, Opportunities, Goal, Objectives, and Resource Significance

Problems	Opportunities	Objectives	Measures Considered	Resource Significance
Loss of emergent wetland habitat quality	Improve habitat diversity which creates a more resilient ecosystem. Improve wetland habitat in a critical area for waterfowl and other migratory birds Increase resiliency of Project measures. Reduce Operation & Maintenance (O&M) costs Reduce impacts from flooding to Yorkinut with greater draining capacity Increase public wildlife viewing and recreational use	Restore and increase early successional and emergent wetland Improve hydrologic conditions for wildlife including waterbirds, neotropical landbirds, and others	• Moist Soil Unit (MSU) construction • Modify berms • Modify drainage • WCSs • Pump station • Well pumps	*Representativeness:* Numerous migratory birds utilize Yorkinut Slough wetland units including waterfowl, shorebirds, and migratory landbirds (USFWS, unpublished data). Relative abundance of birds and total numbers of neotropical migratory birds were almost twice as high in the UMR floodplain as in the adjacent uplands (Knutson, Hoover, & Klaas, 1996)). Upper Mississippi River Great Lakes Joint Venture (UMRGLJV) (Soulliere, et al., 2018) identified the Mississippi River and Lower Illinois River aquatic habitat as highly important to nonbreeding waterbirds. *Limiting Habitat*: National Audubon Society designated the area an Important Bird Area for concentrations of wetland birds and breeding populations of Prothonotary Warbler (NAS, 2008). Both groups are limited by suitable habitat on the landscape. *Status and Trend:* Wetland habitat diversity in the Illinois Mississippi River confluence have declined over time.
Loss of hard mast forest and woodland	Improve habitat diversity which	Restore and increase floodplain forest	• Tree planting • Ridge and swale construction • Timber Stand Improvement	*Status and Trend:* Forest diversity in the Illinois Mississippi River confluence have

Problems	Opportunities	Objectives	Measures Considered	Resource Significance
habitat	creates a more resilient ecosystem. Improve wetland habitat in a critical area for waterfowl and other migratory birds	and floodplain woodland Improve hydrologic conditions for wildlife including waterbirds, neotropical landbirds, and others	• Modify berms • WCSs • Modify drainage	declined over time.
Loss of ridge and swale topography	All of the above	All three objectives	• Ridge and swale construction	*Scarcity*: Hard-mast forest resources have declined due to hydrologic changes and land use changes along the UMRS and in the study area (Nelson, Redmond, & Sparks, 1994); (Cosgriff, Nelson, & Yin, 1999) *Biodiversity:* Neotropical and other migratory landbirds, Indiana bats, and the other floodplain species that rely on the forest resources will be severely impacted. *Representativeness:* (Knutson, Hoover, & Klaas, 1996) described the importance of floodplain forest in the conservation and management of neotropical migratory birds. (Kirsch & Wellik, 2017) describe the importance oak and other declining species in UMR floodplain forests for neotropical migrant landbirds.

A. Development of Initial Array of Alternatives

Measures deemed feasible were carried forward for consideration in the development of alternatives. Alternatives are combinations of measures that will contribute to attaining the planning objectives. This section describes considerations that led to the development of an initial array of alternatives for this Project and the evaluation of alternative plans ability to meet Project objectives.

Formulation strategies, defined by Planning Manual Part II: Risk -Informed Planning 2017, are a set of conditional decisions that shape and guide the development of alternatives.
The formulation strategies combine measure(s) together into alternatives based on the study goal, objectives, planning criteria, and opportunies, while avoiding constraints. Measures were combined based on appropriate dependencies and exclusivities. Yorkinut Slough HREP formulation strategies were based on the following:

- **No Action:** This alternative is defined as the alternative in which no federal action takes place. The FWOP condition would be anticipated as a result of no federal action.
- **Minimum:** This alternative strategy identifies the smallest (least cost) plan resulting in minimal improvements towards each Project objective while making a measurable and cost-effective improvement to existing conditions.
- I**ntermediate A:** This alternative strategy focuses on measures that improve the structure and function of emergent wetlands and expansion of new hard-mast resources while prioritizing measure configurations that minimize unit size.
- **Intermediate B:** This alternative strategy focuses on measures that improve structure and function of emergent wetlands and forest resources while prioritizing measure configurations that optimize unit depth.
- **Emergent Wetlands Alternative:** This alternative strategy focuses on optimizing Objective 1: Restore and increase herbaceous early successional and emergent wetland within the study area during the period of analysis. Measures that improve emergent wetland quality by focusing on water depth, conveyance, and distribution limitations as well as flood impacts at the site were included in the strategy.
- **Maximize Efficiency & Minimize OMRR&R Alternative**: This alternative strategy focuses on measures that improve the structure and function of emergent wetlands and forest resources while prioritizing configurations that minimize infrastructure and long-term maintenance requirements.
- **Water Level Flexibility:** This alternative strategy would improve emergent wetland and forest quality by focusing on water conveyance and distribution limitations as well as flood impacts to the study area. Measures included in this strategy provide the Refuge with maximum flexibility to be able to move water around and/or off Yorkinut Slough and Six Mile Island.
- **Maximum Alternative:** This alternative strategy maximizes habitat improvements for both quality and quantity and improves structure and function for emergent wetland and forest communities. Measures included in this strategy address Project problems statements to the greatest extent.

Table 14 shows the initial array of alternatives and the measures included in each.

Table 14. Initial Array of Alternatives Measures Inclusion

Measure #	Measure	Maximum	Inter-mediate B	Inter-mediate A	Minimum	Emergent Wetlands	Maximize Efficiency/ Minimize OMRRR	Water Level Flexibility
1	Modify Moist Soil Units (MSUs) (reconfigure, consolidate, expand, add)	x	x	x	x	x	x	x
3	Enhance drainage to Illinois/Mississippi River through Calhoun Point	x	x	x			x	x
4	Ridge and swale construction	x	x	x		x		
5	Modify berms	x	x	x				
6	New Water Control Structures (WCSs)					x	x	
7	Tiered wetland units	x	x	x		x		x
9	Wells (well pumps) & supporting pipe work for Ducks Unlimited wells	x	x	x	x	x	x	x
12	Raise Yorkinut Slough berm	x	x	x	x			x
13	New pump to Illinois River					x		x
14	New/Larger drainage structure to Illinois River							x
16	Reroute upland flow	x	x	x				x
19	Channel improvements on Six Mile Island	x						x
20	Side channel on Six Mile Island	x						
21	Raise spillway on Six Mile Island/Illinois River berm	x	x					x
24	Tree planting	x	x	x	x		x	
25	Timber Stand Improvement (TSI)	x	x					

No Action alternative not shown (it includes no measures).

B. Evaluation and Screening of Initial Array of Alternatives

Evaluation of the initial array of alternatives was based on Economic and Environmental Principles and Guidelines For Water And Related Land Resources Implementation Studies (1983, referred to as P&G for the remainder of this report). P&G criteria include:

- **Completeness** is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned effects.
- **Effectiveness** is the extent to which an alternative plan alleviates the specified problems and achieves the specified objectives.
- **Efficiency** is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and achieving the specified objectives.
- **Acceptability** refers to the workability and viability of the alternative with respect to acceptance by state and local entities and the public compatibility with existing laws.

The USACE study team gave each alternative a qualitative metric (high/moderate/low) and a quantitative score for tallying. A qualitative score of "high" signifies the metric was met considerably, a score of "moderate" denotes the metric was met moderately, and a score of "low" indicates the metric was minimally met, if at all. The metrics are described below. If the metric was high it was given a score of 3, moderate a score of 2, and low a score of 1. **Table 15** provides the ranking for each alternative based on the totals.

Effectiveness: In order to measure the effectiveness of each alternative, the study team created metrics for each of the Project objectives:

Bottomland Hardwood Habitat Objective Metric – This metric documents how well each alternative improves the ability for the bottomland hardwood forests to regenerate in the study area.

Restore Natural Hydrologic Conditions And Function To The Floodplain Objective Metric – This metric documents how well each alternative allows for the management of natural floodplain water level variability in the study area.

Emergent Wetland Objective Metric – This metric documents how well each alternative restores the function of the emergent wetlands in the study area.

Efficiency: The efficiency metric used to compare the initial array included whether Construction, and Operation, Maintenance, Repair, Replacement & Rehabilitation (OMRRR) costs are anticipated to be high in comparison to the predicted benefits.

Acceptability: The acceptability metric used to compare the initial array refers to the workability and viability of the alternative with respect to acceptance by federal and non-federal entities and the public, and compatibility with existing laws, regulations, and public policies. In order to measure the acceptability of each alternative, the study team created the metrics described below. All the alternatives in the final array are in accordance with Federal law and policy so all alternatives scored high.

USACE Policy Compliant – This metric evaluated the magnitude of potential policy concerns for each alternative.

Complements the larger federal, state and local objectives – This metric provided how well each alternative complemented other USFWS and IDNR management and objectives in and adjacent to the study area, showing the alternatives' viability for acceptance by non-federal entities and the public.

Completeness: The study team evaluated future potential investments, state investments, non-governmental investments, and land use changes to determine if these activities were necessary to or would prohibit achievement of this study's planning objectives. The study team determined that at this stage of the planning process, no additional investments were needed to obtain benefits so all alternatives are considered "complete".

Table 15. Evaluation of Initial Array of Alternatives

Alternative	EFFECTIVE			EFFICIENT	ACCEPTABLE		COMPLETE	SCORE
	Wetland	Forest	Hydrologic Conditions	Minimizes cost relative to benefit	Minimizes USACE policy concern	Complies with federal, state and local entities	All items considered	Total
No Action	Low	Low	Low	Low	High	Low	Low	9
Maximum	High	High	High	Moderate	High	Moderate	High	19
Intermediate B	High	High	High	Moderate	High	High	High	20
Intermediate A	High	Moderate	High	Low	High	Moderate	High	17
Minimum	Low	Low	Low	High	High	Moderate	Moderate	13
Emergent Wetlands	Moderate	Low	Moderate	Moderate	High	Low	Low	12
Maximize Efficiency & Minimize OMRR&R	Low	Low	Low	Moderate	High	Low	Low	10
Water Level Flexibility	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	15

High = metric was met considerably; Moderate = metric was met moderately; Low = metric was minimally met or not met. If the metric was high it was given a score of 3, moderate a 2, and low a 1. Total quantitative score is listed in Total column.

The following alternatives were screened. For all three alternatives, the reason for screening was that the measures and function of the alternative was very similar to an alternative that was retained (lack of meaningful difference), while addressing the objective(s) less effectively (ineffective).

- Emergent Wetlands Alternative – This alternative was focused on maximizing emergent wetlands in the study area, and included similar measures to Intermediate A, but did not include tree planting or TSI. Without these features, the alternative did not meet Objective #2 (Restore and Increase Floodplain Forests) and was therefore less effective than Intermediate A.
- Maximize Efficiency & Minimize OMRR&R Alternative – This alternative included similar measures to Intermediate A, but did not include berm work or a new pump station; without these features to improve hydrology, the forest would remain more vulnerable to flooding and the alternative would be less effective and efficient than Intermediate A.
- Water Level Flexibility Alternative – This alternative included similar measures to Intermediate B. As the alternatives were developed, the Water Level Flexibility alternative included such similar components to Intermediate B that there was not enough meaningful difference between them to retain both alternatives.

C. Final Array of Alternatives

The final array of alternatives includes:

- No Action Alternative
- Minimum Alternative
- Intermediate A Alternative
- Intermediate B Alternative
- Maximum Alternative

These alternatives include the following measures:

- **A4 – Maximum:** The Maximum alternative includes combining and reconfiguring several MSUs (in a configuration unique to this alternative), creating tiered MSUs (in a configuration unique to this alternative), allowing drainage of the County Road MSU through Calhoun Point to the Illinois or Mississippi rivers (rather than through Yorkinut Slough), enhancing ridge and swale topography near existing woodland near County Road 1, raising the Yorkinut Slough northern berm, constructing two new wells and installing pipe work supporting those wells and the two new Ducks Unlimited wells, a new short upland flow and sediment containment berm from Yorkinut Slough to Six Mile Island, channel improvements and a side channel on Six Mile Island, raising the spillway on the Six Mile Island/Illinois River berm, tree planting on Six Mile Island and near existing woodland along County Road 1, and TSI on Six Mile Island. These measures were identified as a unique combination that would maximally address all three objectives.
- **A3 – Intermediate B:** The Intermediate B alternative includes combining and reconfiguring several MSUs (in a configuration unique to this alternative), creating tiered

MSUs (in a configuration unique to this alternative), allowing drainage of the County Road MSU through Calhoun Point to the Illinois or Mississippi rivers (rather than through Yorkinut Slough), enhancing ridge and swale topography near existing woodland near County Road 1, raising the Yorkinut Slough northern berm, constructing two new wells and installing pipe work supporting those wells and the two new Ducks Unlimited wells, a new short upland flow and sediment containment berm from Yorkinut Slough to Six Mile Island, raising the spillway on the Six Mile Island/Illinois River berm, tree planting on Six Mile Island and near existing woodland along County Road 1, and TSI on Six Mile Island. These measures were identified as a unique combination that would address all three objectives.

- **A2 – Intermediate A:** The Intermediate A alternative includes combining and reconfiguring several MSUs (in a configuration unique to this alternative), creating tiered MSUs, allowing drainage of the County Road MSU through Calhoun Point to the Illinois or Mississippi rivers (rather than through Yorkinut Slough), creating ridge and swale topography near existing woodland near County Road 1, raising the Yorkinut Slough northern berm, pipe work supporting the two new Ducks Unlimited wells and two existing wells (Well 2 and Well 3), a new meandering upland flow and sediment containment berm from Yorkinut Slough to Six Mile Island, raising the spillway on the Six Mile Island/Illinois River berm, and tree planting near existing woodland along County Road 1. These measures were identified as a unique combination that would address all three objectives.
- **A1 – Minimum**: This Alternative addresses minimal improvements towards all three objectives. It includes combining the Duck Club and Office MSUs, fixing the drainage issues in Pump Station MSU, and regrading the County Road MSU, raising the Yorkinut Slough northern berm, pipe work supporting the Ducks Unlimited wells, and tree planting near existing woodland along County Road 1. These measures were identified as some of the simplest and most cost-effective ways to address the objectives.

Table 16 outlines key measures and differences across alternatives. Measure numbers correspond to measure numbers in Table 10. Measures with a letter after the number (e.g., 1a) indicate different configurations of the same measure with differences in design and/or location, as shown in Figures 20-27; measure configurations were developed for differences in design/function. Yellow indicates measure configurations are the same between alternatives. Gray indicates a measure not included in the alternative.

Table 16. Measure Comparison Across Alternatives

	Measure configuration (measure number, configuration if any, and short description of configuration)				
Measure #	**Measure Description**	**Maximum Alternative**	**Intermediate B Alternative**	**Intermediate A Alternative**	**Minimum Alternative**
1	Modify Moist Soil Units (MSUs)	**1a3** (Megaunit) **1b2** (2 new units) **1b3** New Upper HQ unit **1c1** (County Rd regrade)	**1a8** (unique configuration) **1b2** (2 new units) **1b3** New Upper HQ unit **1c1** (County Rd regrade)	**1a4** (Smaller units: Duck Club+Office; Calhouns; Pump Station+Schoolhouse) **1b2** (2 new units) **1b3** New Upper HQ unit **1c1** (County Rd regrade)	**1a1** (Duck Club+Office) **1a9** (new) - Fix Pump Station MSU seepage issues (no change to MSU boundaries) **1c1** (County Rd regrade)
3	Drain to Illinois & Mississippi rivers through Calhoun Point	**3a**	**3a**	**3a**	
4	Ridge and swale construction	**4a**	**4a**	**4a**	
5	Modify berms	**5a** (fix seepage issues) **5b** (shallower Yorkinut berm)	**5b** (shallower Yorkinut berm)	**5a** (fix seepage issues) **5b** (shallower Yorkinut berm)	
7	Tiered wetland units	**7a** ("Upper Schoolhouse") **7b** ("Brushpile")	**7c** (unique configuration)	**7a** ("Upper Schoolhouse") **7b** ("Brushpile")	
9	Wells & supporting pipe work for Ducks Unlimited wells	**9a** (New wells x2) **9b** (Pipework x4)	**9a** (New wells x2) **9b** (Pipework x4)	**9b** (Pipework x2)	**9b** (Pipework x2)
12	Raise Yorkinut Slough berm	**12**	**12**	**12**	**12**
16	Reroute upland flow	**16c** (straight berm)	**16c** (straight berm)	**16a** (long berm)	
19	Channel improvements on Six Mile Island	**19**			
20	Side channel on Six Mile Island	**20**			
21	Raise spillway on Six Mile Island/Illinois River berm	**21**	**21**	**21**	
24	Tree planting	**24a1** (Yorkinut maximum) **24b** (Six Mile Island)	**24a2** (Yorkinut medium) **24b** (Six Mile Island)	**24a3** (Yorkinut low)	**24a4** (Yorkinut minimum maintenance)
25	Timber Stand Improvement (TSI)	**25**	**25**		

The alternatives configurations are illustrated in **Figure 20**- **Figure 27**.

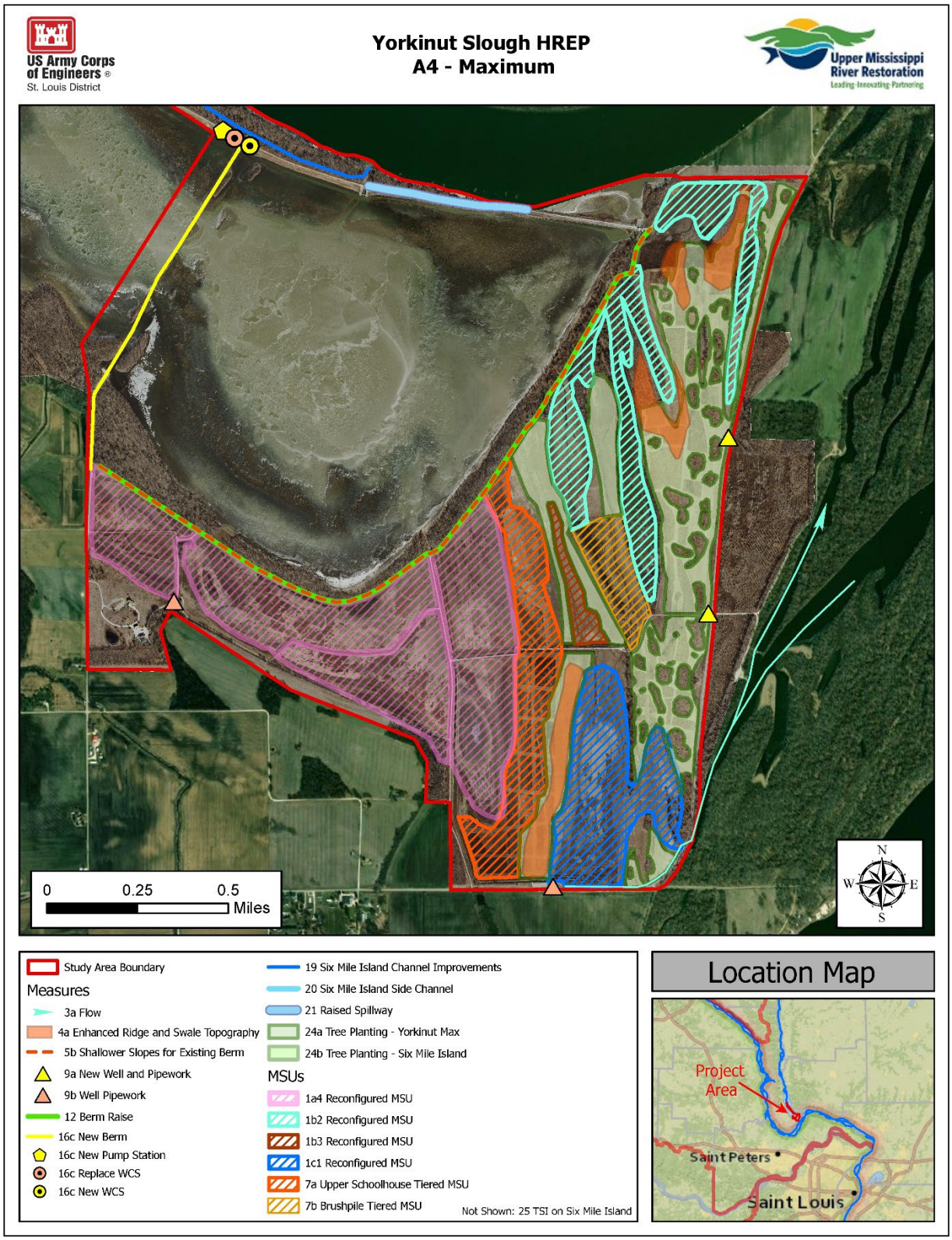

Figure 20. Alternative 4 Maximum

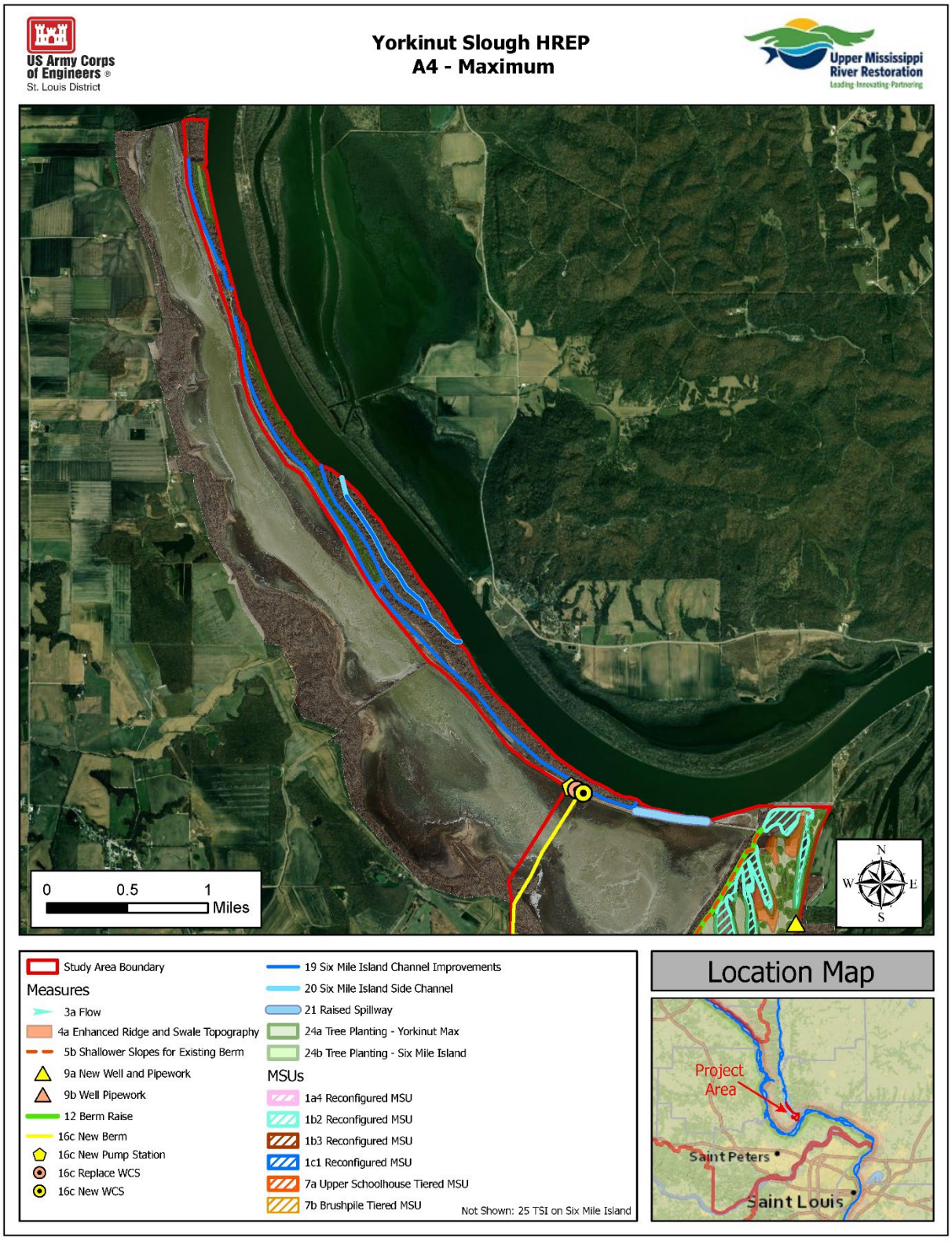

Figure 21. Alternative 4 Maximum – Six Mile Island Measures

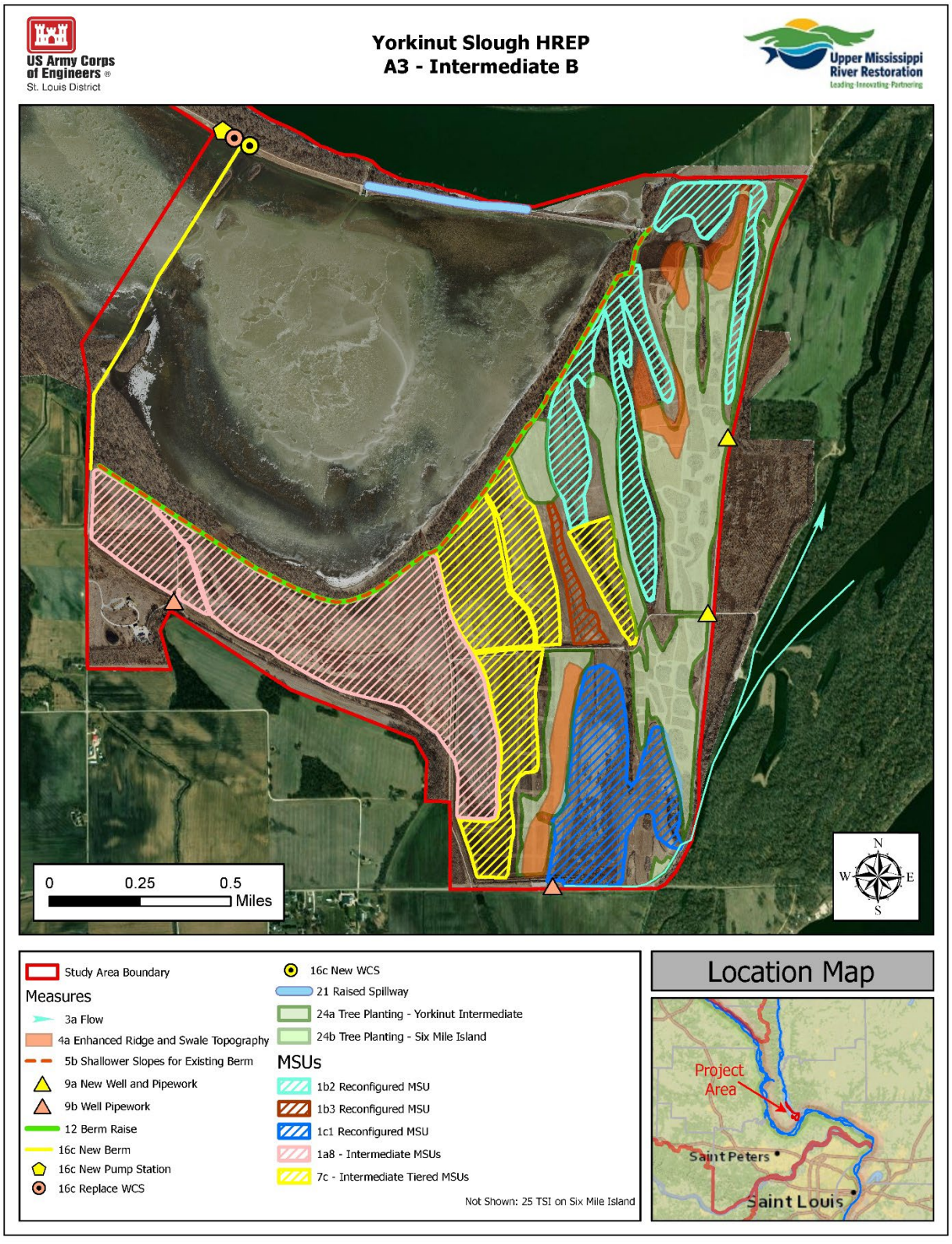

Figure 22. Alternative 3 Intermediate B

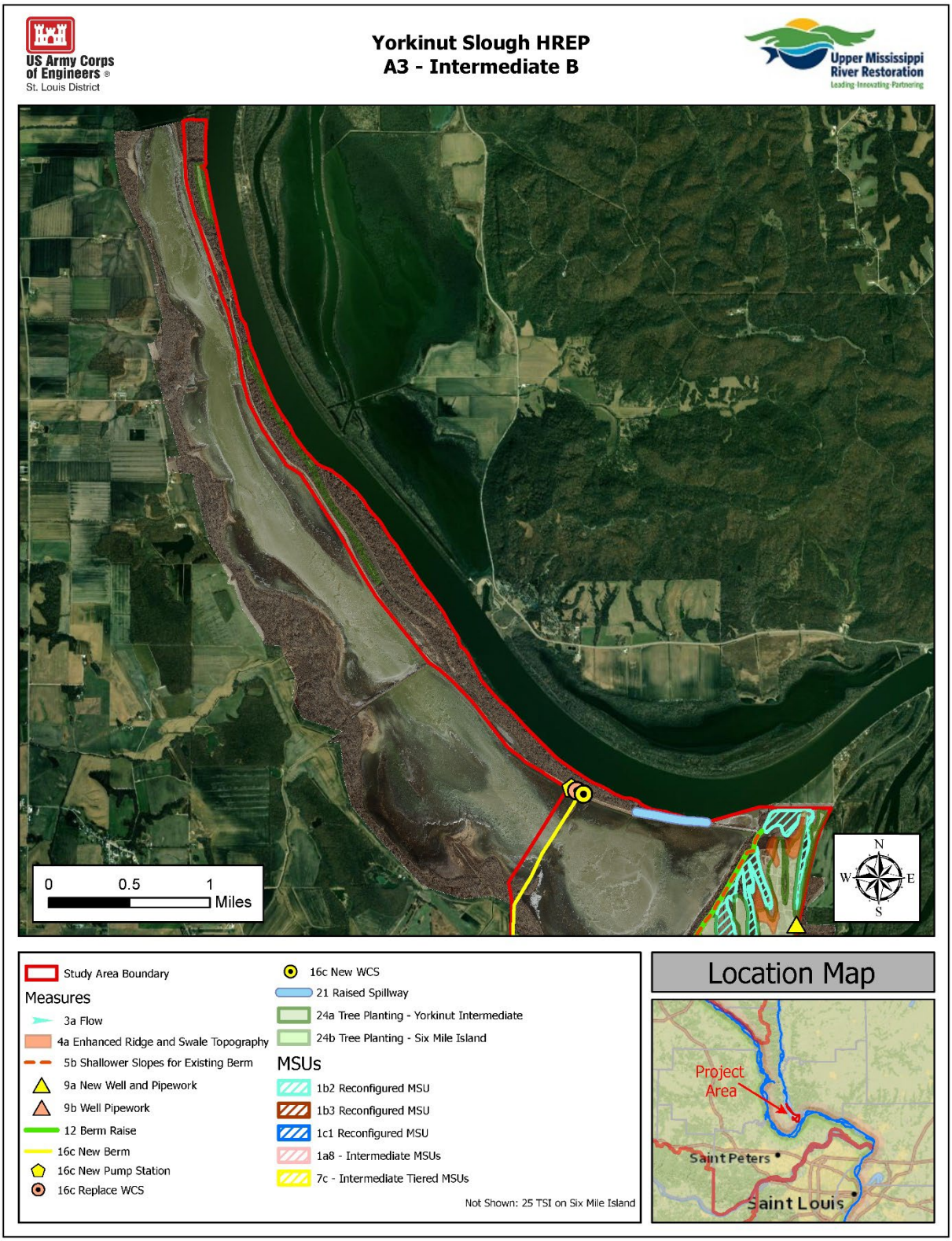

Figure 23. Alternative 3 Intermediate B – Six Mile Island Measures

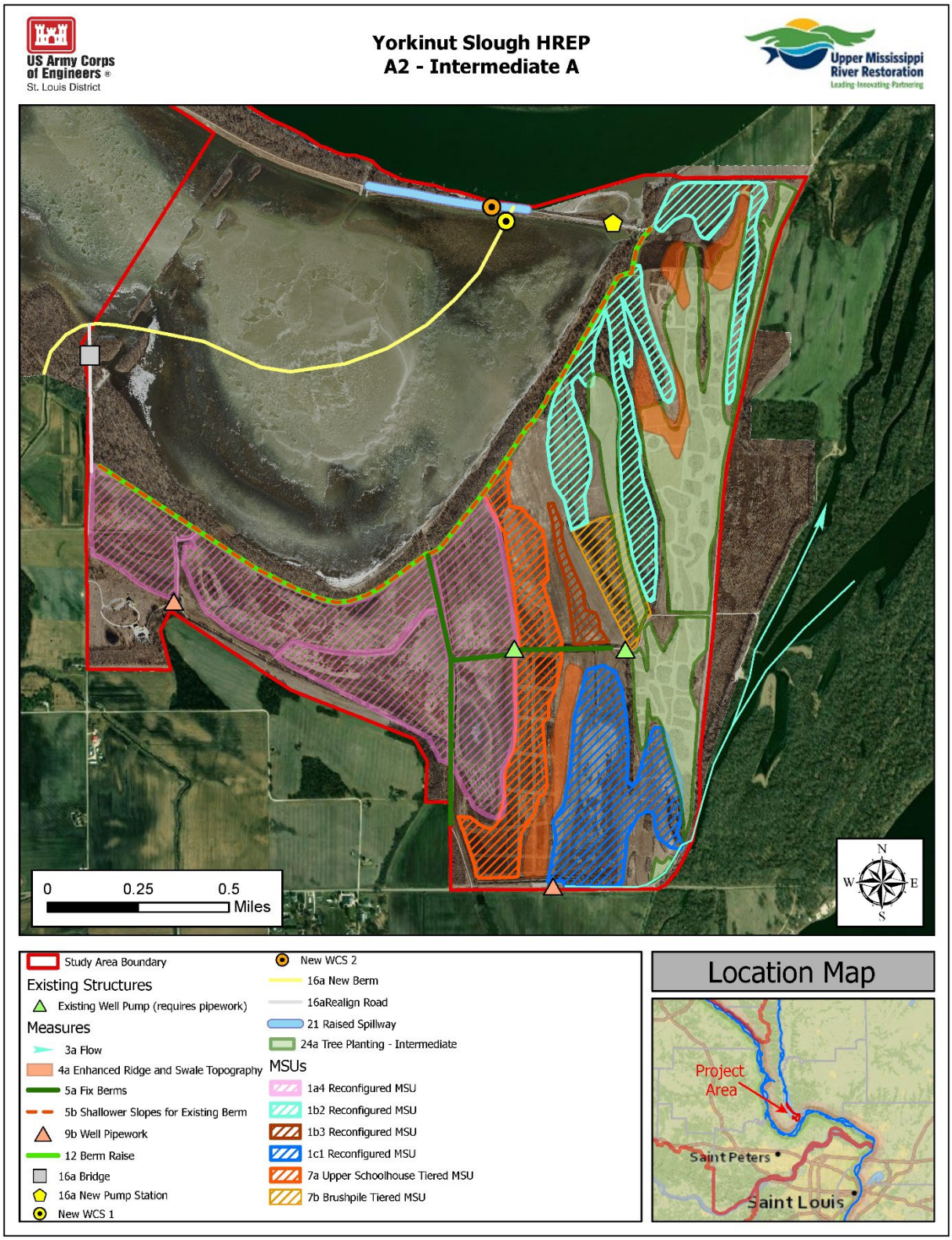

Figure 24. Alternative 2 Intermediate A

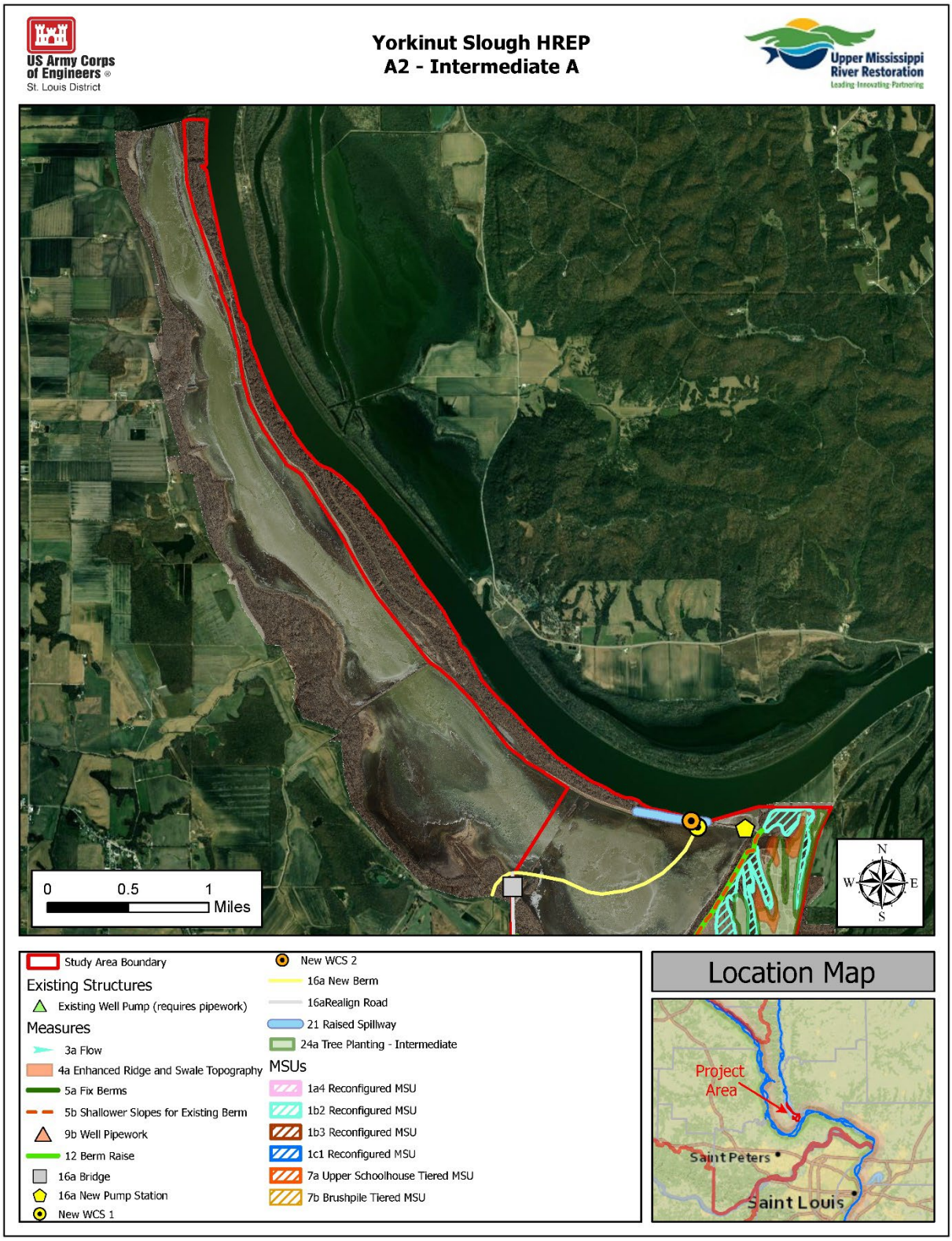

Figure 25. Alternative 2 Intermediate A – Six Mile Island Measures

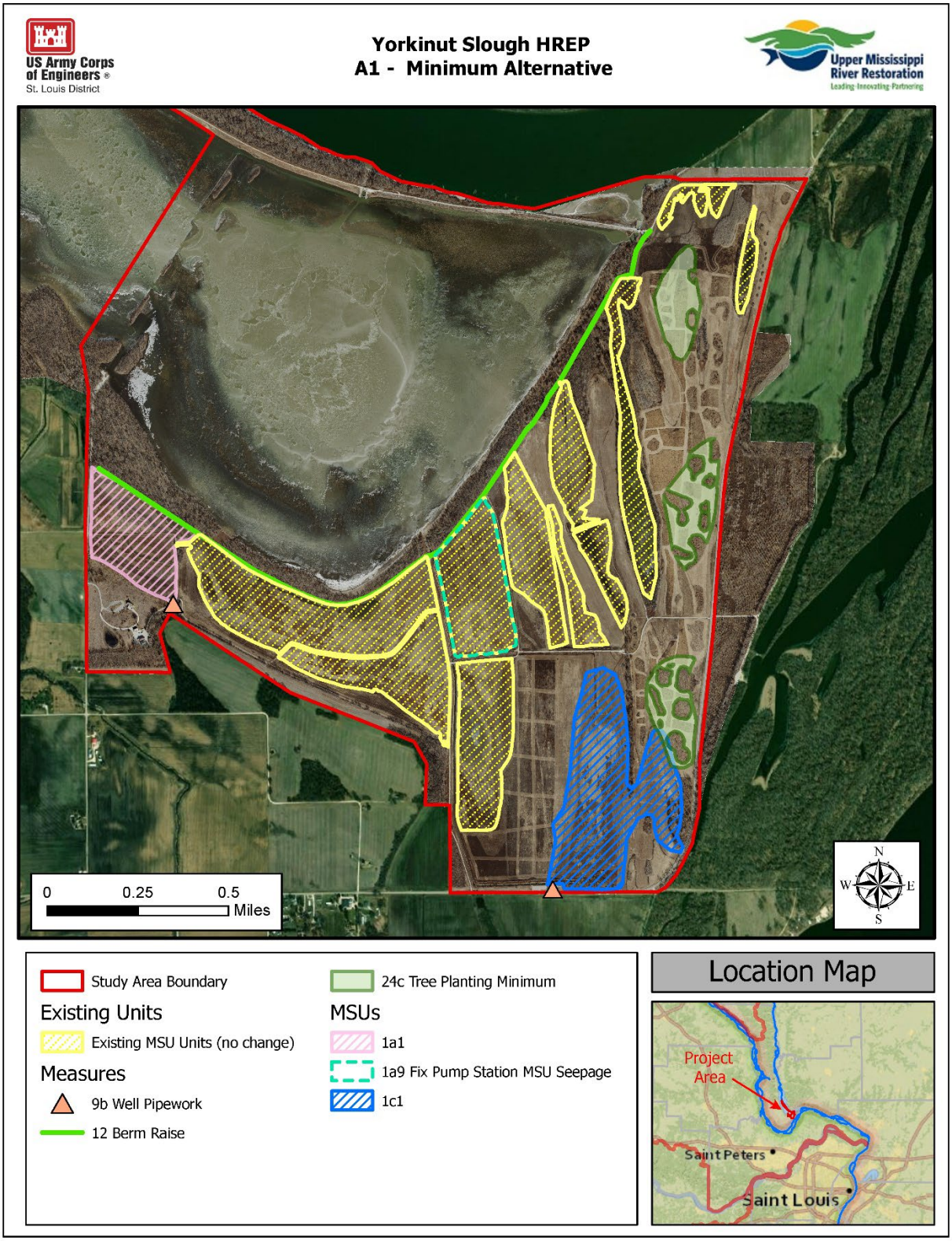

Figure 26. Alternative 1 Minimum

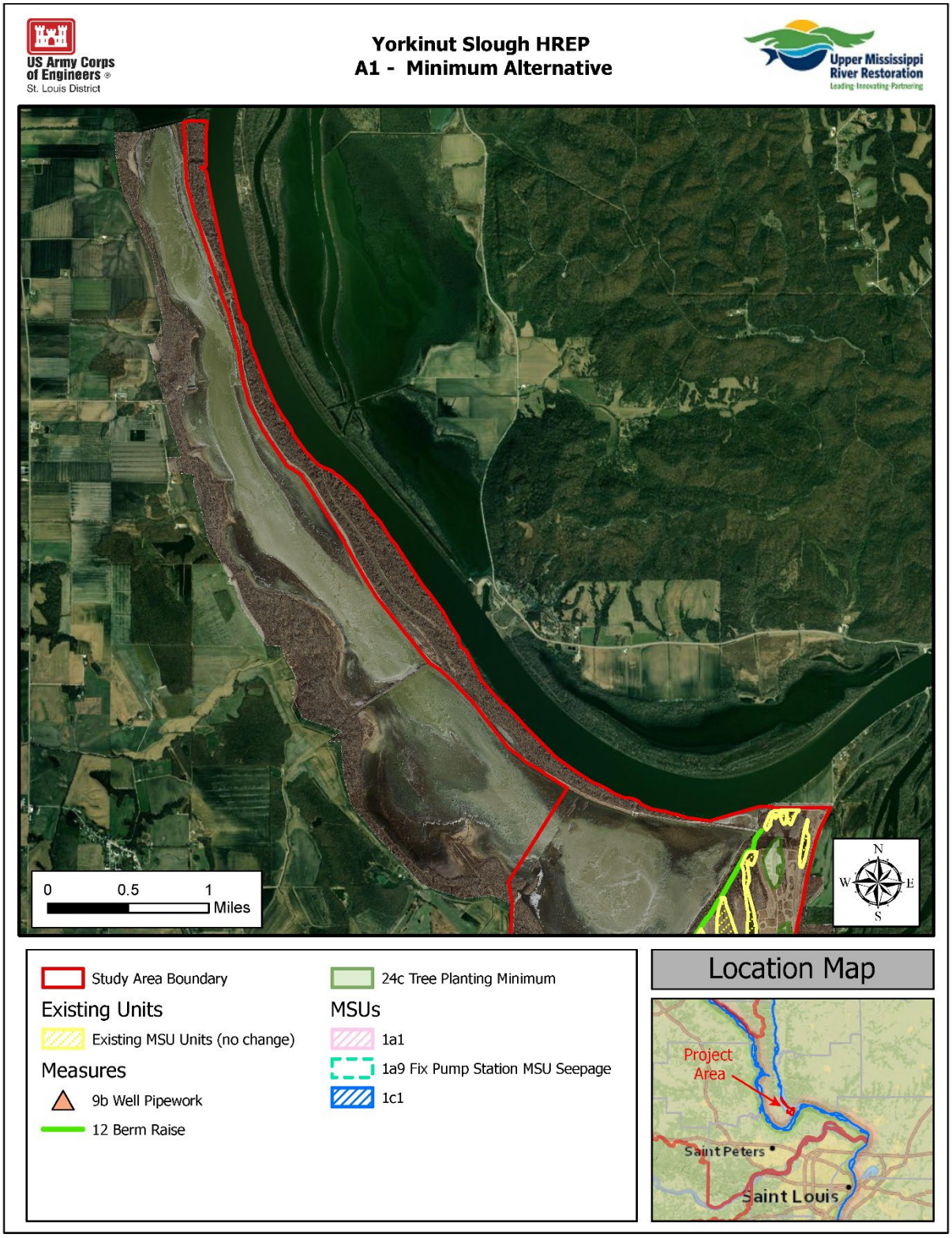

Figure 27. Alternative 1 Minimum – Six Mile Island Measures (none)

CHAPTER 5- EVALUATION AND COMPARISON OF FINAL ARRAY OF ALTERNATIVES

This chapter describes the process and methods utilized to evaluate the final array of alternatives for Yorkinut Slough HREP. The evaluation included use of Habitat Evaluation Procedures (HEP) and development of parametric cost estimates. HEP outputs and costs were entered into IWR Planning Suite Cost Effective/Incremental Cost Assessment (CE/ICA).

A. Habitat Benefits Evaluation

Habitat Evaluation Procedures (HEP; USFWS 1980a) is a habitat-based evaluation methodology used in Project planning. The procedure documents the quality and quantity of available habitat for selected wildlife species. The HEP is based on the assumption that habitat for selected wildlife species can be described by a Habitat Suitability Index (HSI). This index value (from 0.0 to 1.0) is multiplied by the area of applicable habitat (acres) to obtain Habitat Units (HUs). Additionally, HUs were calculated for certain target years based on the HSI model and averaged over the 50-year life of the Project to provide Average Annual Habitat Units (AAHUs). HEP procedures were used to evaluate the effects of the Project measures and summarized by alternative grouping. Two approved and certified [per EC 1105-2-412] HSI models were utilized for the HEP analysis including UMRS Floodplain Forest Model and Duck Use Days model.

This assessment includes a summary of the existing biological conditions used in the evaluation, as well as a forecast for future conditions (both benefits and impacts of measures) under the No Action Alternative and each potential action alternative. Habitat benefits for each habitat type is calculated using a combination of habitat quality and quantity metrics from USACE certified species or habitat models. In this study, potential benefits in two primary habitat types were assessed by a multi-agency team that included representatives from the District, USFWS Southern Illinois Ecological Services Sub-Office, and the Sponsor.

Floodplain forest and floodplain woodland benefits were quantified using the UMRS Floodplain Forest Model.

Floodplain forest changes in HUs are forecasted to occur as the habitat matures naturally or is influenced by forest stand development. These changes influence the cumulative HUs derived over the period of analysis (50 years). HUs were calculated for select target years and annualized using the IWR Planning Suite II tool annualizer over the period of analysis to derive a net Average Annual Habitat Unit (AAHU) quantity. By using target years, AAHUs were annualized using a linear interpolation approach, essentially drawing a straight line between target years, and then calculating the area under the curve for the resulting planning horizon benefit curve. Resulting net AAHUs are used as the output measurement to compare alternatives for the Project.

Emergent wetland benefits were quantified using a habitat-based waterfowl bioenergetics model (Heitmeyer, 2010). The Duck Use Days model estimates the potential food value of existing or projected habitat cover and uses known caloric needs of waterfowl species to calculate the potential carrying capacity of a site. The model is being used outside of its approved region, but is applicable to the study area due to overlap in habitat type and dominant food variables utilized in model calculations. The model author concurs with the use of the Duck Use Days

model for this Project (Mickey Heitmeyer, Greenbriar Wetland Service, Advance, Missouri, personal communication) and the study team received approval, on March 01 2022, from ECO-PCX for one-time use. Existing and proposed emergent wetland habitat was assessed with this model using emergent vegetation seed production to estimate available food for migratory wildlife. Primary bird use is correlated with seed availability provided by emergent wetland species and reflects management capabilities within the Refuge. Duck-use-days values were then converted to an index (0 to 1) by evaluating current or potential food value relative to the maximum potential output. This was done by dividing the current or projected seed production values for a unit from high-quality managed emergent wetlands from the Illinois River Valley (values referenced in model documentation). This value was also comparable to nearby, intensively managed high quality MSUs and therefore the interdisciplinary study team determined that this is representative of the maximum regional potential for emergent wetlands.

A summary of the habitat analysis is provided in **Table 17**; additional details are provided in *Appendix B – Habitat Evaluation and Quantification*.

Table 17. Habitat Types and Area Evaluated for Final Array of Alternatives

Habitat Type	Evaluation Area	Area (acres)	Habitat Suitability
Wetland	Moist-soil/Old-fields below 425' NGVD 88	532	Duck Use Days
Forest / Woodland	Old-fields above 425' NGVD 88	269	UMRS Floodplain Forest HSI
Forest / Woodland	Six Mile Island	632	UMRS Floodplain Forest HSI
TOTAL		1433	

Table 18 summarizes the benefits for each alternative to be carried forward for CE/ICA. Complete documentation of the habitat benefits analysis is provided in *Appendix B – Habitat Evaluation and Quantification*.

Table 18**.** Total AAHU Outputs Per Final Array of Alternatives

Alternative #	Alternative	Acres	Forest Habitat	Wetland AAHU	Total AAHU
A4	Maximum	1433	297	301	598
A3	Intermediate B	1433	269	294	563
A2	Intermediate A	800	151	244	395
A1	Minimum	800	31	87	118

AAHU- Average Annual Habitat Units

A. Cost Estimates

Cost estimates for alternative comparison were prepared using January 2023 price levels; annualized costs include construction costs, contingency costs, adaptive management costs and O&M costs. Project measures are on federal lands; consequently, there are no lands and damages or relocation costs. Total Project costs were annualized based on the Fiscal Year 2023 discount rate of 2.5% and a 50-year period of analysis. Interest During Construction (IDC) was calculated using end of year compounding based on a 2-year period of construction, using the Fiscal Year 2023 discount rate of 2.5%. A more detailed breakdown of costs is outlined in Appendix O - Cost. **Table 20** shows the estimated cost of the alternatives as of completion of the habitat analysis and for use in the comparison of alternatives, prior to selection, refinement, and developing a full cost estimate of a TSP.

B. Comparison of Final Array of Alternatives

Cost Effective Incremental Cost Analysis

IWR Planning Suite software was used to complete a Cost Effective and Incremental Cost Analysis (CE/ICA) for the five alternatives (including the No Action Alternative), using the AAHUs and annualized costs described in this section. The CE/ICA is used when project benefits are not measured in dollars and is used to ensure the least cost alternative is identified for each possible level of environmental output, and the maximum level of output is identified for any level of investment. Cost Effectiveness evaluation is used to identify the least costly solution to achieve a range of project benefits; the Incremental Cost Analysis identifies the subset of cost-effective plans that are superior financial investments, called “Best Buys,” through analysis of the preliminary incremental costs. Best Buys are the plans that are the most efficient at producing the output variable or provide the greatest increase in AAHUs for the least increase in preliminary cost. The first Best Buy is the most efficient plan, producing output at the lowest incremental cost per unit. If a higher level of output is desired than that provided by the first Best Buy, the second Best Buy is the most efficient plan for producing additional output, and so on.

The CE/ICA analysis evaluated five possible alternatives (**Table 19**).

Table 19. Cost Effectiveness Analysis Results on Final Array of Alternatives

Alternative	Alternative Description	Net Annual AAHUs	Project First Cost	Annualized Cost	Annualized Cost per AAHU	Cost Effective
1	No Action	0	$0.00	$0.00	$-	Best Buy
2	Maximum	598	$41,516,555	$1,493,996	$2,498	Best Buy
3	Intermediate B	563	$27,325,233	$983,149	$1,746	Best Buy
4	Intermediate A	395	$25,737,198	$926,031	$2,344	Cost Effective
5	Minimum	118	$3,116,522	$111,737	$947	Best Buy

Figure 28 shows the alternatives differentiated by cost effectiveness. From this list of five alternatives, two cost effective plans (including the No Action Plan) and three Best Buy Plans were identified.

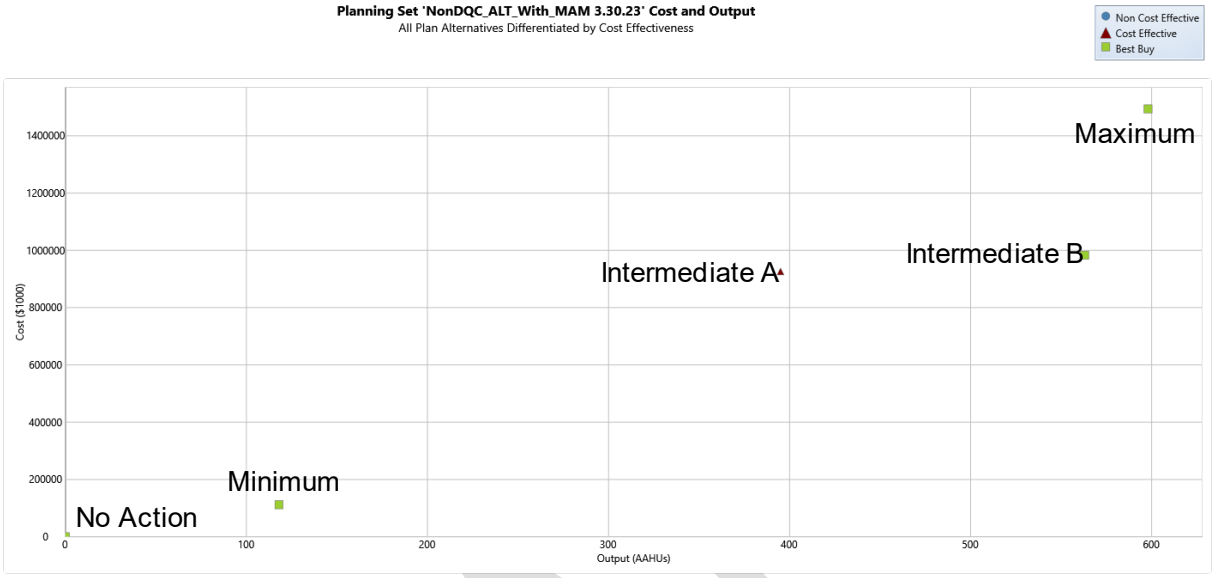

Figure 28. Cost Effectiveness Graph for Final Array of Alternatives

The Intermediate A alternative was screened from further consideration; it is a cost-effective alternative but the other alternatives are more effective at achieving habitat benefits. The three Best Buy alternatives were carried forward for further analysis; these were analyzed to determine which had the lowest incremental cost for each additional increment of output. **Figure 29** presents the alternatives' 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 the Minimum, which has an annual cost of $947 per AAHU. The next Best Buy is Alternative 3 Intermediate B, which has an annual cost of $1,746 per AAHU. The last Best Buy is the Maximum Alternative, which has an annual cost of $2,498 per AAHU.

The No Action Alternative does not include any measures or provide any AAHUs. The No Action Alternative would have no financial cost to the federal government, but does not meet any of the project objectives. Continued high water events would cause ongoing stresses to habitat and management as described in Chapter 3.

The Minimum Alternative would provide a total of 118 AAHU gain over the No Action alternative. While this alternative has a low incremental cost of $947 per AAHU, this alternative would only contribute minimally to the three objectives, adding only small increases in wetland habitat and MSU management (in the new combined Duck Club + Office MSU and Pump Station MSU) and forest habitat (minimal tree planting configuration).

The Intermediate B Alternative would provide a total of 563 AAHU, a net gain of 445 AAHU when compared to the Minimum Alternative. The incremental cost to capture the 445 additional AAHU is $1,958. This alternative would contribute meaningfully to all of the objectives, is a Best Buy plan, and has a low incremental cost, and would be worth the investment.

The Maximum Alterative would provide a total of 598 AAHU, a net gain of 35 AAHU when compared to Intermediate B alternative. The incremental cost to capture the 35 AAHU is $14,596. This alternative represents the maximum contribution towards meeting the objectives but there is a very high incremental cost to capturing the benefits above those in the Intermediate B alternative. The study team and the Sponsor felt that the large increase in federal costs and O&M costs to maintain and operate the additional measures could be better utilized in a different area and therefore was not worth the investment, and that the O&M needed would be a heavy burden for Refuge staff.

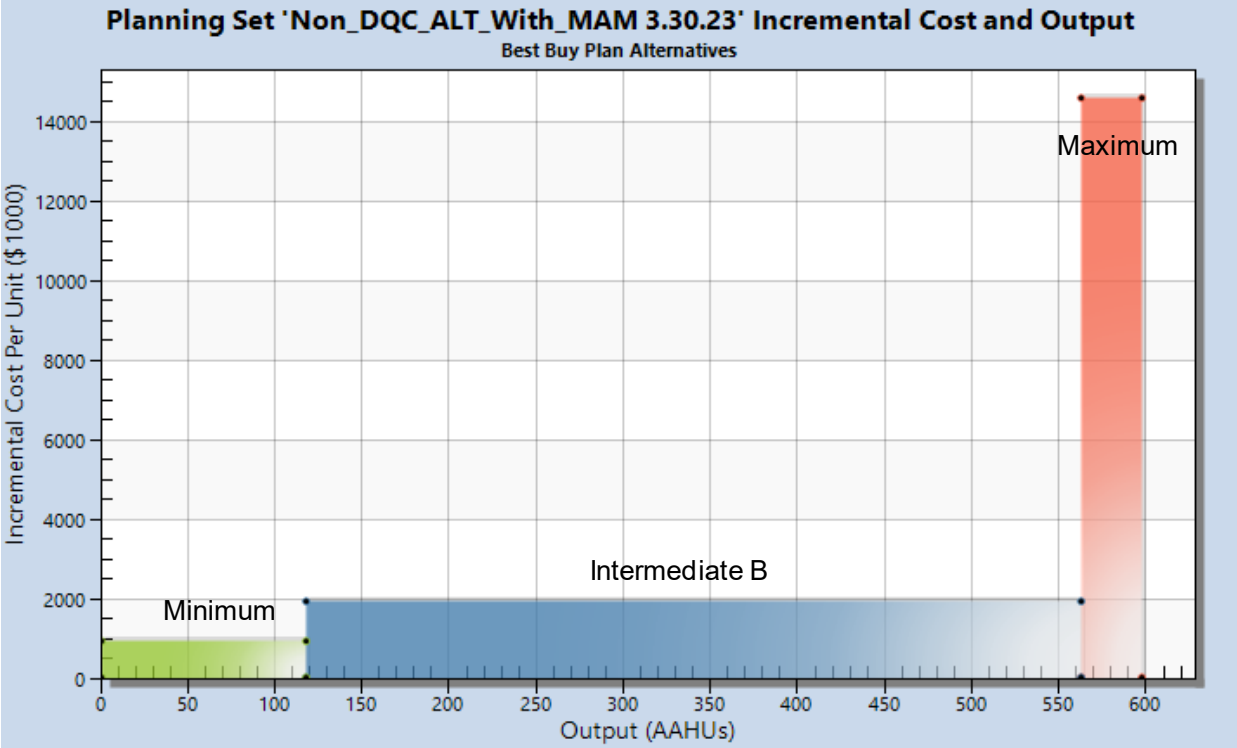

Figure 29. Incremental Cost and Output Results for the "Best Buy" Plans

Comprehensive Benefits

USACE is required to comprehensively evaluate and provide a complete accounting, consideration, and documentation of the total benefits of alternative a full array of benefit categories: NER/NED, regional economic development, other social effects, and environmental quality (ASA(CW)Memorandum, SUBJECT: POLICY DIRECTIVE – Comprehensive Documentation of Benefits in Decision Document, 5 January 2021). Alternatives were assessed to determine if they have net benefits in total and type in each benefit category. Judgement was made in coordination with the Sponsor and non-federal partners and in consideration of other study interests and stakeholders, using available data, analysis, input from peer review, and professional judgement. The Intermediate B alternative was identified as the plan that maximizes net total benefits across all benefit categories. **Table 20** 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 19. Summary of Comprehensive Benefits across P&G accounts

Alternative	NED	RED	EQ	OSE
No Action	High	Low	Low	Low
Minimum	High	Low	Moderate	Low
Intermediate B	High	High	High	Low
Maximum	Low	High	High	Low

National Ecosystem Restoration (NER)/National Economic Development (NED) Account

The National Ecosystem Restoration (NER) account identifies quantified habitat benefits against project costs to determine cost per AAHU; this is determined via alternatives found to be Best Buy under the CE/ICA analysis as described in the **Cost Effective Incremental Cost Analysis** section. The No Action, Minimum, and Intermediate B alternatives were rated "High" because they had an incremental cost of under $2,000 per AAHU; no alternatives were rated "Moderate" with an incremental cost of $2,000-4,000; the Maximum alternative was rated "Low" because it had an incremental cost of more than $4,000 ($14,596).

In terms of NED effects, 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 this 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 costs.

Regional Economic Development (RED Account)

The RED account is intended to illustrate the effects the alternatives will have on regional economic activity, specifically, regional income and employment. While a detailed regional economic development analysis was not performed for any of the alternatives, it is generally accepted that the ecosystem restoration projects that are part of the HREP have contributed RED benefits in small ways as each project is constructed. Over a longer term, ecosystem restoration projects contribute to RED benefits on a larger scale by creating added eco-tourism opportunities and increasing economic opportunities in local communities along the entire UMR system. UMRR, through its 35-year history, has created thousands of employment opportunities related to HREP planning, construction, and evaluation; Long Term Resource Monitoring (LTRM) and research. Once completed, habitat projects create new or improved outdoor recreation opportunities, further stimulating local and regional expenditures. A RED analysis will be completed prior to approval of a Final decision document. For Table 20, RED benefits were assumed to be proportional to total project costs (Low - <$10M, Moderate - $10-20M, High - >$20M).

Other Social Effects (OSE Account)

The OSE account is intended to illustrate the effects the alternatives will have on lives of residents and the social fabric of communities in the study area. The OSE account assists in plan formulation and in choosing an alternative that maximizes social benefits. Ecosystem restoration projects such as this one typically have positive net effects on the OSE account.

Quality of life variables such as health and safety, material well-being, and social connectedness are improved as a result of HREP projects. Recreational opportunities would be improved in the study area because of improved habitat diversity for wildlife and hunting under any of the action alternatives. While the OSE benefits may be slight or difficult to measure for any individual HREP project, taken as a whole, the numerous completed restoration projects over 35 years of the UMRR program have greatly enhanced social factors in the UMR system. All action alternatives considered would contribute positively and somewhat similarly to social benefits and as such, OSE is not a useful metric for comparison of the final array of alternatives. Therefore all alternatives are rated Low under OSE in Table 20.

Environmental Quality Account

The EQ account measures effects on ecological, cultural, and aesthetic resources. For ecosystem restoration projects such as this one, contributions to the EQ account are detailed both through NEPA compliance and through calculation of net ecosystem benefits. Here, NEPA compliance is achieved by integrating an EA into this feasibility report, with a qualitative summary of environmental effects detailed in Chapter 5 of this report. A calculation of net ecosystem benefits was completed through the use of HEP and HSI models. The quantitative results of the evaluation are contained in *Appendix B – Habitat Evaluation* and *Quantification*. The credit for the EQ account is the quantified benefits resulting from the Project (AAHUs). Intangible and or non-quantifiable environmental benefits associated with the alternatives are assumed to increase proportionally relative to the AAHU outputs associated with each alternative. In Table 20, the Minimum alternative was rated as Low because it contributes <250 AAHUs, the Intermediate alternative was rated as Moderate because it contributes 250-500 AAHUs, and the Intermediate B and Maximum alternatives were rated High because they contribute >500 AAHUs.

CHAPTER 6- TENTATIVELY SELECTED PLAN (TSP)

A. Description of TSP- National Ecosystem Restoration Plan

The alternative plan that reasonably maximizes benefits in relation to cost and meets the overall planning objectives is Alternative 3 Intermediate B, which was selected as the National Ecosystem Restoration Plan (NER Plan). The Tentatively Selected Plan was approved by Mississippi Valley Division during the TSP milestone briefing held on January 25, 2023. When viewed relative to the preliminary costs of similar ecosystem restoration projects, the cost per AAHU of Alternative 3 is efficient in achieving the ecosystem restoration objectives. The TSP is supported by the USFWS and is consistent with regional and State plans for the area.

After the Tentatively Selected Plan (TSP) was selected a more refined plan was developed and is documented in this chapter of the report. The TSP is shown in **Figure 30** and **Figure 31**, and includes the following components that comprise the measures:

- Berm construction and associated earthwork (approximately 12 acres)
- Berm enhancement and associated earthwork (approximately 8 acres)
- Berm deconstruction and associated earthwork (approximately 21 acres)
- Remove seven water control structures

- Install 10 water control structures
- Install 2 well pumps
- Well pump pipe installation (approximately 5400 ft.)
- 1 large gravity structure (~16' wide)
- Install 1 pump station
- Excavate 27 acres of channel
- Remove 13 acres of channel
- Excavate/re-grade acres of emergent wetlands (included in channel excavation acreage)
- Tree planting (approximately 215 acres)
- Clearing and grubbing (approximately 5 acres)
- Timber stand improvement (approximately 632 acres)

Construction of the TSP offers an opportunity to more closely mimic the historic, hydrological periods (i.e., summer low-water period followed by winter/spring high-water period) that many floodplain species are adapted to by improving water management capacity and flexibility. As a result, the quality and quantity of emergent wetland, floodplain forest, and floodplain woodland would increase through Project measures. Study area habitat restoration through Alternative 3 Intermediate B is preferred compared to other alternatives due to the degree of improvements to significant resources (institutional, public, and technical) in comparison to cost.

The Intermediate B alternative would help Two Rivers NWR better simulate natural flood and drainage regimes through modifications to existing water control structures, drainage channel, unit berms, and construction of well pumps and one pump station. Together, these measures help to ensure that water can be managed at optimal depths and removed before the growing season or quickly after floods to support high quality habitat for migratory birds (waterbirds and landbirds). This supports the significant institutional resource set forth in the MBTA; EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds; The Bald and Golden Eagle Protection Act of 1940 and the Fish and Wildlife Coordination Act, as amended (16 U.S.C. § 661). Additionally this alternative supports public resource significance by improving the quality of habitats which would better support the bird taxa (i.e. waterfowl, shorebirds, and migrant landbirds) that led to the Important Bird Area designation by the National Audubon Society. The improved habitat quality of the project area would improve recreational opportunities for hiking, bird watching, photography, and waterfowl hunting in the area.

Emergent wetlands will be restored by realigning unit berms along elevational contours, updating water controls structures to better manage water after flood events, and improving well pump capacity to reach desired water levels to promote high quality emergent wetland habitat that supports the critical life stages of wildlife. Improved management capabilities would help to maintain and improved emergent wetland habitat quality which has declined regional. This complements the significance of area wetland resources identified in the U.S. FWS *Two Rivers NWR Habitat Management Plan* (2011), *Waterbird Habitat Conservation Strategy* (2018), *North American Waterfowl Management Plan* (2017), Stafford et al. (2007), and partnership work between Ducks Unlimited and the Refuge to conserve, restore, and manage wetland habitats for migratory waterfowl and waterbirds.

TSI, including selective tree, shrub, and vine removal, would improve horizontal and vertical structural diversity of the floodplain forest. Forestry measures would improve conditions for

natural recruitment and increase age and species diversity. Tree planting would improve underrepresented forest communities that have declined as a result of unsuitable light conditions (hard-mast, cottonwood, sycamore, and some soft-mast species), competition from shade-tolerant species, or low propagule number (seeds from suitable seed sources under natural conditions). Enhanced water level management capabilities would reduce growing season stress on planted trees which would result in healthier forest conditions long-term. These anticipated improvements would help the refuge meet agency management goals as well as interagency management goals for UMRS forests (Guyon, Deutsch, Lundh, & Urich, 2012), habitat management for forest landbird species of continental or regional concern (Rosenberg, et al., 2016); (PIF 2020), and maintenance, diversification (structure and species) and expansion of forest area (Soulliere, et al., 2020). Collectively, the changes in forest and woodland conditions are expected to increase habitat suitability and resiliency for a wide diversity of migratory landbirds in an area that has been identified for its importance to migratory landbirds in the state (NAS, 2009).

A summary of quantities for the TSP measures is shown in **Table 21.** Further details of quantities and design for the TSP can be found in *Appendix I – Civil Engineering*.

Table 20. Summary of Quantities for the Tentatively Selected Plan Measures

Location/Measure	Length (Linear Ft)	Cut Volume (CY)	Fill Volume (CY)	Seeding (Acres)
Berm Creation	8,100		52,935	13
Berm Enhancement	8,900		21,424	5
Berm Removal	5,950	23,467		21
Improved Drainage	10,750	94,726		17

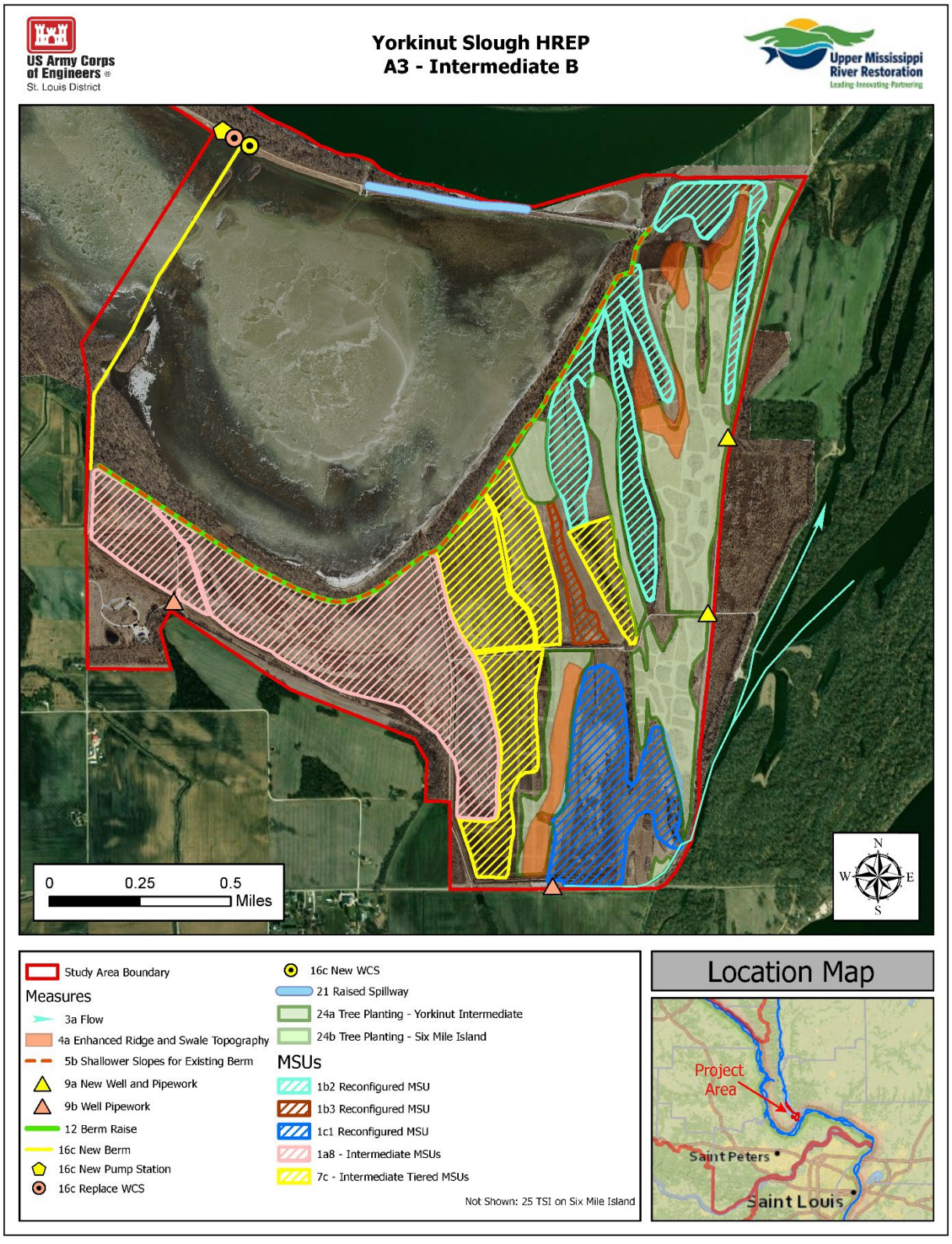

Figure 30. Alternative 3 Intermediate B – Tentatively Selected Plan (Yorkinut Slough view)

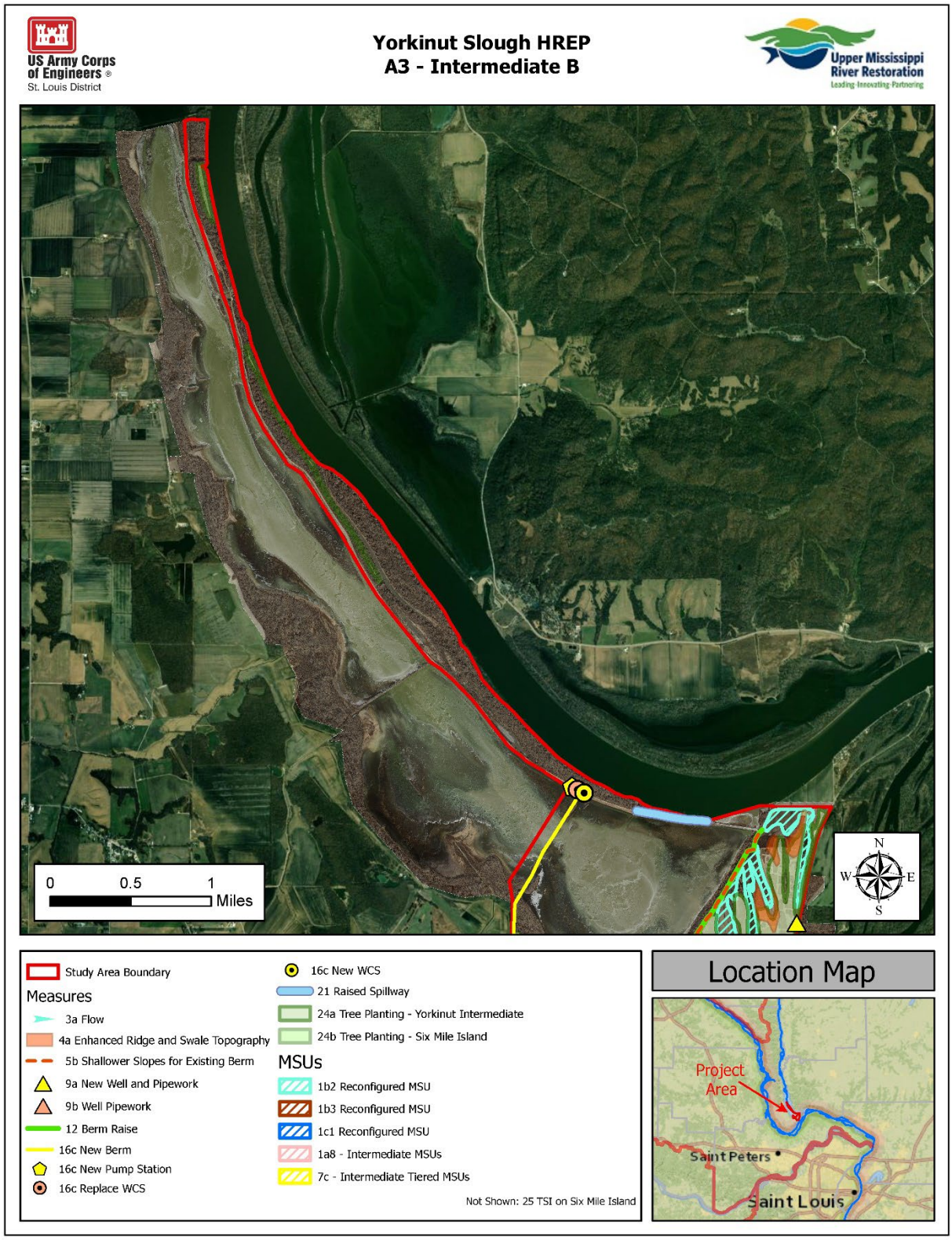

Figure 31. Alternative 3 Intermediate B – Tentatively Selected Plan (Six Mile Island view)

B. Real Estate

All Project lands are owned by the federal Government and managed by USFWS who is serving as the federal partner. USACE reserves all land rights that are not specifically granted per the terms of the applicable Cooperative Agreement.

This Project does not require the acquisition of any real estate. There is no cost for the Special Use Permit as stated in the Amended Cooperative Agreement between the Department of the Army, USACE, and the Department of the Interior, U.S. Fish and Wildlife Service. Therefore, no cost estimate for real estate acquisition will be prepared.

This project will not induce flooding.

A draft Real Estate Plan is included as *Appendix N – Real Estate Plan*.

E. Implementation Schedule

A proposed Project implementation schedule is shown in **Table 22**.

Table 21. Project Implementation Schedule

Event	Scheduled Date
Public Review of Draft Report	May 2023
Submit Final FR/EA to MVD	August 2023
Approved Final FR/EA from MVD	Fall 2023
Execute the Memorandum of Agreement with the Sponsor	Fall 2023
Initiate Design Contracts	Fall 2023

*Further data collection needs, scope changes, design complications, etc., can and will affect the schedule.

Further details of quantities and design for the TSP can be found in *Appendix I – Civil Engineering*.

F. Relationship of the TSP to Land Use Plans

The Project will not change the use of any floodplain or aquatic resources. If implemented the USACE does not expect the proposed action to alter or conflict with other authorized projects and land use plans guiding resource management within the study area. The Yorkinut Slough HREP problems and stressors were aligned with Habitat Needs Assessment II goals, Project objectives, and primary habitat and priority resources of concern documented in the NWFR Habitat Management Plan identified in **Table 1**.

G. Environmental Effects of the TSP*

The following sections and **Table 23** below describe the potential environmental effects (both adverse and beneficial) of the TSP on the resources addressed in **CHAPTER 3- EXISTING CONDITIONS AND FUTURE WITHOUT PROJECT CONDITIONS.** The No Action alternative describes a scenario without intervention, where continued flooding resulting from riverine and

upland sources continue to degrade both aquatic and floodplain forest resources in the study area. Some emergent wetlands are expected to convert to open water habitats or other plant communities that would provide minimal habitat for waterbirds and other wildlife. Floodplain forest would continue to degrade because of increased tree mortality and conversion to Japanese Hops or other invasive species. Hard-mast woodlands would continue to be limited because of low seed availability, plant competition, and lack of suitable disturbance. The effects described in the following sections may be temporary or long-term in duration. Minor effects are typically considered negligible, while moderate adverse effects may be either avoided or counteracted by other actions that further enhance or benefit the resource. According to NEPA guidance, the meaning of significant effects varies with the context (where the action occurs) and intensity (how much damage or improvement the action causes). “No effect” means there is no substantial change to the resource, while significant effects may be beneficial or adverse. The effects of the TSP may furthermore occur immediately because of the action (direct), occur later in time, or removed in distance in response to the action (indirect), or may be reasonably expected to occur, given similar restoration actions within the UMRR Program (cumulative).

Table 22. Summary and Comparison of Environmental Effects of the TSP

Environmental Effects	No Action	Intermediate B
Management & Land Use	Negative	Positive
Hydrology and Hydraulics	Negative	Positive
Wetland	Negative	Positive
Floodplain Forest	Negative	Positive
Geology and Soils	No effect	No effect
Wildlife	Negative	Positive
Illinois Resources of Concern	No effect	Positive
Federal Threatened and Endangered Species	Negative	Positive
Invasive Species	No effect	Positive
Water Quality	Negative	Positive
Air Quality	No effect	No effect
Climate Change	No effect	No effect
HTRW	No effect	No effect
Historic and Cultural Resources	No effect	No effect
Socioeconomic Resources	No effect	Positive
Aesthetic Resources	No effect	Positive
Noise Levels	No effect	No effect
Environmental Justice	No effect	No effect

1 Short-Term Construction Effects

Construction of the TSP would take place completely on federal land within the Two Rivers National Wildlife Refuge. No measurable change in floodplain storage would occur as a result of the TSP, and the Project would not directly induce additional development/construction within the floodplain. Additional information is provided in *Appendix G – Hydrologic and Hydraulic Engineering* and *Appendix D – Clean Water Act Section 404(B)(1) Evaluation*.

Staging areas and access to the site for construction would occur on publicly owned land within the study area. Use of existing roads would be utilized to reduce potential environmental impacts. Temporary disruption of traffic may occur related to increased travel for staging and construction area but would return to preconstruction conditions once construction is complete.

Temporary increases in turbidity, dust, and noise because of construction activities will occur. Additionally, wildlife may be temporary disturbed during construction. Benthic organisms may be lost in the footprint of new berms. Native seed would be used to revegetate disturbed areas after construction. Restoration of hydrologic conditions after construction completion will result in the rapid recolonization of benthic organisms.

Due to the potential presence of several USFWS and IDNR threatened and endangered species, seasonal construction restrictions would be implemented to avoid and minimize potential impacts.

2 Management and Land Use

The TSP would result in positive impacts to management in the study area. Berms would be reconfigured to more closely follow natural elevation contours which would improve water conveyance in units. The separation of upland runoff will reduce the total volume of water needing to be drained before water can be managed in the study area. The total number of structures would be reduced by 3 structures compared to current conditions and 4 water control structures would be replaced to achieve water level management goals. The addition of two well pumps to the site would improve water supply capacity to fill and maintain units to seasonal target levels. The addition of a pump station and water control structure on the Illinois River Berm would increase capacity to manage water levels after flood events from upland runoff, the river, and in the spring. Overall, proposed measures in Alternative 3 Intermediate B would improve management efficiency and capacity of Refuge staff to meet water level management goals throughout the year.

3 Hydrology & Hydraulics

Positive impacts would result from the TSP and associated management measures. Under construction of this alternative, berms and unit drainage would be reconfigured to follow on-site topographic patterns more closely. Reconfiguration of drainage would utilize construction of broad swales within units to improve drainage, enhance flow between units, and reduce operation and maintenance costs. The drainage from the County Road MSU would be realigned with the historical contours to flow towards Calhoun Point instead of through a drainage ditch through Yorkinut Slough and then to the Illinois River. The alignment would improve drainage rates, thus reducing flood impacts to units located at the southern boundary of the study area.

Berm reconfigurations would result in approximately 21 acres of berm deconstruction (5,950 linear ft) and placement of new berms on approximately 20 acres (17,000 linear ft). Seven water control structures would be removed from units and replaced with 11 structures with greater capacity. Ducks Unlimited is constructing two well pumps on site, rated at 3000 gallons per minute, which replaces two existing well pumps rated at 2000 gpm. The TSP would install two 3000 gpm well pumps and provide piping from Ducks Unlimited well pumps to units. Collective changes to well pumps will increase capacity and provide water to emergent wetland units in the eastern and northern portions of the study area. This addition would improve water supply rates for expanded units and allow the USFWS to achieve and maintain seasonal water level targets more quickly. The lowest section of Swan Lake may be managed independently of the rest of the Lake with the existing pump station and 16-foot stoplog structure, enhancing water level flexibility and reducing flood impacts to water level management. These changes would result in improved sheet flow and improve management flexibility, and reduce the time needed for the Refuge to meet seasonal water level targets within units. Sheet flow is the overland transport of rainwater where water pools on the soil surface and runs downhill. The improved sheet flow would enhance gradual flooding and drying of units which would be expected to result in more desirable plant response and development.

Alternative 3 Intermediate B would have a positive effect on hydrology and hydraulics and would not result in negative impacts to navigation or flood heights. Additional information is provided in *Appendix G – Hydrologic and Hydraulic Engineering*.

4 Aquatic & Wetland Resources

Construction of the TSP will result in temporary, short-term negative impacts to wetland resources due to construction activities. These temporary impacts would include localized increases in turbidity, disturbance to aquatic wildlife, and local aesthetics. Reconfiguration of unit berms would impact approximately 9.2 acres of wetlands through construction of berms, but this would be offset by deconstruction of 21 acres of existing berms which would be graded to surrounding wetland topography. In the long-term, the TSP would benefit 531 acres of wetland habitat, both directly and indirectly, through an increase in emergent wetland structure and function. Staging of equipment is expected to occur primarily along existing federal parking lots, access roads, or upland sites. However, temporary staging in moist-soil management areas may be required. Staging areas would be limited in size (< 0.5 ac) to minimize impacts and would be revegetated and returned to preconstruction drainage patterns once construction is completed.

Emergent wetland is a plant community type that is dependent on periodic disturbance, annual flooding in the fall, and an annual terrestrial period during the growing season to recruit and support emergent wetland species. The timing of these three factors as well as the rate of flooding and dewatering determines the species composition and habitat quality for migratory waterfowl and other wildlife. Management of water levels also influences the distribution, composition, and quality of habitats at higher elevations nearby. Proposed Project measures would improve natural sheet flow conveyance within units, reduce flood impacts from the river and upland runoff on management actions within the study area, and increase capacity to fill and drain units to desired levels according to annual Refuge wetland management goals. Together, the measures will improve the diversity of species and conditions supported in the Refuge, enhance access to food and cover for wildlife, and improve maintenance efficiency. The increased wetland diversity would provide habitat for a range of wetland dependent species, including aquatic invertebrates.

Overall, the wetland impacts would be outweighed by the restoration of emergent wetland habitat that would otherwise continue to degrade, resulting in lower diversity wetlands with low food resources for wildlife. Through the habitat evaluation and quantification process, the wetland habitat considered for the DUD model generated 294 net AAHU for the TSP (for more details refer to *Appendix B – Habitat Evaluation and Quantification*). Therefore, these alternatives would have a positive effect on aquatic and wetland resources. Additional discussion of aquatic and water quality impacts is contained in *Appendix D – Clean Water Act Section 404(B)(1) Evaluation.*

5 Floodplain Forest and Woodland

Floodplain forest in the study area has degraded as changing hydrological conditions favor more flood- and shade-tolerant species for regeneration resulting in stands becoming more uniform in species and structure and age class. This has resulted in an increase in less desirable species and the development of less suitable conditions for natural regeneration to occur. In addition, hard-mast species and Cottonwood are reaching the end of their typical lifespan, and Green Ash will become less abundant in the overstory as a result of expanding Emerald Ash Borer. Together a significant component of the overstory will succumb to age- or insect-related mortality during the period of analysis. Under the TSP, floodplain forest habitat is expected to improve, and floodplain woodland is expected to improve in extent and quality. The proposed timber stand improvement measure would increase horizontal and vertical structural diversity through removal of undesirable species that are more abundant , and that prevent suitable light conditions which support desired natural regeneration from occurring. Additionally, available ridges on the Six Mile Island would be utilized to enhance hard-mast species and early successional tree species (i.e., Cottonwood and Sycamore) abundance and extent on the island through creation of suitably-sized gaps to allow growth and development.

Floodplain woodland is limited in the study area and region by shade-tolerant species (i.e., Silver Maple) that prevent recruitment of hard-mast species and by flood-related stressors that reduces growth and survivorship. As a result, canopy cover and extent is lower than desired. Project measures that improve water level management capacity and capabilities (Resource 4, preceding section) would improve hydrologic conditions in the study area for hard-mast tree development and survival. In the FWOP condition, the areas identified for woodland plantings would continue as emergent vegetation cover that is inaccessible to migratory waterfowl or continue to be dominated by aggressive, annual herbaceous species because of frequent spring and fall flooding.

Approximately 5 acres of forest would be cleared to construct a pump station and gravity drain output channel on Six Mile Island that would improve water management capabilities in the emergent wetland area of the study area. The pump station would be used to manage water levels in Swan Lake in response to river flooding, upland flooding, and annual drawdowns to promote emergent vegetation for migratory waterfowl. Even though tree clearing is proposed during construction of Project measures, the measures would improve 943 acres of floodplain forest, 215 acres of floodplain woodland, and increase the extent of hard-mast and early successional species by a minimum of 50 acres on Six Mile Island. Therefore, the pump station and gravity drain installation measures would not be considered an impact as there would remain a net increase in forest resources. Through the habitat evaluation and quantification process, the UMRS Floodplain Forest I generated 269 net AAHU over the No Action Alternative (*Appendix B – Habitat Evaluation and Quantification*).

6 Geology & Soils

Temporary, minor impacts to geology and soils would be expected due to construction activities and Project measures. Excavating berms, water control structures, and regrading MSUs would impact existing topography and drainage. However, the current geology and soils within the study area have already been altered through agricultural activities and construction of original Refuge units. Thus, the TSP would have no effect on geology and soils long-term.

No impacts to acres that qualify as prime farmland would be expected because no prime farmland is currently used for agriculture within the study area; therefore, the Project would not contribute to conversion of farmland to nonagricultural uses.

7 Wildlife

7.1 Migratory Birds

Enhancement of emergent wetland habitat within the study area would directly benefit migratory waterfowl. Approximately 531 acres of emergent wetland enhancement would occur with the TSP. Reconfiguration of units resized water control structures, installation of two well pumps, and installation of one pump station would improve water level management capacity and flexibility by reducing flood impacts from the Illinois and Mississippi Rivers and upland runoff. This would result in high-quality emergent wetlands for migratory and resident waterfowl as well as other wildlife. Emergent wetland enhancement that would result from constructed measures in the TSP would result in increased vegetative diversity and acreage that provide valuable food and cover resources for migratory waterfowl.

Enhancement of forest and woodland resources would also occur in the study area as a result of Project measures. Timber stand improvement and tree planting would increase the species, horizontal, and vertical structural diversity in the study area. This would be expected to result in more diverse food sources for migratory landbirds, as individual species support different dependent insects. Many of the planted trees in woodland restoration areas would be bottomland oak species which are a limited resource in the floodplain. Additionally, oaks support a high diversity of insects which migratory landbirds depend on to sustain themselves during migration and breeding periods. Cottonwood and Sycamore as well as other more flood-tolerant species will be incorporated into plantings that occur in areas with longer annual average growing season inundation periods to increase forest diversity and resilience long-term. Cottonwood is an important species at maturity for a wide range of wildlife, including bats, raptors, and cavity nesting species due to its large size, growth habit, and bark characteristics. Without the Project measures, conditions would be less suitable for Cottonwood to establish and it would become less common in the study area and nearby floodplain forest. The proposed forest measures would enhance approximately 943 acres of existing forest and create an additional 215 acres of bottomland woodland. Therefore, the TSP would have a positive effect on migratory birds and other wildlife.

8 Illinois Resources of Concern

No Illinois Natural Area Inventory (INAI) sites occur in the study area or would be impacted by Alternative 3 Intermediate B. The two Illinois listed bats (i.e., Indiana and Northern Long-eared Bat) would likely benefit from the TSP through forest enhancement measures that increase structural diversity and age class diversity. Existing, preferred roosting tree species are succumbing to age-related mortality, but forestry measures in the TSP will help to ensure that suitable future roosting sites are developed and maintained. Proposed measures to improve emergent wetland habitat would likely benefit a variety of species of concern. The remaining state-listed riverine species would not directly benefit from Project measures due to the shallow nature of proposed wetlands in the study area, but Best Management Practices (BMPs) would be utilized during construction to limit potential impacts to these species. Once construction was

complete, aquatic conditions would be anticipated to return to preconstruction conditions. Therefore, no negative impacts to Illinois resources of concern are anticipated under the TSP.

9 Bald Eagle

One Bald Eagle nest is known to occur in the study area, and suitable nest trees exist within the vicinity of the study area. No forestry measures would be utilized within a buffer of at least 100 ft of a known Bald Eagle nest location. At least a 330 ft buffer would be utilized for TSI in locations where the eagle nest is not visible through a forested buffer. A 660 ft buffer would be utilized under instances of direct line of site according to the National Bald Eagle Management Guidelines. Staging of equipment would not be allowed within a 660 ft buffer of a known nest. Additional coordination with the USFWS would be conducted during the design phase to account for changes in condition and potential addition of nest locations in the study area prior to or during construction. Improvement of the forest resources within the study area would allow successful regeneration of hard mast trees as well as Cottonwood and Sycamore, which all provide valuable nesting habitat for Bald Eagles in the region. As a result, suitable nest trees would be recruited and be provided by study area resources for a longer duration than under the FWOP condition. Therefore, positive impacts to Bald Eagles with TSP will be expected.

10 Federally Threatened and Endangered Species

In accordance with the Endangered Species Act, a list of federally threatened and endangered species was obtained from the USFWS. This satisfies the "request for species list requirements" for ESA Section 7 Consultation. The Indiana Bat, Northern Long-eared Bat, and Decurrent False Aster are listed as federally threatened or endangered. In addition, Monarch is a candidate species, and the Tricolored Bat is proposed for listing as endangered. USACE prepared a biological assessment (*Appendix C – Biological Assessment*) and submitted it to the USFWS on 8 February 2023. Based on the information provided, USACE determined the Project *May Affect, but is Not Likely to Adversely Affect* the Indiana Bat, Northern Long-eared Bat, Tricolored Bat, Decurrent False Aster, and Monarch. A concurrence letter from the USFWS was received on xx March 2023 [expected to receive early March prior to public review] (*Appendix A – Coordination*)

11 Invasive Species

The effect of the Project on invasive species distribution and abundance were considered throughout the planning process. The District has weighed the benefits that this Project will have on invasive species, as well as to the native communities that it is intended to sustain and support.

The Project would buffer against Japanese Hops and Reed Canary grass population growth by managing canopy gap opening size and distribution in existing forests to promote tree growth which would shade and outcompete the species. Tree plantings in more open conditions have factored in canopy closure rates needed to suppress invasives and would be utilized for project implementation. Any disturbance has the potential to increase invasive species abundance in absence of management. Maintenance would be incorporated into post-planting to ensure tree development is adequate for suppressing invasives species in forest resources.

The proposed water management measures, including berms, water control structures, wells, and pump station will enhance the Refuge's management flexibility and capacity to aid in management of invasive species within emergent wetland units. This will occur in two primary ways. First, improved water level management will be used to exclude some invasive species with hydrological conditions that favor desirable, emergent wetland species. Second, the increased water level management flexibility will provide greater opportunity to drain locations and access sites for maintenance which will treat invasive species that establish before they become widespread. The enhanced ability to convey water is anticipated to enhance the USFWS ability to reduce Asian Carp abundance which has become a regional management issue. Overall, the Project is anticipated to increase the Refuge's efficiency and ability to treat invasive species in the study area.

12 Water Quality

Short-term minor increases in turbidity are expected to occur due to construction activities within the study area. Avoidance and minimization were utilized in development and analysis of alternatives and would continue to be utilized through implementation. Best management practices would be required during construction to reduce movement of sediments and nutrients to aquatic areas. As a result, these effects would be less than significant.

After construction, the proposed Project measures improve water management capabilities and restore emergent wetland, floodplain forest, and floodplain woodland communities, resulting in slightly improved water quality in the study area. These restored communities will filter nutrients and reduce sediment inputs to the Illinois River. Project measures would not be anticipated to affect water quality parameters that impact fish consumption recommendations. Overall, the TSP will have a positive effect on water quality; additional information is provided in *Appendix D – Clean Water Act Section 404(B)(1) Evaluation*.

13 Air Quality

Heavy machinery utilized during construction will result in minor temporary impacts during construction. BMPs will be utilized during construction to reduce impacts on air quality from fossil fuel combustion and emissions. At present, all levels for criteria pollutants are below USEPA air quality standards. Impacts to air quality would be localized and would not result in a change in attainment category. Any required air quality restrictions would be followed and implemented. Air quality would return to current conditions upon construction completion; therefore, no long-term impacts would occur.

14 Greenhouse Gas Emissions & Climate Change

Heavy machinery during mobilization, transport of materials, and construction will result in minor greenhouse gas emissions under the TSP. The potential impacts of climate change on Project measures' function, resilience, and longevity were considered during development of measures and alternatives. The study team considered potential Project risks as a result of climate change in relation to the TSP and determined that the residual risk level was at a low and acceptable level. Therefore, the TSP would have no effect on greenhouse gas and climate change. Additional information is provided in *Appendix H – Climate Assessment*.

15 HTRW

A Phase I Environmental Site Assessment for the Yorkinut Slough HREP was conducted. The Phase I Environmental Site Assessment revealed no evidence of a Recognized Environmental Condition that could potentially affect the study area. Based on the Phase I Environmental Site Assessment, no further HTRW assessment is recommended. There is a short-term risk for a fuel or fluid spill during construction activities. The contractor would be required to have a spill clean-up plan and utilize BMPs during construction. There is no expected increase in risk for HTRW concerns because of the TSP. Therefore, no HTRW impacts to the study area or surrounding environment are anticipated, additional information is provided in *Appendix F – Hazardous, Toxic, & Radioactive Waste*.

16 Historic and Cultural Resources

Four previously identified archaeological sites have been identified within Yorkinut Slough HREP study area; only three previously identified sites are within the TSP's Area of Potential Effect (APE). One site, 11C152, has been mitigated through Phase III excavations and another site, 11C159, was determined ineligible to the National Register of Historic Places (NRHP). The third site, 11C388, was not evaluated. A Phase I cultural resource survey will need to be completed for compliance with Section 106 of the NHPA and NEPA.

The St. Louis District initiated consultation with 25 federally recognized Indian Tribes on January 4, 2022. In that initial letter, Tribes were requested to notify the St. Louis District about concerns related to traditional cultural properties (TCPs), sacred sites, or other resources of tribal concern that may be located within the Yorkinut Slough HREP study area. None of the Tribes notified the St. Louis District about concerns related to TCPs, sacred sites, or other resources of tribal concern.

A Phase I cultural resource survey is planned to determine if these three sites or other previously unidentified sites are present within the APE. If cultural resources are identified within the APE, the properties will be evaluated for eligibility to the NRHP, in coordination with the SHPO and Indian Tribes. The St. Louis District will consult with the SHPO and Indian Tribes to adjust the final Project design to avoid or minimize impacts to historic properties. Coordination with the SHPO and Indian Tribes will also take place if the cultural resource survey has negative findings. Correspondence and additional information is provided in *Appendix A – Coordination*.

17 Socioeconomic Resources

No short-term or long- term impacts to the growth of the neighboring community or region are anticipated because of the Project. Some temporary impacts to recreational uses may occur as a result of construction activities. However, recreational opportunities would be improved in the study area because of improved habitat diversity which would increase the attractiveness of the area for wildlife observation and hunting. The study area is all on federal land; therefore, no residential property or land would be displaced. Additionally, no changes in property values or tax revenues would occur because of the Project. The Project would result in short-term employment opportunities in the area during construction but would not directly affect employment of the labor force in nearby Illinois or Missouri counties. Overall, the Project would have no adverse impacts to the quality of the human environment.

18 Aesthetic Resources

Minor, temporary impacts to aesthetics would occur as a result of heavy machinery on site, construction of measures, selective removal of trees, and creation of noise, fumes, and dust related to construction activities. Following construction, areas would be reseeded, planted with trees, or managed to promote natural regeneration. No permanent adverse impacts to study area aesthetics are anticipated. Overall, the improvement in habitat quality and diversity as a result of the Project would make the area more aesthetically pleasing to visitors both short- and long-term by addressing factors that limit habitat extent or management at present. Therefore, the TSP would have a positive effect on aesthetic resources overall.

19 Noise Levels

Minor, temporary impacts would occur as a result of increased noise levels from heavy machinery during construction. This could result in disturbance and temporary displacement of wildlife and could result in temporary disturbance to recreational users in the area. Noise levels that result from construction of the Project would be less than significant and would return to current conditions upon construction completion. Best management practices would be utilized throughout construction to minimize disturbances, and additional measures would be incorporated into construction considerations to reduce impacts to potential recreational users. Therefore, the TSP would have only minor, temporary impacts on noise levels.

20 Environmental Justice

Environmental Justice is a national goal and 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 (see Chapter 3.C). Project goals and objectives were established to provide environmental restoration and enhance the quality of the environment for all people. Public involvement, via public meetings and distribution of information concerning the proposed project, has and will continue to be an integral part of planning for this project to ensure that concerns of all people will be fully considered in the decision-making process. No differential impacts to communities of color or underserved populations are expected with any of the considered alternatives. Short-term increases in employment could be realized during construction but would then return to pre-construction conditions. Therefore, the considered action alternatives would not have disproportionately high and adverse environmental effects on communities of color or underserved populations.

21. Man-Made Resources

The Project would not impact flood reduction levees in Illinois. The Project would not result in any significant change in floodplain storage. All Project measures are contained within the boundary of the Refuge; therefore, there would be no impacts to navigation training structures on the Illinois River. Impacts to navigation would not occur as a result of the tentatively selected plan.

22 Short-Term Versus Long-Term Productivity

Construction activities would temporarily disrupt wildlife and human use of the study area. Long-term productivity for natural resource management would benefit from construction of the Project. Long-term productivity would be enhanced through increased water level management reliability, enhanced and expanded emergent wetlands, enhanced forest structure and diversity,

increased hard-mast availability, and by providing more dependable habitat to support migratory and resident wildlife species. The habitat changes and development that would occur as a result of the Project would benefit both game and nongame species. This would result in enhanced recreational opportunities for both consumptive and non-consumptive users. Negative long-term impacts are expected to be minimal for all ecosystems associated with the Project.

23 Irreversible or Irretrievable Resource Commitments

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

24 Cumulative Effects

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 Alton Pool of the Illinois River and Pool 26 of the Mississippi River. There would be little to no cumulative effects to operation and maintenance of the nine-foot navigation channel, commercial traffic, and residential development, agricultural practices, and watershed management as a result of this Project or past and future UMRR projects. Overall, it is anticipated that the Project would include beneficial changes to floodplain forests, floodplain woodlands, and emergent wetlands.

Past Actions

The authorization, construction, and maintenance of the nine-foot navigation channel project has resulted in significant impacts to distribution, proportional cover, and acreage of floodplain habitats. Construction of the Locks and Dams on the Illinois River and at Pool 26 raised water levels by approximately 5.5 ft. As a result, there was a conversion in habitat. Emergent wetlands were converted to permanently inundated lakes and sloughs, many of the permanently inundated lakes have converted to open water habitats, and there was also a conversion of lower elevation forests to aquatic habitats. In addition, the hydrologic fluctuations and sediment transport processes were modified with construction of the lock and dam system. These altered conditions have resulted in reduced topographic diversity, floodplain vegetation diversity, vegetated wetlands, and a modified disturbance regime that only partially supports regeneration of hard-mast and early successional tree species such as Cottonwood.

Six UMRR HREP projects have been constructed in the Alton Pool of the Illinois River and in Pool 26 of the Mississippi River (**Table 24**: Alton Pool and Pool 26 HREP Project). In all, 9,766 acres of floodplain habitat have been enhanced by these projects. Dresser Island, Calhoun Point, Stump Lake, and Swan Lake aimed to enhance wetland and backwater habitat. Pools 25 and 26 Islands HREP aimed to enhance floodplain forest and backwater habitat. Cuivre Island HREP aimed to enhance wetland and floodplain forest habitat.

Table 23. UMRR HREP Projects in Alton Pool of the Illinois River and Pool 26 of the Mississippi River

Project	Pool	Year Constructed / Expected Construction	Acres Affected
Stump Lake	Alton	1999	2,950
Swan Lake	Alton	2001	2,900

Calhoun Point	Alton	2009	2,150
Dresser Island	26	1991	940
Pools 25/26 Islands	26	2017	2,026
Piasa Island	26	2024	1,380
Cuivre Island	26	1999	1,750

Present and Foreseeable Actions

USACE will continue to operate and maintain the nine-foot navigation channel along the Illinois and Mississippi Rivers. This includes continuation of dredging, placement of material, and construction, operation, and maintenance of river regulating structures such as chevrons, closing structures, and wingdams. While maintenance dredging is uncommon in Alton Pool, the study team assumed that it may occur at some point in the future.

One HREP project is under construction currently and would affect an additional 1,380 aquatic habitat acres in the future. Piasa Island HREP aims to enhance side channel and backwater habitat. Three NESP projects on the Illinois River are anticipated to be constructed in the near future at Moore's Towhead (RM 76) (anticipated construction summer 2023), and Wing Island (RM 40) and Fisher Island (RM 38) (in design as of February 2023). All three projects were designed to address erosion issues at the islands and mitigate some of the effects of the locks and dams system. In addition, flood damage repair to the Illinois riverside berm is anticipated around 2025.

Cumulative impacts of the proposed action are not expected to be significant. The Project should have a positive long-term benefit on floodplain forest, emergent wetland, and associated wildlife inhabiting the area. The Project, in concert with previously constructed HREPs in the region, should counter some of the past, current, and foreseeable actions described earlier. In total 62 HREPs have been completed along the UMRS, benefitting nearly 120,000 acres of wetlands, aquatic habitat, and floodplain forest. Additionally, 24 HREP projects are currently in planning, design, and construction that would benefit over 76,000 acres of floodplain habitat.

H. Performance Monitoring & Adaptive Management Measures

Per Section 2039 of WRDA 2007, monitoring for ecosystem restoration studies will be conducted to determine Project success. "Monitoring includes the systematic collection and analysis of data that provides information useful for assessment of Project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain Project benefits." This section summarizes the post-construction evaluation plan, which includes performance monitoring and adaptive management, described in **Table 25**. *Appendix E – Monitoring and Adaptive Management* has descriptions of post-construction evaluation, including performance monitoring and adaptive management activities.

Table 24. Post-Construction Evaluation Description

Monitoring Stage (Post-Construction Evaluation)	Length of Time	Description	Funding Source
Performance Monitoring	10 years	For entire Project, determine the degree to which the Project is meeting the success criteria and for informing potential adaptive management decisions	Project Cost
Adaptive Management	10 years	Provides a process for making decisions in the face of uncertainty and learning from outcomes of management actions; may improve the performance of a designed construction measure that is not meeting performance criteria	Project Cost

Table 26 presents the post-construction evaluation plan, which displays several specific parameters and the levels of enhancement that the Project hopes to achieve. Other factors may be considered to evaluate Project performance and success.

Costs for post-construction evaluation, as described in **Performance Monitoring & Adaptive Management Measures,** are provided in *Appendix E – Monitoring and Adaptive Management*. Performance monitoring and adaptive management are funded by the Project. Monitoring to support Long-Term Performance Reporting starts following completion of performance monitoring and adaptive management (approximately 10 years), if implemented, except for water quality monitoring. Long-term performance reporting is a UMRR Program cost and not included in the Yorkinut Slough HREP cost estimate.

Table 25. Post-Construction Evaluation Plan and Adaptive Management Schedule

Measures	Performance Indicator	Activity*	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Sub-total
Berm	Days to drain/fill	Observation	300	300	300	300	300	300	300	300	300		$2,700
	AM measure: Berm modification							**$187,220**					**$187,220**
Structures	Meet flow and fill capacities of designed structures across study area	Monitor water input and drainage	300	300	300	300	300	300	300	300	300		$2,700
	AM measure: Resize structures							**$90,750**					**$90,750**
Wells	Water supply not sufficient	Observation	300	300	300	300	300	300	300	300	300		$2,700
	AM measure: Additional well pumps							**$477,400**					**$477,400**
Emergent Wetland	Species diversity	Vegetation surveys	*IWMM surveys										
	Species composition	Vegetation surveys											
	Ability to seasonally drain/fill and hold water at desired levels.	Water drainage/filling	300	300	300	300	300	300	300	300	300		**$2,700**
	None Identified												
Tree Planting	Forest Community Diversity and Survivorship	Forest Monitoring	Captured through planned Rivers Project Office forestry monitoring.										
	AM measure: supplemental planting							**$12,100**					$12,100
Timber Stand Improvement	Regeneration occurring	Regeneration Surveys	5000	5000	5000	5000	5000		5000		5000		$35,000
	AM measure: additional Timber Stand Improvement (TSI)							**$95,040**					$95,040
	Performance Evaluation Report	Inspection and report writing						25,000				25,000	$50,000
													$958,310

I. TSP Cost Summary

Table 27 presents the Project first cost of the TSP. Total project cost of Intermediate B alternative was further developed based on additional analysis, including an increase in contingency. Quantities and costs may vary during final design. A full description of the cost estimate, including all related elements, can be found in *Appendix O - Cost*.

Table 26. Project Design and Construction Cost Estimates (January 2023 Price Level)

Account	Measure	Project First Cost
01	Lands and Damages	$0
06	Fish and Wildlife Facilities	$14,152,000
13	Pumping Plant	$2,420,000
30	Planning, Engineering and Design	$2,983,000
31	Construction Management (S&A)	$1,326,000
	Monitoring and Adaptive Management	$958,000
	Contingency (37%)	$8,081,000
	Project cost estimate	$29,920,000

*Figures in table rounded to the nearest thousand.

The annualized costs and AAHUs were used to calculate a total annual cost per annual habitat unit and are shown in **Table 28**. The total cost per habitat unit is $2,122. The costs used for analysis purposes include total Project costs including monitoring and adaptive management costs, Interest During Construction (IDC), and annualized O&M costs.

Table 27. Yorkinut Slough HREP Project Implementation Cost Summary

Item	**Cost ($)**
Project First Cost	$29,920,000
IDC (2-year Construction) 2.5%	$620,000
Average Annual Project Cost	$1,077,000
Annual O&M	$118,000
Total Average Annual Cost	$1,195,000
AAHU Gain	563
Total Average Annual Cost/AAHU	$2,122

*Figures in table rounded to the nearest thousand.

J. Design Considerations

During pre-construction engineering and design (PED), the USACE and USFWS would complete the detailed engineering and technical analysis needed to begin construction of the Project as recommended in this decision document. This includes engineering design documentation and the plans and specifications. Further refinement, and any necessary changes to the TSP will occur during this phase.

H.1 Engineering

Geotechnical – Additional subsurface exploration will be obtained during PED for the design of Project measures. Unit berm configuration may change slightly as a result of ongoing geotechnical investigations to reduce risk of water seepage from and to the current Pump Station unit area. Based on available information during feasibility, the District determined that the tentatively selected plan would be amenable to any anticipated changes that may occur as a result of additional geotechnical information while maintaining the purpose and intent of the TSP. More information is available in *Appendix J – Geotechnical Engineering.*

Civil –Additional surveying may be required throughout the design process as needs arise. Particularly, the need for detailed topography at the pump station and gravity structure should be further considered. During PED, civil features will be modeled in greater detail. The need for borrow or spoil areas will become apparent as cut/fill is finalized. See *Appendix I – Civil Engineering* for all design considerations.

Hydraulics & Hydrology – During PED, decisions will be made regarding several details related to hydrology and hydraulics. The dimensions and locations of new water control structures that will pass through berms within the management units will be determined. The dimensions and location of a new gravity drainage structure that will pass through the Swan Lake berm will be determined. The capacity and location of a new pump station that will pass through the Swan Lake berm will be determined. Two new well pumps designed and commissioned by Ducks Unlimited (DU) are under construction. DU planned to construct two additional new well pumps, but it is not known whether this organization will have funding for construction. If it does not, these two additional new well pumps will be constructed as part of this HREP (likely in the same two locations planned by DU). For all four new well pumps, piping will have to be designed that will transfer the water from the well pumps to the various management units. Another design feature of this HREP deals with rainfall runoff from several agricultural areas south of Illinois Route 1 (IL Rt 1). This runoff enters the managed area in a south-to-north direction in two culverts through the IL Rt 1 embankment. It is planned that this runoff will be directed generally eastward within the managed area and will eventually flow in a culvert through the IL 1 embankment at the southeast corner of the managed area and into the Calhoun Point Project area. See *Appendix G – H&H Engineering* for all design considerations.

Structural – See *Appendix K – Structural Engineering* for all design considerations.

Mechanical – During PED, a decision will likely made between using stoplogs or a tilting weir gate as a water control structure. Changes in the pump station capacity may occur depending on any reevaluation that is done by H&H. Further information on these topics is available in *Appendix L – Mechanical Engineering*.

Electrical – See *Appendix M – Electrical Engineering* for all design considerations.

H.2 Cultural

There are no known historic properties within the study area. One site, 11C388, has not been evaluated for eligibility to the NRHP. This site could be impacted by the proposed plan features. However, to avoid or minimize adverse effects to this or other cultural resources within the study area, final Project site selection and design may be altered as a result of the cultural resource survey or further consultation with the SHPO and Tribes which may take place in the future.

Design specifications will include requirements, developed in consultation with SHPO and consulting Tribes, to the contractor for what to do in case culturally sensitive sites are encountered during construction.

H.3 Public Access and Safety

Safety and security are important factors that would be detailed during Plans and Specifications Phase. One item of particular note would be coordination of hunting seasons in the region with construction activities.

K. Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made regarding the reliability of estimated benefits and the costs of alternative plans. Risk is defined as the probability or likelihood for an outcome. Uncertainty refers to the likelihood that an outcome results from a lack of knowledge about critical elements or processes that then contributes to risk or natural variability in the same elements or processes (IWR 1017-R-03 Planning Manual Part II: Risk-Informed Planning.)

The District worked to manage risk in developing measures by expanding on and referencing successful similar work completed by previous HREPs and the Design Handbook referenced in **Table** 1. The District 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.

The dynamic and complex nature of riverine environmental processes is a principal source of uncertainty. Post-construction monitoring and adaptive management plans will be used to address uncertain outcomes in all TSP components.

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

Sea level rise is not expected to impact the TSP since the study area is located several hundred ft above mean sea level and located in the midcontinent. There is risk and uncertainty associated with climate change, which may result in increased flood frequency and duration, and changes in sediment deposition and aggradation. Project measures were designed based on FWP hydraulic conditions described in *Appendix H – Climate Assessment*; assumptions included consideration for climate change based on reasonable consensus on an increasing trend in observed temperature, precipitation, and streamflow.

Hydrologic and hydraulic modeling and analysis was conducted to understand the existing conditions in the study area: hydrologic modeling of runoff from frequency rainfall events for tributary watersheds, hydraulic modeling of gravity drainage of existing management units, and hydraulic modeling of filling of existing management units with existing well pumps. Then,

hydraulic modeling of both gravity draining and filling was done for the proposed measures. The proposed measures were hydraulically modeled to visualize how water would behave if the measures were implemented. The sizes and types of proposed water control structures, and the capacity of the proposed pump station, will be refined later in the design phase with a hydraulic model of the TSP that will be developed.

L. Construction Considerations

The District identified several construction considerations in the study area. A summary of critical construction considerations is provided in the following sections. Refer to *Appendix I – Civil Engineering* for more detail related to construction of measures and sequence of activities.

J.1 Protected Species

J.1.a Bald Eagles

Consideration (in coordination with the USFWS) would be given during design preparation to sequence construction activities in a manner that minimizes impacts. No forestry measures would be utilized within a buffer of at least 100 ft of a known Bald Eagle nest location. At least a 330 ft buffer would be utilized during the nesting season for TSI in locations where the eagle nest is not visible through a forested buffer. A 660 ft buffer would be utilized under instances of direct line of site during the active nesting season according to the National Bald Eagle Management Guidelines. Staging of equipment would not be allowed within a 660 ft buffer of a known nest. Additional coordination with the USFWS would be conducted during the design phase to account for changes in conditions in the study area relative to proposed project features prior to or during construction.

J.1.b Indiana Bat, Northern Long-eared Bat, and Tricolored Bat.

Construction work requiring tree clearing activities must be scheduled outside April 1 to November 15 when bats are known to inhabit summer habitat. Continued coordination with USFWS will occur through future Project phases if tree clearing would be done during the roost season. During clearing, dead trees, split trees, trees that have cavities, and trees with exfoliating bark would be favored for retention where possible. Design of forestry measures would aim to improve foraging habitat and promote development of long-term roost tree sites.

J.2 Migratory Wildlife

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. Tree clearing during winter would avoid impacts to nesting migratory wildlife.

J.3 Air Quality

Diesel emissions and fugitive dust during Project construction may pose environmental and human health risks and should be minimized. Applicable protective measures as outlined in USEPA's "Construction Emissions Control Checklist" would be followed.

J.4 Permits

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

J.4.a Section 404/401 Compliance

The District is compliant with Section 404 and 401 of the Clean Water Act. See the 404(b)1 evaluation (*Appendix D – Clean Water Act Section 404(B)(1) Evaluation*) for more details. Based on this evaluation, the Project qualifies for a Nationwide 27 permit for Ecosystem Restoration. The Nationwide 27 permit includes general conditions that meet IL EPA Section 401 water quality certification requirements. Therefore, the necessary Section 401 water quality certification would be achieved through the associated Nationwide 27 permit conditions.

Since the Project meets the conditions of the Nationwide 27 permit, the necessary Section 401 water quality certification would be achieved through included general conditions.

J.4.b National Pollutant Discharge Elimination System (NPDES)

A storm discharge or NPDES permit for construction activities may 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 study area may trigger the need for the contractor to apply for this permit. The contractor would be required to prepare an erosion control plan to ensure that unprotected soil is not allowed to leave the study area work limits. The contractor would be required to comply with all local codes and permit requirements.

J.5 Construction Schedule Constraints

Scheduling of construction contracts would depend on availability of funds. The following documents constraints related to construction:

- No clearing of trees shall be allowed between April 1 and November 15 to avoid impacts to bat roosting trees.
- During waterfowl season construction activities may be limited to certain areas.
- Specific tree planting dates would be determined during PED, and would occur once earth moving activities are complete for that feature. Trees shall be planted during optimum times for each species.
- Construction staging and access points to Project measures would be defined during Plans and Specifications to avoid and minimize potential impacts to wetland resources.
- Coordination with USFWS personnel is required prior to working during deer hunting seasons.
- No clearing of trees where roosting or occupied nests exist shall be allowed when bald eagles are present in the area. There is one known active bald eagle nest within the study area. Construction activities and other sources of disturbance would be avoided within a 660-foot buffer area from the nest, when active.
- In accordance with Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds, take of migratory birds protected under the MBTA should be

avoided or minimized, to the extent practicable, to avoid adverse impact on migratory bird resources.

M. USACE Responsibilities

The District is responsible for project management and coordination with the Sponsor, Project partners, and other affected agencies. The USACE St. Louis District will submit the Final Feasibility Report; program funds; finalize Plans & Specifications (P&S); complete all NEPA requirements; provide necessary access permits and/or real estate outgrants to the contractor, advertise and award a construction contract; and perform construction contract supervision and administration. Section 906(e) of WRDA 1986 states that first cost funding for enhancement measures will be 100% federal cost because the Project measures will be located on federally-owned land that is managed by the USFWS as a national wildlife refuge.

After construction of the Project, performance monitoring, which includes monitoring of physical/chemical conditions and some limited biological parameters, will be a USACE responsibility. Performance monitoring is not to exceed ten years. However, the partnering agencies plan to collect various data that will assist the USACE in the performance evaluation for this Project (*Appendix E – Monitoring and Adaptive Management*). The states and other federal agencies will provide this information as part of their typical monitoring effort within Yorkinut Slough HREP.

Operation and maintenance (O&M) will be required for measures of the Project as outlined in **Project Sponsor Implementation Responsibilities** of this report. USACE will provide an O&M Manual at the completion of each functional portion of a project or separable element.

Should rehabilitation exceeding the annual maintenance requirements be required (as a result of a specific storm or flood) a mutual decision between the participating agencies will be made regarding whether to rehabilitate the Project. If rehabilitated, the federal share of rehabilitation will be the responsibility of the USACE.

N. Project Sponsor Implementation Responsibilities

Because the Project will be located on land managed by the UMR Two Rivers NWR, the Regional Director of the USFWS, Region 3, will determine whether the Project is compatible with NWR goals and objectives and the NWR Comprehensive Conservation Plan. The USFWS Regional Director will also determine if the USFWS approves the TSP Plan for implementation and if the USFWS assumes operation and maintenance responsibilities. The Regional Director will determine, based on the facts and recommendations contain herein, whether the integrated Feasibility Report and EA meets the USFWS's obligation under NEPA, the Fish and Wildlife Coordination Act (FWCA) of 1965, the Endangered Species Act (ESA) of 1973, the Migratory Bird Treaty Act of 1918, and the Bald Eagle Protection Act of 1940. The USFWS has been a cooperating agency in the preparation of this EA and has been integral in the decision-making process for the Feasibility Report.

The USFWS is the federal Sponsor and has actively participated in the planning process. USFWS is in support of implementation of TSP, Alternative 3 Intermediate B. Operations and

Maintenance is the responsibility of the USFWS in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. Annual O&M costs are estimated at $118,000 per year. The Project was formulated with consideration given to low operation and maintenance costs. Annual O&M costs include operating and maintaining pumps, well infrastructure, and pump station. Additional information for O&M is provided in *Appendix I – Civil Engineering*. Projected costs are provided in the Project Operations and Maintenance (O&M) Manual, which will be updated after construction completion of a functional portion of the Project or separable element, as determined by the District Engineer to the USFWS as discussed in ER 1110-2-401.

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

Upon completion of a functional portion of the Project or separable element, as determined by the District Engineer as discussed in ER 1110-2-401, in consultation with the federal sponsor, USFWS shall accept the Project as part of the General Plans lands managed by the USFWS. The USFWS shall operate and maintain the Project as defined in this Report. The USFWS's financial support obligation are dependent on congressional appropriations.

There are no proposed Public Law 91-646 relocations as there are no acquisitions required. No land acquisition is needed for the Project. A Real Estate Plan is included as *Appendix N – Real Estate Plan*. Estimated operation and maintenance costs can be found in **TSP Cost Summary**. A draft Memorandum of Agreement is included in *Appendix P – Memorandum of Agreement*.

O. Environmental Operating Principles (EOPs) & Campaign Plan

USACE has reaffirmed its commitment to the environment by formalizing a set of Environmental Operating Principles (EOP) applicable to all its decision-making and programs. The formulation of alternatives considered for implementation met all the EOP principles which include:

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

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

The USACE has developed a Campaign Plan with a mission to "provide vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risk from disasters." This study is consistent with the USACE Campaign Plan https://www.usace.army.mil/About/Campaign-Plan/.

P. Compliance with Environmental Statutes

Status of compliance activities with major environmental regulation and guidelines is listed in **Table 29**. All compliance activities will be completed prior to approval of the final feasibility report.

Table 28. Relationship of Plans to Environmental Protection Statutes and Other Environmental Requirements

Federal Environmental Protection Statutes and Requirements	Applicability/ Compliance[1/2/3]
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et	Partial
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Full
Clean Water Act, Sections 404 and 401	Full
Endangered Species Act of 1973, as amended, 16 S.C. 1531, et	Partial
Environmental Justice (EOs 12898, 13985, 13990, 14008)	Full
Executive Order 11988 – Floodplain Management	Full
Executive Order 11990 - Protection of Wetlands	Full
Executive Order 12898 – Environmental Justice	Full
Executive Order 13112 - Invasive Species	Full
Farmland Protection Policy Act. 7 U.S.C. 4201, et seq.	Full
Federal Water Protection Recreation Act, 16 U.S.C. 460-(12), et	Full
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et seq.	Partial
Green House Gases, CEQ Memorandum 18, Feb 2010	Full
Land and Water Conservation Fund Act, 16 U.S.C. 460/-460/-11,	Full
National Environmental Policy Act, 42 U.S.C. 321, et seq.	Partial
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Partial
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001,	Full
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Full

[1] Full Compliance = having met all requirements of the statute for the current stage of planning
[2] Partial Compliance = having met some requirements of the statute for the current stage of planning or anticipate full compliance at completion of planning (additional information below)
[3]Not Applicable = no requirements for the statute or Project does not contain resources applicable to the law

CHAPTER 7- PUBLIC INVOLVEMENT, COORDINATION, AND CONSULTATION*

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

Scoping and coordination have been conducted with the following state and federal agencies, and other interested parties:

- U.S. Fish and Wildlife Service
- Illinois Department of Natural Resources
- Illinois State Historic Preservation Office
- U.S. Environmental Protection Agency
- River Resources Action Team (RRAT)
- Ducks Unlimited

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

A. Coordination Meetings

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

A Scoping Charrette was held over six sessions between 21 April and 6 May 2020 prior to the development of this report. Twenty-five technical experts from the U.S. Fish and Wildlife Service and USACE attended the workshop. The study team provided input on Project objectives, potential Project measures, future conditions of the site, and resource issues. A copy of the Workshop Report is provided in *Appendix A – Coordination.* In addition, development of this report was actively coordinated throughout the planning process with the Project partner, USFWS, as well as other natural resource agencies.

Refer to *Appendix A – Coordination* for more information about Sponsor and partner meetings and coordination.

B. Coordination by Correspondence

Tribal Scoping: The United States government has a unique legal relationship with federally recognized American Indian tribes based on recognition of inherent powers of Tribal sovereignty and self-government. Consultation with 25 federally recognized tribes that have an interest in this area was initiated by USACE with a letter dated 4 January 2022. This letter informed the tribes of the Project scope and known cultural resources within the study area. Tribes were requested to provide USACE with any concerns pertaining to traditional cultural properties, sacred sites, or other resources that may be within the study area.

Seven tribes responded to the initial letter. The Eastern Shawnee Tribe of Oklahoma (14 January 2022), Iowa Tribe of Kansas and Nebraska (14 January 2022), and Nottawaseppi Huron Band of the Potawatomi, Michigan (5 January 2022) stated they had no objects to the Project and requested to be informed if any archaeological or human remains are discovered within the study footprint. The United Keetowah Band of Cherokee of Oklahoma (10 January 2022) stated they had no issue with the Project and requested to be updated as the project progresses. The Osage Nation (19 April 2022) requested a Phase I archaeological survey be performed and expected to review the archaeological survey report. The Match-e-be-nash-she-wish Band of Pottawatomi Indians (15 February 2022) requested to be informed as the project progressed, including reviewing a Phase I archaeological survey report, and requested that site 11C152 be avoided. The Miami Tribe of Oklahoma (12 January 2022) requested all known documentation on sites 11C152, 11C159, and 11C388 (USACE sent all site forms and previous reports to the tribe on 14 January 2022) and requested to serve as a consulting party on this project.

Consultation continued with tribes on 3 February 2023, when another letter was sent to 24 federally recognized Indian tribes that have an interest in this area. The letter informed the tribes of the TSP and the proposed area of potential effects (APE) based upon the TSP. Tribes were requested to review the information and to notify USACE of any concerns related to the APE. Six tribes responded to this letter. The Nottawaseppi Huron Band of Potawatomi, Michigan (3 February 2023), Iowa Tribe of Kansas and Nebraska (3 February 2023), Forest County Potawatomi Community (6 February 2023), Caddo Nation (7 February 2023), Miami Tribe of Oklahoma (14 February 2023), and Eastern Shawnee Tribe of Oklahoma (16 March 2023) stated they had no objections to the Project and requested to be informed if any archaeological or human remains are discovered within the APE.

Tribal consultation will continue following the cultural resource survey.

(*Note: On 2 February 2023, the Quapaw Nation informed USACE they had no area of interest within Calhoun County, Illinois and requested to no longer be notified about USACE actions within this county. Therefore, the Quapaw Nation was not engaged in consultation for the APE determination).*

Copies of all tribal correspondence are provided in *Appendix A - Coordination*.

SHPO Scoping: Consultation with the Illinois SHPO was initiated on 2 February 2023 through a letter discussing the project, TSP, and proposed APE. The SHPO has yet to respond to this request to consult.

A copy of the SHPO correspondence is provided in *Appendix A – Coordination*.

Public Views and Comments

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

Comments received during public review will be incorporated into the report where appropriate, and copies of written comments received will be provided in *Appendix A – Coordination.*

C. Views of the USFWS/Sponsor

Because the Project will be located on land managed by the Two Rivers NWR, the Regional Director of the USFWS, Region 3, will determine whether the Project is compatible with NWR goals and objectives and the NWR Comprehensive Conservation Plan. The USFWS Regional Director will also determine if the USFWS approves the TSP for implementation and if the USFWS assumes operation and maintenance responsibilities. The Regional Director will determine, based on the facts and recommendations contain herein, whether the draft integrated Feasibility Report and EA meets the USFWS's obligation under NEPA, the Fish and Wildlife Coordination Act (FWCA) of 1965, the Endangered Species Act (ESA) of 1973, the Migratory Bird Treaty Act of 1918, and the Bald Eagle Protection Act of 1940. The USFWS has been a cooperating agency in the preparation of this EA and has been integral in the decision-making process for the Feasibility Report.

Letters of support received for the Project will be provided in *Appendix A – Coordination*.

The USFWS is the federal Sponsor and has actively participated in the planning process. USFWS is in support of implementation of Alternative 3 Intermediate B as the TSP**.** Operations and Maintenance is the responsibility of the USFWS in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. Annual O&M costs are estimated at $118,000 per year. The USACE will further specify activities in the Project Operations and Maintenance (O&M) Manual, which will be provided after construction completion of a functional portion of the Project or separable element, as determined by the District Engineer to the USFWS as discussed in ER 1110-2-401.

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

A draft Memorandum of Agreement between USACE and the Sponsor is included in *Appendix P – Memorandum of Agreement*.

CHAPTER 8 - RECOMMENDATION

The Tentatively Selected Plan (TSP) is Alternative 3 Intermediate B shown in **Figure 30** and **Figure 31**, and includes the following components that comprise the measures:

- Berm construction and associated earthwork (approximately 12 acres)
- Berm enhancement and associated earthwork (approximately 8 acres)
- Berm deconstruction and associated earthwork (approximately 21 acres)
- Remove seven water control structures
- Install 10 water control structures
- Install 2 well pumps
- Well pump pipe installation (approximately 5400 ft.)
- Install 1 large gravity structure (~16' wide)
- Install 1 pump station
- Excavate 27 acres of channel
- Remove 13 acres of channel
- Excavate/re-grade acres of emergent wetlands (included in channel excavation acreage)
- Tree Planting (approximately 215 acres)
- Clearing and grubbing (approximately 5 acres)
- Timber stand improvement (approximately 632 acres).

The estimated federal share of the Project first cost of the Tentatively Selected Plan is $29,920,000 (January 2023 price level), which includes monitoring and adaptive management costs of $958,000. Upon completion, USFWS is responsible for O&M at an estimated cost of $118,000 per year.

The expected outputs of the TSP include restoration of 1,432 acres of habitat. The TSP will contribute 563 average annual habitat units over the 50-year period of analysis.

I have weighed the outputs to be obtained from the full implementation of the Yorkinut Slough HREP against its estimated cost and have considered the various alternatives proposed, impacts identified, and overall scope. The St. Louis District recommends that the Yorkinut Slough HREP Project be implemented as generally described in this report.

The recommendations herein reflect the information available at the time and current Department of the Army policies governing the formulation of individual projects. They do not reflect programming and budgeting priorities inherent in the formulation of national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are approved for implementing funding. However, prior to approval, the state, federal agencies and other parties will be advised of any modifications and afforded the opportunity to comment.

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DRAFT FINDING OF NO SIGNIFICANT IMPACT*

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

Yorkinut Slough
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

ALTON POOL, ILLINOIS RIVER MILES 5-11
CALHOUN, ILLINOIS

The U.S. Army Corps of Engineers, St. Louis District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The draft Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated 30 March 2023, for the Upper Mississippi River Restoration Program Yorkinut Slough Habitat Rehabilitation and Enhancement Project addresses restoring ecosystem structure and function opportunities and feasibility in Calhoun County, Illinois.

The draft IFR/EA, incorporated herein by reference, evaluated various alternatives that would restore ecosystem structure and function in the study area. The recommended plan is the Intermediate B Alternative and includes:

- Berm construction and associated earthwork (approximately 12 acres)
- Berm enhancement and associated earthwork (approximately 8 acres)
- Berm deconstruction and associated earthwork (approximately 21 acres)
- Remove seven water control structures
- Install 10 water control structures
- Install 2 well pumps
- Well pump pipe installation (approximately 5400 ft.)
- Install 1 large gravity structure (~16' wide)
- Install 1 pump station
- Excavate 27 acres of channel
- Remove 13 acres of channel
- Excavate/re-grade acres of emergent wetlands (included in channel excavation acreage)
- Tree planting (approximately 215 acres)
- Clearing and grubbing (approximately 5 acres)
- Timber stand improvement (approximately 632 acres).

In addition to a "no action" plan, four action alternatives were evaluated (Refer to Chapter 4 for discussion on alternative formulation and selection).[1] The alternatives included:

[1] 40 CFR 1505.2(b) requires a summary of the alternatives considered.

- Maximum Alternative
- Intermediate B Alternative
- Intermediate A Alternative
- Minimum Alternative

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in Table 1:

Table 1: Summary of Potential Effects of the Recommended Plan

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Hydrology and Hydraulics	☒	☐	☐
Wetland	☒	☐	☐
Floodplain Forest	☒	☐	☐
Geology and Soils	☒	☐	☐
Fish and wildlife habitat	☒	☐	☐
Illinois Resources of Concern	☒	☐	☐
Federal Threatened and Endangered Species	☒	☐	☐
Invasive Species	☒	☐	☐
Water Quality	☒	☐	☐
Air Quality	☐	☐	☒
Climate Change	☒	☐	☐
HTRW	☒	☐	☐
Historic and Cultural Resources	☐	☐	☒
Socioeconomic Resources	☒	☐	☐
Aesthetic Resources	☒	☐	☐
Noise Levels	☒	☐	☐
Environmental justice	☐	☐	☒
Man-Made Resources	☒	☐	☐

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts as discussed in Chapter 6 of the IFR/EA. [2] No compensatory mitigation is required as part of the recommended plan.

Public review of the draft IFR/EA and FONSI is scheduled to occur __ April 2023. All comments submitted during the public review period will be responded to in the Final IFR/EA and FONSI.

[2] 40 CFR 1505.2(C) all practicable means to avoid and minimize environmental harm are adopted.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the recommended plan may affect but is not likely to adversely affect the following federally listed species or their designated critical habitat: Indiana Bat, Northern Long-eared Bat, Tricolored Bat, and Decurrent False Aster. The U.S. Fish and Wildlife Service (FWS) concurred with the Corps' determination on **DATE OF CONCURRENCE LETTER**

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that historic properties would not be adversely affected by the recommended plan. The **ENTER THE APPROPRIATE SHPO OR THPO** concurred with the determination on **DATE OF CONCURRENCE LETTER.**

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 section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in *Appendix D – Clean Water Act Section 404(B)(1) Evaluation* of the IFR/EA.

A water quality certification pursuant to section 401 of the Clean Water Act was obtained through meeting the conditions of Section 404 Nationwide 27 permit for *Ecosystem Restoration* as the general conditions therein satisfy Section 401 water quality certification requirements from the Illinois Environmental Protection Agency. Pending information to be developed during the pre-construction engineering and design phase, a Nationwide 27 permit for *Ecosystem Restoration* will be obtained prior to construction and a letter stating that the recommended plan appears to meet the requirement therein. All conditions of the Nationwide 27 permit for *Ecosystem Restoration* shall be implemented in order to minimize adverse impacts to water quality.

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

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.[3] 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.[4]

[3] 40 CFR 1505.2(B) requires identification of relevant factors including any essential to national policy which were balanced in the agency decision.

[4] 40 CFR 1508.13 stated the FONSI shall include an EA or a summary of it and shall note any other environmental documents related to it. If an assessment is included, the FONSI need not repeat any of the discussion in the assessment but may incorporate by reference.

_____ _____

Date

COL. Kevin R. Golinghorst
U.S. Army Corps of Engineers
District Commander