UPPER MISSISSIPPI RIVER RESTORATION

DRAFT FEASIBILITY REPORT

WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

OAKWOOD BOTTOMS GREENTREE RESERVOIR HABITAT REHABILITATION AND ENHANCEMENT PROJECT

October 2020

US Army Corps of Engineers ®
St. Louis District

Mississippi River
Miles 73 – 84
Jackson County, Illinois
Project Partner: U.S. Forest Service

Acknowledgments

Oakwood Bottoms Greentree Reservoir Habitat Rehabilitation and Enhancement Project (HREP) USACE FY2020 Project Delivery Team (PDT) members, with roles and experience, are listed below.

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Bryan Dirks	Civil Engineer/Technical Lead	BS Civil Engineering MS Civil Engineering	12
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Amanda Goltz	Geotechnical Engineer	MS Civil Engineering	10
Mike Gawedzinski	Geographer		7
Devin Isselhard	Hydraulic Design	BS Civil Engineering	3
Ray Kopsky, Jr., P.E., P.H.	Hydraulic Design	BS Civil Engineering MS Civil Engineering	34
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Mark Smith, Ph.D.	Cultural & Historic Resources	BA Anthropology MA Nautical Archaeology Ph.D. Archaeology	20
Gafur Umarov	Economics	BA Econ/Finance	1
Josh Morrison	Cost Estimating		6
Terrence Ollis	Real Estate		1
Danny Graves	Electrical Engineering	BS Biology BS Electrical Engineering	10
Keli Broadstock	Office of Counsel	JD	11

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OAKWOOD BOTTOMS GREENTREE RESERVOIR
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MIDDLE MISSISSIPPI RIVER MILES 73 THROUGH 84
JACKSON COUNTY, ILLINOIS

EXECUTIVE SUMMARY

Purpose of Report. The purpose of this integrated feasibility report with environmental assessment, including the Finding of No Significant Impact (FONSI), is to document the decision-making process for the proposed U.S. Army Corps of Engineers (USACE) ecosystem restoration project in the Oakwood Bottoms Greentree Reservoir (OBGTR). The OBGTR Habitat Rehabilitation and Enhancement Project (HREP) focuses on the 4,700-acre greentree reservoir portion of Oakwood Bottoms.

This report was developed by the USACE with the United States Forest Service (USFS) serving as the study sponsor and cooperating agency, and the U.S. Fish and Wildlife Service (USFWS) serving as a Federal coordinating agency. This report provides planning (including National Environmental Policy Act compliance), engineering, and sufficient construction details of the recommended plan to help inform the final recommendation.

Study Area Location. The OBGTR, consisting of approximately 4,700 acres bottomland forest and wetlands, is located within the Shawnee National Forest in the Mississippi River floodplain on the left descending bank of the Mississippi River between River Miles (RM) 73-84 in Jackson County, Illinois.

Problem Identification. There is a significant reduction in functional bottomland hardwood forest habitat and emergent wetland habitat in the OBGTR. Fluctuating water levels are important to creating and maintaining habitat for different plants and tree growth. The levee system adjacent to the study area changed the function of the floodplain river dynamic. Currently, the land is managed to counter the loss of river connectivity to its floodplain. However, the existing structures and processes do not mimic typical water levels at appropriate times, thereby reducing the ability of the study area to function for multiple habitat types, particularly bottomland hardwood forest and emergent wetlands.

Study Goal and Objectives. The overarching goal of this study is to formulate alternatives to restore the aquatic ecosystem within the OBGTR. In addition, the study also documents if USACE participation is economically justified in restoring ecosystem structure and function within the study area.

As part of the USACE planning process, the following ecosystem restoration objectives were identified for the study:

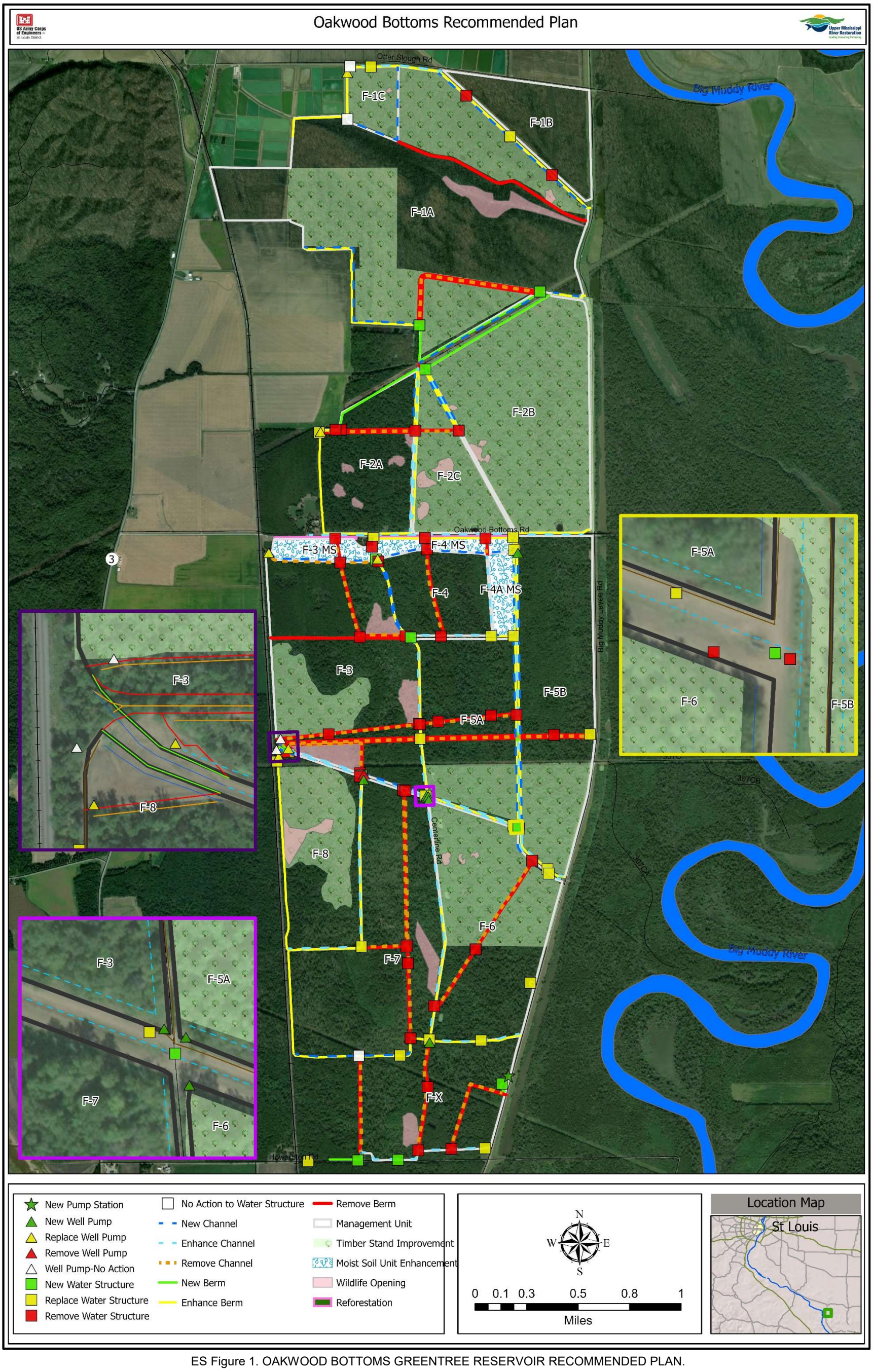
- Increase regeneration of bottomland hardwood forest within the study area during the period of analysis.
- Restore natural hydrologic conditions and function to the floodplain by emulating natural flooding and drainage regimes within the study area during the period of analysis.
- Restore degraded wetland habitat within the study area for resident migratory wildlife during the period of analysis.

Plan Formulation, Evaluation, and Comparison. The interagency planning team, which includes biologists, engineers, and planners from the USACE, the USFS, and USFWS, developed a series of measures for consideration to address the identified problems. The measures were formulated based on data collection and analyses, as well as, by experts in the fields of geomorphology and forestry. The final list of measures consisted of water structure additions and removals, pump station, well pumps, excavation, berm modifications, additions, and removals, and non-structural measures (i.e., reforestation, timber stand improvement).

Six unique alternatives were initially developed using various formulation strategies (including the No Action Alternative). This initial array of alternatives was evaluated for completeness, effectiveness, efficiency, and acceptability. From this initial evaluation, four alternatives, including the No Action Alternative were retained for further analysis. Preliminary cost estimates and habitat benefits were calculated using Habitat Suitability Index (HSI) for the remaining alternatives. Habitat benefits were calculated using HSI models. Outputs from these models are defined as habitat units. The habitat outputs were compared to the cost for each alternative through a cost effective and incremental cost analysis (CE/ICA). This analysis, along with an alternative's ability to meet project objectives, National Environmental Policy Act (NEPA) compliance, and USACE Planning and Guidance evaluation criteria, Planning and Guidance Accounts, study opportunities and constraints were used to compare and evaluate the alternatives. Ultimately, one alternative, the *Forest Service Preferred Alternative,* ES Figure 1, was identified as the National Ecosystem Restoration (NER) plan, or the plan that maximizes net benefits. Because of this and the other aforementioned criteria, the *Forest Service Preferred Alternative* is the recommended plan, yielding 1,183 net average annual habitat units (AAHU) for an average annual cost of $973 per habitat unit, using the FY20 federal discount rate of 2.75% and 50 year period of analysis. The average annual costs include the project first cost to construction, interest during construction, and assumed OMRRR costs. These sites include various measures such as a pump station, water structure additions and removals, excavation, reforestation, timber stand improvements, well pumps, and berm modifications to restore and improve the structure and function of approximately 4,700 acres of forested and wetland habitat. Implementation of the recommended plan would increase regeneration of bottomland hardwood forest within the study area, restore natural hydrologic conditions and function to the floodplain by emulating natural flooding and drainage regimes within the study area, and restore degraded wetland habitat within the study area for resident migratory

wildlife during the period of analysis. The recommended plan is deemed acceptable by the Federal Sponsor (USFS).

Based on October 2019 price levels, the current estimated project first cost (i.e., cost to construct) is estimated at $28,428,000 which includes monitoring costs of $227,000 and adaptive management costs of $1,110,000. The project first cost is 100-percent Federal and, if funded, appropriations will come through the UMRR program. The USFS would be responsible for operation, maintenance, repair, rehabilitation, and replacement (OMRRR) at an estimated average annual cost of $215,000. No compensatory mitigation is included in the proposed plan as none is required. During construction there could be temporary adverse effects to the environment including temporary clearing of vegetation. These effects would be minimized by the use of erosion and pollution control best management practices and conducting removal activities according to State and Federal requirements. Conservation measures would be implemented during construction to minimize effects to Federally-listed plants and animals.



ES Figure 1. OAKWOOD BOTTOMS GREENTREE RESERVOIR RECOMMENDED PLAN.

UPPER MISSISSIPPI RIVER RESTORATION
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***Denotes National Environmental Policy Act required sections**

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ACRONYMS

AAHU – Average Annual Habitat Unit
ATR – Agency Technical Review
AWI – American Watershed Initiative
BE – Biological Evaluation
BGEPA – Bald and Golden Eagle Protection Act
BMP – Best Management Practices
CAP – Continuing Authorities Program
CE/ICA – Cost Effective / Incremental Cost Analysis
CEQ – Council of Environmental Quality
CFR – Code of Federal Regulations
CWA – Clean Water Act
dB - Decibel
DBH – Diameter at Breast Height
DOI – U.S. Department of Interior
DQC – District Quality Control
ECHO – Enforcement and Compliance History Online
EEC – Essential Ecosystem Characteristics
EIS – Environmental Impact Statement
EOP – Environmental Operating Principles
EQ – Environmental Quality
ER – Engineer Regulation
ERDC – Engineering Research and Development Center
ESA – Endangered Species Act
FE – Federally Endangered
FT – Federally Threatened
FEMA – Federal Emergency Management Agency
FONSI – Finding of No Significant Impact
FPPA – Farm Protection Policy Act
FWCAR – Fish and Wildlife Coordination Act Report
FWOP – Future without Project

FWP- Future with Project

FY – Fiscal Year

GIS – Geographic Information System

GLO – Government Land Office

HEP – Habitat Evaluation Procedures

HNA – Habitat Needs Assessment

HREP – Habitat Rehabilitation and Enhancement Project

HSI – Habitat Suitability Index

HTRW – Hazardous, Toxic, Radioactive Waste

HU – Habitat Unit

IDNR - Illinois Department of Natural Resources

IEPA – Illinois Environmental Protection Agency

INAI - Illinois Natural Area Inventory

IWR – Institute for Water Resources

LERRD – Land, Easements, Rights of Way, Relocation, and Disposal

LiDAR – Light Detection and Ranging

LTRM – Long-Term Resource Monitoring

MBTA – Migratory Bird Treaty Act

MIS - Management Indicator Species

MMR – Middle Mississippi River

MMRWFS - Middle Mississippi River Wetland Field Station

MSU – Moist Soil Unit

NAAQS – National Ambient Air Quality Standards

NEPA – National Environmental Policy Act

NER – National Ecosystem Restoration

NHPA – National Historic Preservation Act

NRHP - National Register of Historic Places

OBGTR – Oakwood Bottoms Greentree Reservoir

OMRRR – Operation, Maintenance, Repair, Rehabilitation, and Replacement

OSE – Other Social Effects

P&G – Principles and Guidelines

PDT – Project Delivery Team

PE – Proposed Endangered

PED – Pre-construction Engineering and Design

PPM – Parts Per Million

REC - Recognized Environmental Condition

RECONS – Regional ECONomic System

RED – Regional Economic Development

RFSS - Regional Forest Sensitive Species

RM – River Mile

S&A - Supervision and Administration

SGCN - Species of Greatest Conservation Need

SHPO – State Historic Preservation Office

SNFLRMP- Shawnee National Forest Land and Resource Management Plan

SVC - Species of Viability Concern

T&E – Threatened and Endangered

TMDL – Total Maximum Daily Load

TSI – Timber Stand Improvement

TSS- Total Suspended Solids

UMR - Upper Mississippi River

UMRR – Upper Mississippi River Restoration

UMRS – Upper Mississippi River System

USACE – United States Army Corps of Engineers

USDA – United States Department of Agriculture

USFS – United States Forest Service

USFWS – United States Fish and Wildlife Service

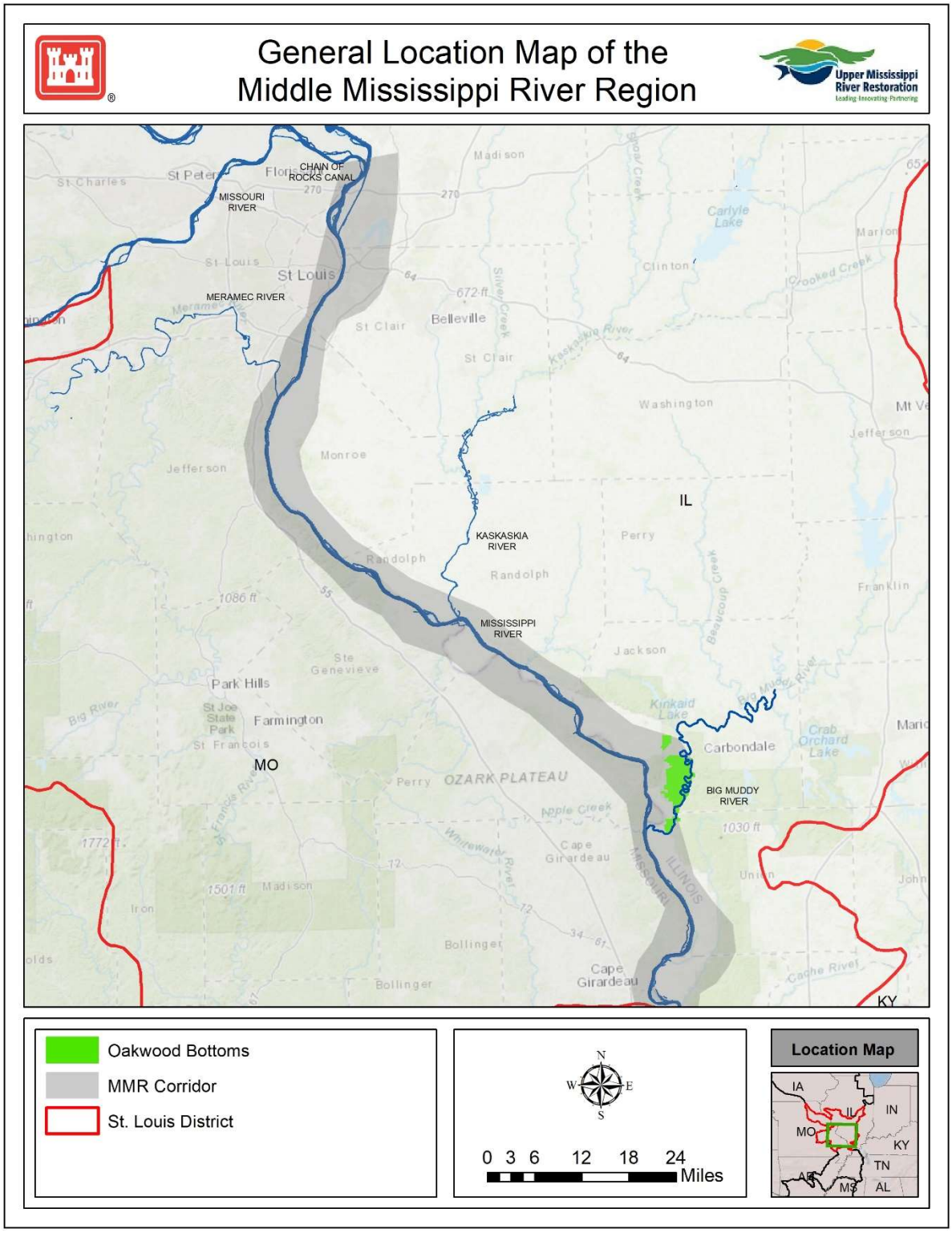
WRDA – Water Resources Development Act

1 STUDY BACKGROUND*[1]

1.1 Purpose and Scope of Investigation

The scope of this study focuses on evaluating proposed management measures that would restore structure, function, and processes of the floodplain forest and wetland habitat within the Oakwood Bottoms Greentree Reservoir (OBGTR) Habitat Rehabilitation and Enhancement Project (HREP),

[1] Asterisk denotes a National Environmental Policy Act (NEPA) requirement.


General Location Map of the
Middle Mississippi River Region
Upper Mississippi River Restoration
MISSOURI RIVER
CHAIN OF ROCKS CANAL
MERAMEC RIVER
KASKASKIA RIVER
MISSISSIPPI RIVER
BIG MUDDY RIVER
St Louis
Belleville
Carbondale
Farmington
Park Hills
Cape Girardeau
OZARK PLATEAU
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Oakwood Bottoms
MMR Corridor
St. Louis District
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Location Map
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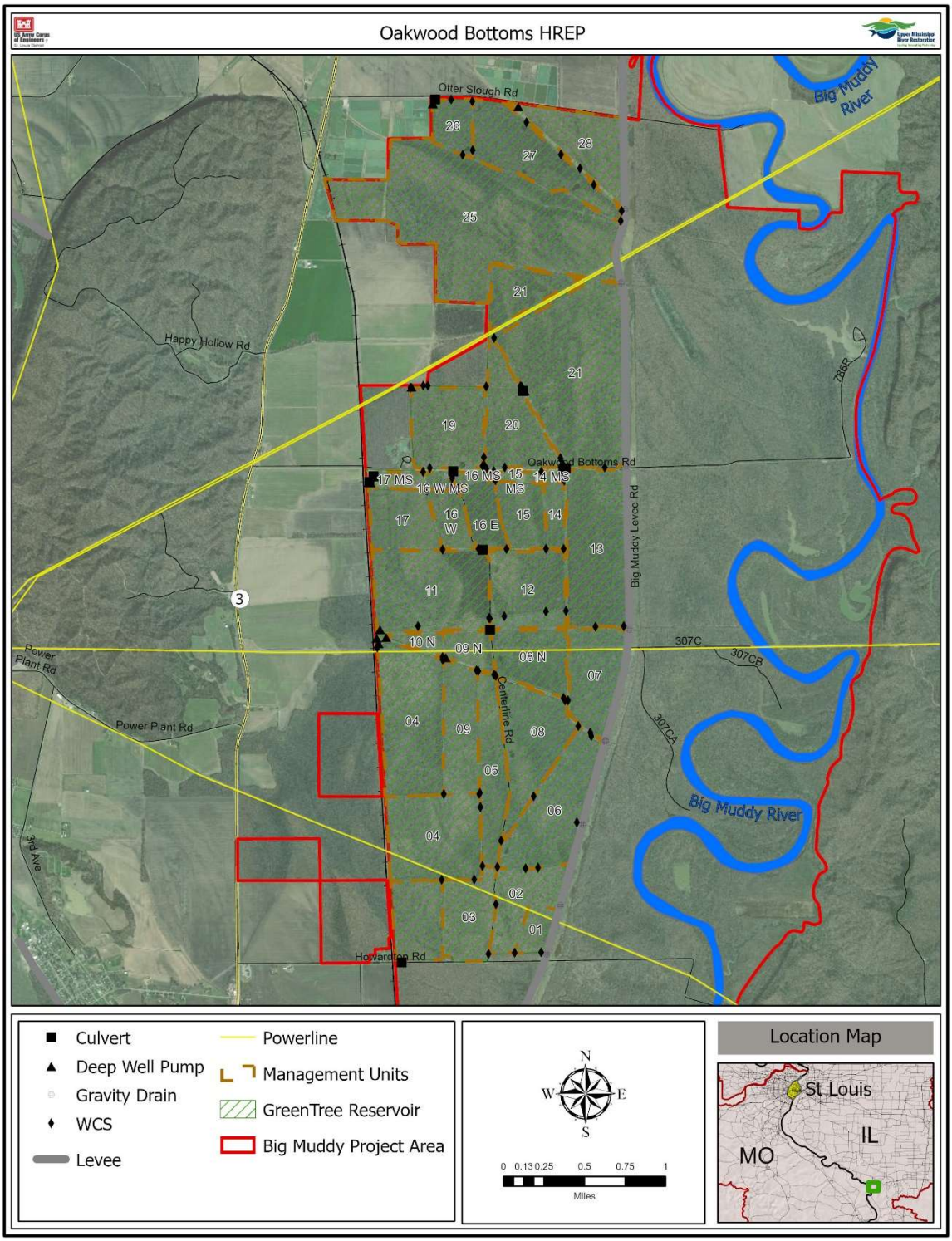
Figure 1 and .


Oakwood Bottoms HREP
Otter Slough Rd
Big Muddy River
Happy Hollow Rd
Oakwood Bottoms Rd
Big Muddy Levee Rd
Power Plant Rd
Centerline Rd
307C
307CB
307CA
3rd Ave
Howard Top Rd
786R
Culvert
Deep Well Pump
Gravity Drain
WCS
Levee
Powerline
Management Units
GreenTree Reservoir
Big Muddy Project Area
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0 0.13 0.25 0.5 0.75 1
Miles
Location Map
St Louis
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MO

Figure 2. This study follows the U.S. Army Corps of Engineers' (USACE's) six-step planning process specified in Engineer Regulation (ER) 1105-2-100 and is consistent with agency goals. The process identifies and responds to problems and opportunities; provides a flexible and rational framework to make decisions; and allows the interested public and decision makers to be fully aware of the basic assumptions employed, data analyzed, risks and uncertainties identified, and significant implications of each alternative plan, including the No Action alternative. The development and comparison of alternatives allows for the ultimate identification of the National Ecosystem Restoration (NER) Plan. The NER plan reasonably maximizes ecosystem restoration benefits compared to costs. The NER also considers information that cannot be quantified, such as environmental significance, scarcity, socioeconomic impacts, and historic properties.

1.2 Authority

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

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

UMRR's geographic extent encompasses 2.7 million acres of river floodplain along the Congressionally-defined navigable portions of the Upper Mississippi (from Lock and Dam 1 in Minneapolis to Cairo, Illinois) as well as the Illinois, Minnesota, Black, Saint Croix, and Kaskaskia Rivers. The UMRR Program mission is *to work within a partnership among federal agencies, state agencies, and other organizations; to construct high-performing habitat restoration projects; to produce state-of-the-art knowledge through monitoring, research, and assessment; and to engage other organizations* (USACE 2016).

The original authorizing legislation has been amended several times since its enactment. The 1990 WRDA, Section 405, extended the original UMRR HREP and UMRR-LTRM authorization an additional five years to fiscal year 2002. The 1992 WRDA, Section 107, amended the original authorization by allowing limited flexibility in how funds are allocated between the HREP program and the UMRR-LTRM element. In accordance with the 1992 WRDA, the sole responsibility for Operation and Maintenance, Repair, Replacement and Rehabilitation (OMRRR) of habitat projects is assigned to the federal, state, or local agency that is responsible for management activities for fish and wildlife on project lands. The 1999 WRDA, Section 509, reauthorized UMRR HREP and UMRR-LTRM as a continuing authority and changed the cost sharing percentage from 25 percent to 35 percent. The 2007 WRDA, Section

3177, allowed for the inclusion of water quality research.

The Oakwood Bottoms are located on federally-owned lands managed as part of the USFS Shawnee National Forest System; therefore, pursuant to 1986 WRDA, Section 906(e) (3), as amended, the Project first costs, the cost estimate in constant dollars at the current price level, are 100-percent federally funded.

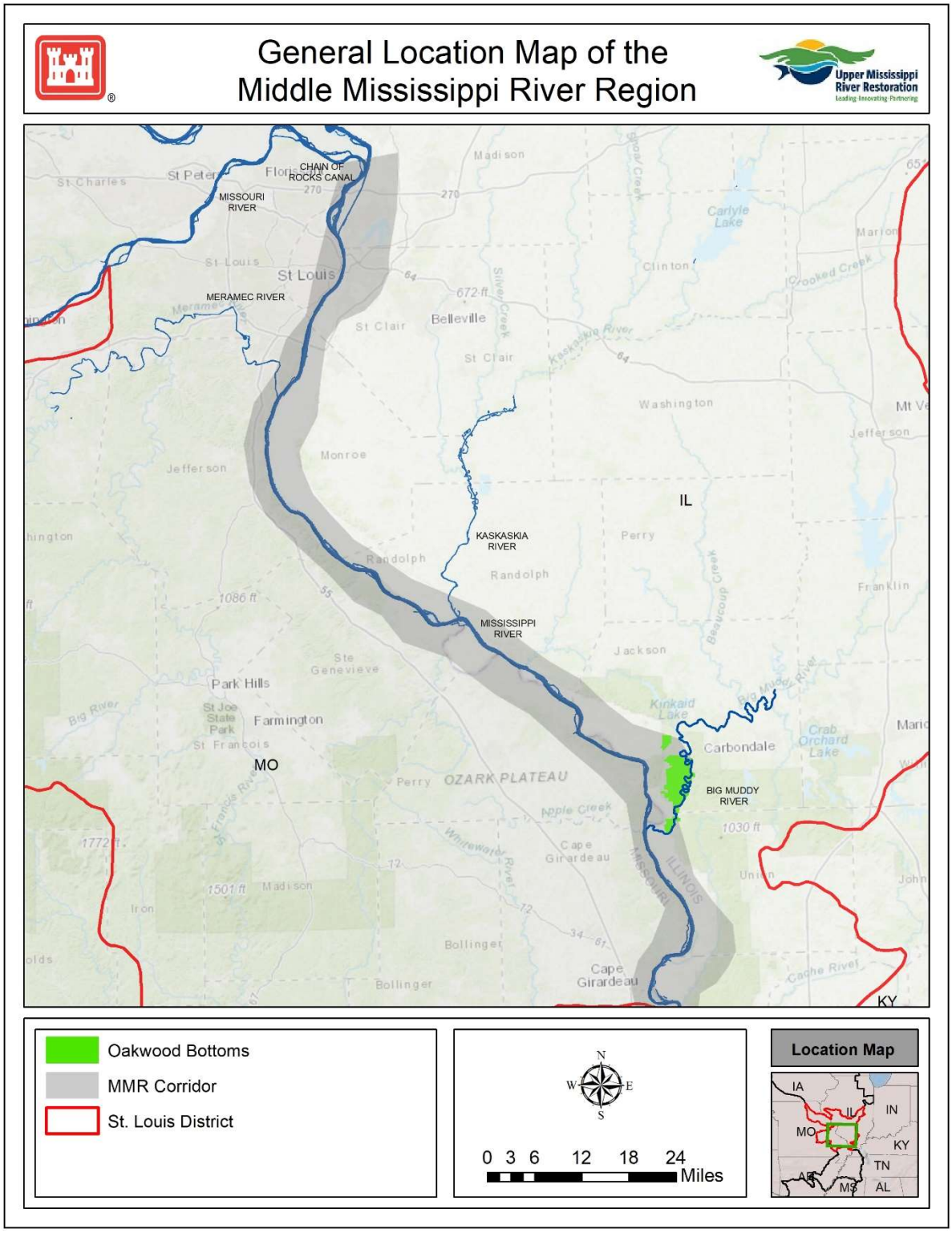
1.3 Federal Sponsor

The Federal Sponsor is the U.S. Forest Service (USFS). The USFS, an agency of the U.S. Department of Agriculture, manages the nation's national forests and grasslands, which encompass 193 million acres.

1.4 Study Area Description

Part of the USFS national forest portfolio is the Shawnee National Forest, which includes approximately 280,000 acres of upland and bottomland forest in southern Illinois. The Oakwood Bottoms, consisting of approximately 13,500 acres bottomland forest and wetlands, is located within the Shawnee National Forest in the Mississippi River floodplain on the left descending bank of the Mississippi River between River Miles (RM) 73-84 in Jackson County, Illinois. The Oakwood Bottoms HREP focuses on the 4,700-acre greentree reservoir portion of Oakwood Bottoms (Oakwood Bottoms Greentree Reservoir, or OBGTR). A “greentree reservoir” refers to a bottomland hardwood forest that is shallowly flooded in the fall and winter to provide waterfowl habitat and waterfowl hunting opportunities.

The portion of the Upper Mississippi River (UMR) described as the Middle Mississippi River region is also described as “Open” or “Unimpounded” because it is the first section of free-flowing river below the UMR lock-and-dam navigation system.


General Location Map of the
Middle Mississippi River Region
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Leading-Innovating-Partnering
CHAIN OF ROCKS CANAL
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MERAMEC RIVER
St Louis
St Clair
Belleville
Madison
Clinton
Washington
Monroe
Jefferson
Randolph
Perry
Franklin
Jackson
Union
Williamson
KASKASKIA RIVER
MISSISSIPPI RIVER
BIG MUDDY RIVER
Carbondale
Park Hills
Farmington
St Joe State Park
Ste Genevieve
St Francois
Cape Girardeau
Bollinger
Iron
OZARK PLATEAU
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Oakwood Bottoms
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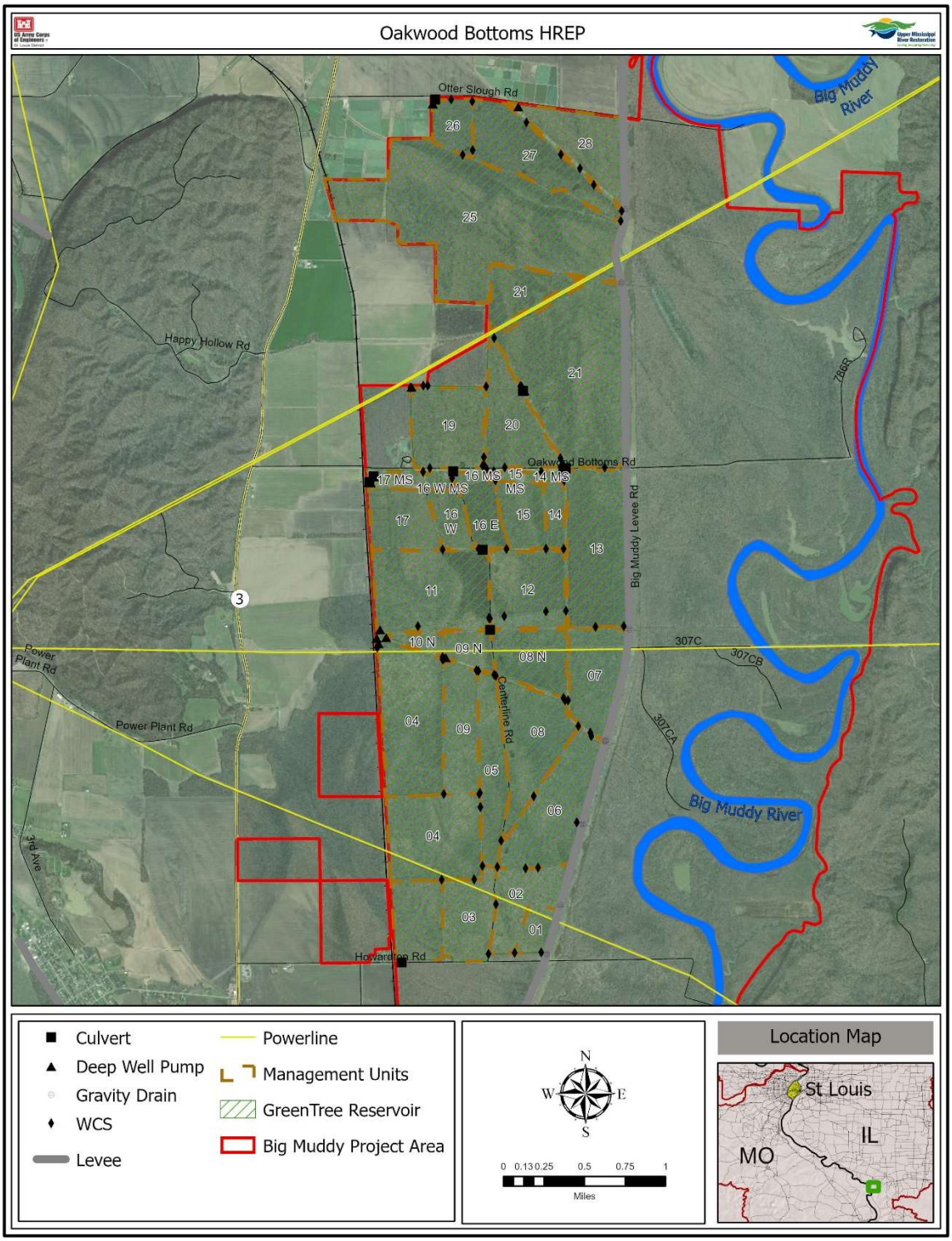
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Management Units
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Location Map
St Louis
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Figure 2 respectively provide a vicinity map and a specific location map for the OBGTR HREP study area.

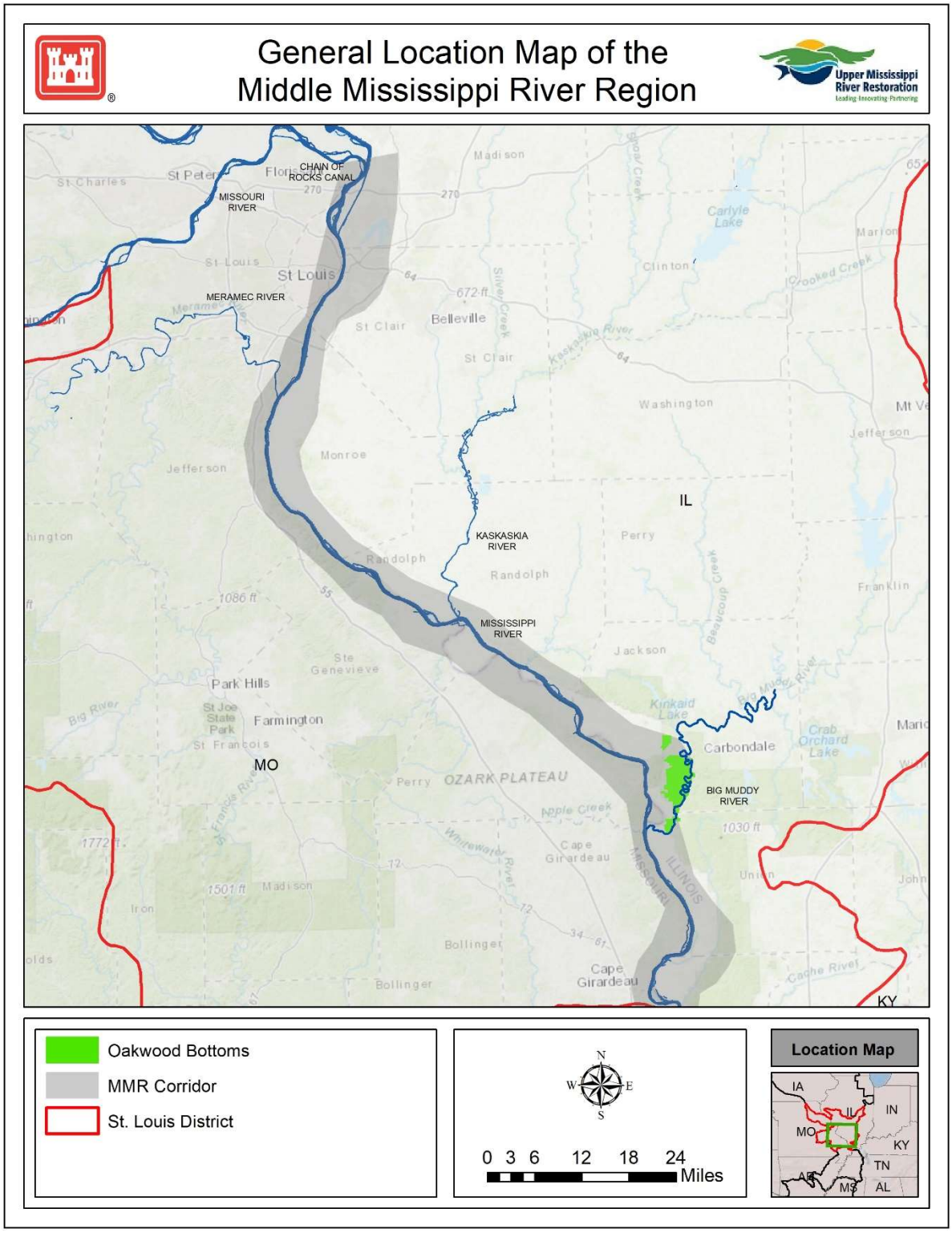

Figure 1. Middle Mississippi River Region.

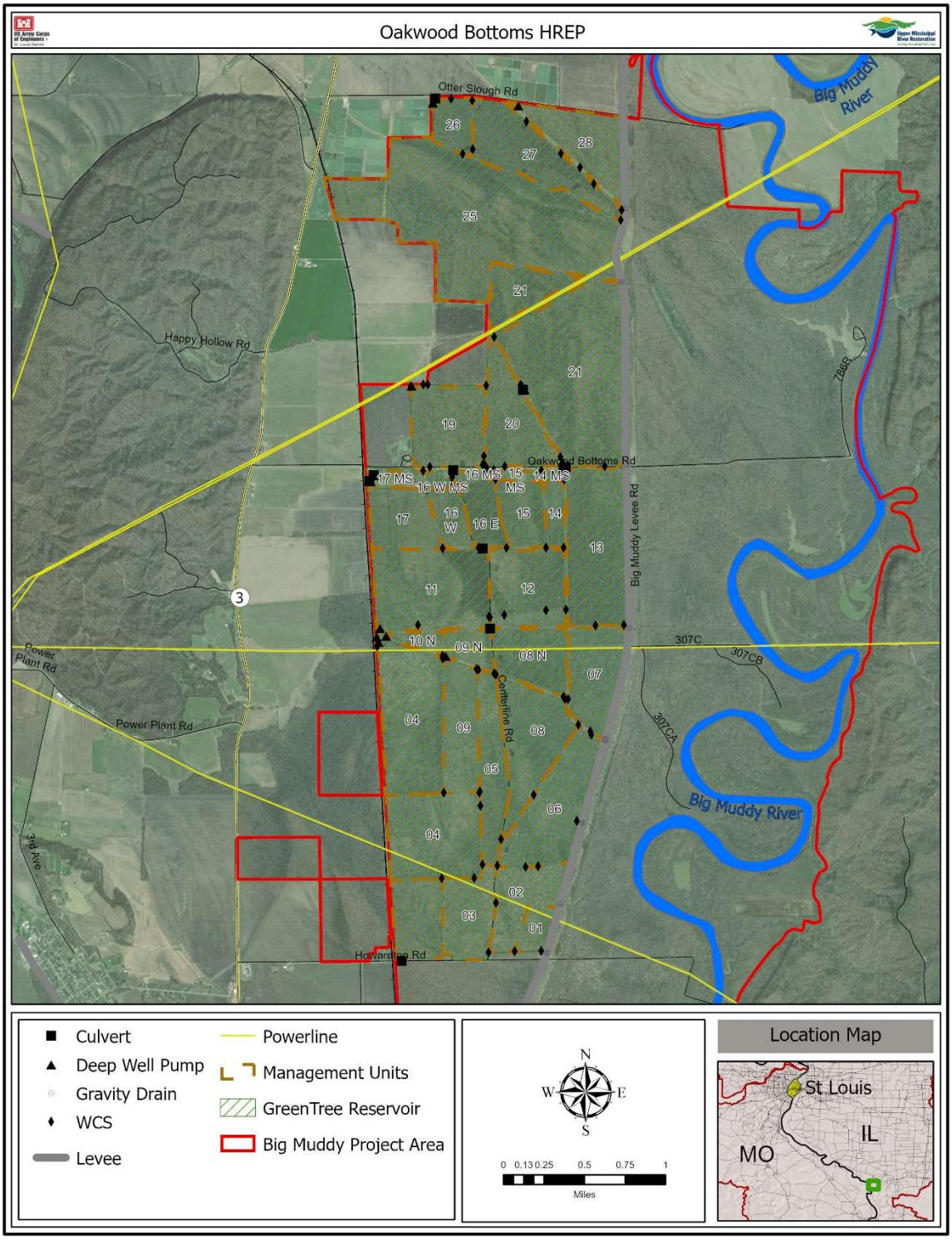

Figure 2. OBGTR Study Area.

1.5 Purpose & Need*

The purpose of the OBGTR HREP feasibility study is to determine whether there is a federal interest to restore the bottomland hardwood forest and emergent wetland habitat that is currently declining in the area due to the altered hydrology.

The purpose of this Draft Feasibility Report with Integrated Environmental Assessment (EA), including the draft unsigned Finding of No Significant Impact (FONSI), is to assess the environmental effects of a reasonable range of potential alternatives or actions designed by USACE, including the no action plan, while complying with current applicable laws, regulations, and policies, prior to decision making.

The need for this study is demonstrated by the large number of local, state, and federal activities taking place in the study area. Federal interest stems from environmental factors affecting the ecosystem structure and function at OBGTR both directly and indirectly. The key factors include the altered hydrology, which negatively impacts the forest community's recruitment and regeneration, which negatively impacts both resident and migratory wildlife. The Federal interest is further substantiated in the following documents:

- *Shawnee National Forest Land and Resource Management Plan* (2006) (SNFLRMP) identifies a need to maintain/restore the oak-hickory ecosystem resilience in the project area by reducing shade tolerant understory competition, creating light conditions favorable for the establishment of oak-hickory regeneration, improving forest structure, reducing stressors caused by overstocked conditions, and improve/enhance the health, vigor, and growth of existing trees and native vegetation communities to improve wildlife habitat diversity. There is also a need to maintain high quality recreation opportunities and wildlife habitat in the project area by increasing regeneration of bottomland hardwood forest, restoring natural hydrologic conditions and function to the floodplain by emulating natural flooding and drainage regimes, and restoring degraded wetland habitat for resident and migratory wildlife.
- *Habitat Needs Assessment – II for the Upper Mississippi River Restoration Program: Linking Science to Management Perspectives.* U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL. (McCain, et al. 2018). The Habitat Needs Assessment (HNA) II summarized the desired future conditions in conjunction with high-importance indicators for the open river as 1) Restore function and diversity of aquatic habitat types by improving quality and distribution of lotic and lentic habitats; 2) Restore floodplain topographic diversity and diversify inundation periods to mimic pre-dam conditions; and 3) Restore, maintain and enhance floodplain vegetation diversity, including hard-mast trees.

1.6 Project Selection

To ensure the UMRR Program leverages limited funds, as well as ensuring a watershed approach is taken, all HREP projects are endorsed by interagency coordination teams made up of federal, state, and non-governmental agencies involved in the planning of ecosystem restoration.

Once the USFS Oakwood Bottoms area was endorsed by the interagency coordination team, a USACE-UMRR Factsheet was developed to determine federal interest to study potential solutions to address the problems occurring within the study area.

The Mississippi Valley Division-approved Oakwood Bottoms HREP Factsheet can be found in Appendix A - *Coordination*.

1.7 Resource Significance*

The Planning Guidance Notebook (2000) ER 1105-2-100 defines significance in terms of institutional, public, and technical recognition. Significance in the UMR Basin applies to the MMR, since it is a subset of the UMR Basin. See Table 1 for additional information.

1.7.1 Institutional Significance

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. Sources of institutional recognition include public laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal Government; plans, laws, resolutions, and other policy statements of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

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

The UMR and Great Lakes Region Joint Venture was established under the North American Waterfowl Management Plan (NAWMP 2004). Joint Ventures are comprised of a coalition of Federal, state, private agencies, and individuals that cooperate and pool resources to achieve the objectives of the NAWMP. Because the UMR Basin is part of an approved Joint Venture under NAWMP, it is recognized as institutionally significant from a national/international perspective. The OBGTR HREP is expected to support the NAWMP's goals for conservation and management of waterfowl species and habitat by protecting migratory waterfowl species populations through restoration and maintenance of floodplain forest and wetland habitat in OBGTR.

Additionally, Section 906 of WRDA 1986 emphasizes the institutional significance of bottomland hardwood forest by documenting the need to mitigate impacts.

Table 1 documents institutional significance.

1.7.2 Public Recognition

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

involve membership in an organization, financial contributions to resource-related efforts, and providing volunteer labor and correspondence regarding the importance of the resource.

Ecosystem restoration and monitoring of the Upper Mississippi River System (UMRS) provide substantial benefits to the river communities, the UMRS region, and the nation. The UMRR Program, throughout its 30+ year history, has created public outreach opportunities related to HREP planning, construction, evaluation, and Long-Term Resource Monitoring (LTRM). For example, *Our Mississippi*, an educational guide and quarterly newsletter produced by USACE, highlights work done under UMRR in the Mississippi River Basin. It is published in cooperation with other state and federal agencies and other river interests to move toward long-term sustainability of the economic uses and ecological integrity of the river system.

Additional public significance for the study area is through public outreach and significant conservation work being performed in the study area by Ducks Unlimited. Ducks Unlimited is dedicated to the preservation and enhancement of natural resources. As of March 2020, Ducks Unlimited has leveraged significant funding for habitat restoration within Oakwood Bottoms. Table 1 documents the public significance of the OBGTR.

1.7.3 Technical Recognition

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

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 document significance of the resources in the UMR basin[2].

In a 1995 report, the U.S. Department of Interior (DOI) listed large streams and rivers as endangered ecosystems in the United States. The DOI documented an 85 to 98 percent decline in this ecosystem type since European settlement. In particular, large floodplain-river ecosystems have become increasingly rare worldwide. Two large

[2] https://umesc.usgs.gov/ltrm-home.html

floodplain-river ecosystems are located within the UMRS, namely the Upper Mississippi and Illinois Rivers. These two ecosystems still retain some seasonal flood pulses, and half of their original floodplains remain unleveed and open to the rivers (Sparks et al. 1998). The UMRS is one of the few areas in the developed world where ecosystem restoration can be implemented on large floodplain-river ecosystems (Sparks 1995).

In addition, technical resource agencies (federal, state, and non-profit) view the resources in the MMR as significant and are reflected in the ongoing habitat restoration efforts in the region including the proposed projects at Crains Island and Harlow Island. The *Upper Mississippi River System Habitat Needs Assessment II* (McCain, et al. 2018) has also technically recognized the need to restore bottomland hardwood forest and emergent wetland habitat within the MMR.

Table 1. Resource Significance for OBGTR.

	Institutional	Public	Technical
Threatened and Endangered Species	Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661) Endangered Species Act (ESA) of 1973, as amended National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy	American Rivers, a non-governmental organization dedicated to protecting and restoring healthy, natural rivers, listed the Mississippi River as number three in America's Top Ten Endangered Rivers for 2019. Congress has recognized the Nation's rich natural heritage is of "esthetic, ecological, educational, recreational, and scientific value to our Nation and its people."	*Representativeness:* USFWS has identified the Indiana bat; northern long-eared bat; gray bat; least tern; and pallid sturgeon as federally-endangered or threatened species that have the potential to occur within Jackson County, IL.
Migratory Birds	Migratory Bird Conservation Act of 1929, and associated treaties Migratory Bird Treaty Act of 1918 EO 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds Bald and Golden Eagle Protection Act of 1940 North American Waterfowl Management Plan	Migratory birds provide the public with recreational opportunities, such as bird watching and waterfowl hunting. National Audubon's Mississippi River Campaign has been working to raise awareness of the importance of the Mississippi River as an internationally significant resource since 1998. The Upper Mississippi River Waterfowl Conservation Region (Region 19) is a level III Ducks Unlimited conservation priority area, providing a migration corridor for hundreds of thousands of dabbling ducks and significant numbers of divers.	*Representativeness:* Numerous migratory birds utilize OBGTR; the following as the most relevant in the area: Bald Eagle, Great Blue Heron, Waterfowl, and neotropical migratory birds. *Representativeness:* Knutson et al. (1998) found relative abundances of all birds and total numbers of neotropical migratory birds were almost twice as high in the UMR floodplain as in the adjacent uplands. *Status and Trend:* Changes in the MMR forest community have contributed to a reduction in diversity of habitat over time. These trends are likely to continue, and without intervention, OBGTR will cease to provide migration, dispersal, breeding, nesting, and cover habitat for a wide range of migratory birds.
Floodplain	Fish and Wildlife	The UMRCC recognized the importance of the	*Representativeness:* OBGTR contains

	Institutional	Public	Technical
Forests	Coordination Act, as amended (16 U.S.C.§ 661) ESA of 1973, as amended National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy	floodplain forest to the fish and wildlife of the UMR in the report, *Upper Mississippi and IL River Floodplain Forests* (Urich et al., 2002).	approximately 4,700 acres of floodplain forest habitat. *Biodiversity:* The largest concern is without intervention, the study area is likely to continue to experience forest fragmentation and limited species and structural diversity. Consequently, neotropical and other migratory birds, Indiana bats, and the other floodplain species that rely on the forest resources will be severely impacted. Knutson et al. (1996) described the importance of floodplain forest in the conservation and management of neotropical migratory birds.
Wetlands	The 2015 *Implementation Guide to the Illinois Wildlife Action Plan* Tier 3 – Highest Priority area for restoration and management through the Wetlands Campaign. Executive Order No. 11990 of May 1977 (Protection of Wetlands) Water Resources Development Act of 1990, Section 307(a) National Wildlife Refuge Systems Biological Integrity, Diversity, and Environmental Health Policy.	Protecting wetlands from excessive pollution and destruction is a Mississippi River Collaborative priority. MRC has established a Wetlands Group to address this specific issue. The Middle Mississippi River Wetland Field Station (MMRWFS) is a 1,380 acre research area managed by Southern Illinois University Carbondale. The purpose of the MMRWFS is to serve as a research, education, and demonstration area on large river floodplain ecology, management, and restoration.	*Scarcity:* In the United States, over a period of 200 years, between the 1780s and the 1980s, the lower 48 states have lost an estimated 53% of the 221 million acres of original wetlands. *Scarcity:* Through land use changes, approximately 90% of pre-settlement wetlands were lost by the 1980's in Illinois. *Status and Trend:* Without OBGTR HREP, the site will continue to lack emergent wetlands, needed to support a variety of wildlife species.

1.8 Scoping and Coordination*

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

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

- U.S. Forest Service (USFS)
- U.S. Fish and Wildlife Service (USFWS)
- Illinois Department of Natural Resources (IDNR)
- Illinois State Historic Preservation Office
- The Nature Conservancy
- U.S. Environmental Protection Agency (USEPA)
- Ducks Unlimited
- Missouri Department of Conservation (MDC)

The input received during scoping was incorporated in the process of making decisions for the project. Appendix A - *Coordination* documents the coordination.

1.8.1 Coordination Meetings

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

A planning charrette was held (1-3 November 2017) prior to the development of this report. Twenty-four technical experts from the USFS, USFWS, IDNR, MDC, Arkansas Game and Fish, Southern Illinois University at Carbondale, and USACE attended the workshop. The team provided input on project objectives, potential management measures, and future conditions of the site, and identified resource issues. A copy of the executive summary is provided in Appendix A - *Coordination*. A full copy of the Planning Charrette report is available upon request. In addition, development of this report was actively coordinated throughout the planning process with the project partner, the USFS, as well as other natural resource agencies.

Refer to Appendix A - *Coordination* for more information about Federal Sponsor meetings and coordination.

1.8.2 Public Review and Comments

USACE St. Louis District is the lead federal agency for NEPA. USFS is a cooperating agency, as such per FSH 1909.15 11.31b *"Cooperating with Other Agencies Where National Forest System lands are involved -The Forest Service shall play a strong role in the preparation of environmental documents. When National Forest System lands are involved and the Forest Service is not the lead agency, the responsible Forest Service official shall make a written request to participate as a cooperating agency in scoping, environmental analysis, and documentation."*

In accordance with NEPA, the report with integrated environmental assessment and unsigned draft FONSI will be made available to interested members of the public during a 30-day public review period scheduled to start in October 2020. The report will be made available on the USACE St. Louis District's website, will be sent to the Federal Sponsor to post on their informational webpages, and a letter will be mailed to interested members of the public addressing where to find the report, and how to provide comments. 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.*

Additionally, a public meeting was held in Grand Tower, Illinois on 18 October 2018 to elicit feedback from the public on improvements that could enhance habitat within OBGTR HREP. A site visit to the study area occurred on 27 October 2018 with seven members of the public to gain a better understanding of the potential project. As the project was further refined, an additional meeting was held on 5 March 2020 to inform the public as well as elicit additional feedback on the potential measures. The main topics discussed included converting areas with only dead timber remaining to moist soil, reconstructing current moist soil units to drain and fill effectively, timing of water on and off of the study area, and waterfowl refuge areas. Notes from all topics discussed can be found in Appendix A – *Coordination.*

1.8.3 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. Appendix A - *Coordination* provides copies of all tribal correspondence.

1.9 Prior Studies, Reports, and Existing Water Projects

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

Heitmeyer, M.E., and Bartletti, June 2019. Hydrogeomorphic Evaluation of Ecosystem Restoration and Management Options for the Oakwood Bottoms Habitat Rehabilitation and Enhancement Project, Jackson County, Illinois. Advance, MO: Greenbrier Wetland Services. 1) Identify the pre-European settlement ecosystem condition and ecological processes; 2) Evaluate differences between pre-European settlement and current conditions with specific reference to alterations in hydrology, vegetation community structure and distribution, and resource availability to key fish and wildlife species, and 3) Identify restoration and management approaches and ecological attributes needed to successfully restore and sustain specific habitats and conditions, especially bottomland hardwood forest.

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.

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

Oakwood Bottoms Greentree Reservoir Operation Guide and Management Plan. 2014. Prepared by Chad Deaton, USFS Wildlife Biologist, Shawnee National Forest. This report provides information on the current and projected operation and management of the study area.

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

The Shawnee National Forest Land and Resource Management Plan. 2006. A document that guides all natural resource management for 285,000 acres of the National Forest System within Southern Illinois. USFS management objectives for the OBGTR are outlined within this planning document.

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

2 ASSESSMENT OF EXISTING RESOURCES*

Section 2 assesses the existing conditions of resources, organized by resource topic. This is not a comprehensive discussion of every resource within the study area, but rather it focuses on those aspects of the environment that were identified as relevant issues during scoping or may be affected by the considered alternatives. The environmental effects and cumulative effects on these resources are described in sections 6 and 7, respectively.

Resource History of the Study Area

As a whole, the MMR has a diversity of ecological communities ranging from prairie-dominated floodplains in the north to bottomland hardwood forests in the south. Since early European settlement, the MMR has been modified by humans. Starting in the late 1800s, large areas of forest and prairie were cleared and drained for agricultural production. Today the MMR is a major navigation transportation corridor. The MMR, while part of the UMR, is centrally located within the larger Mississippi River drainage system and is used for shipping of agricultural, industrial, and commercial commodities. The MMR is now confined by major levees, drainage ditches, roads, and floodplain development.

Prior to European settlement, forest communities had a higher proportion of hard mast, *i.e.*, nut producing tree species such as oaks (*Quercus* spp.) and hickories (*Carya* spp.) (Nelson et al 1994). In the MMR region, the bottomland hardwood forest was widely dispersed and interconnected.

During the steamboat era of the 1800s, logging of the bankline for fuel and removal of trees to prevent future snags drastically altered the MMR forest community (Norris 1997; Theiling 1998).

In the early 19th century, land acquisition within Jackson County, Illinois followed soon after the early Government Land Office (GLO) surveys. Shortly thereafter, land was purchased and settled by early European inhabitants.

In the 1840s, GLO surveyors captured the forest composition by describing the existing witness trees located adjacent to recorded monument corners. The study area was primarily classified as “forest” with tree species including: elm (*Ulmus spp*.), ash *(Fraxinus spp.)*, maple *(Acer spp.),* hickory, and oak. Of the 50 GLO survey points within Oakwood Bottoms and east of the Levee, 24 included oak species within the recorded data set (Fralish et al., 2010). A comment noting “wet prairie” along the northern boundary of the study area implies that there was some variation in landscape cover type – it was not all forested.

Overlaying the historic known location of oak species from the GLO surveys (conducted in the 1840s) with the existing LIDAR elevation data (collected in 2015) indicates oaks existed on elevation ranging from 352 to 359 feet above sea level (NAVD 88) with an average elevation of 355.7 feet. Water-tolerant tree species (e.g., maple, ash, and elm) dominated elevations lower than 352 feet.

In the 1900s, the bottomland hardwood forest along the MRR continued to disappear

due to conversion to agriculture (Theiling 1999). The majority of OBGTR Study Area was intensively farmed and/or grazed prior to USFS acquisition in the late 1930s. As part of the early agricultural development, drainage ditches, fences and buildings were constructed by the landowners. These land modifications are shown in an aerial photography interpretation from a 1938 image (Figure 4).

The USFS completed land acquisition in the OBGTR Study Area in 1938, under Federal Authority of the Weeks Act of 1911. The Flood Control Act of 1936 recognized flood control as a national priority. The Degognia/Fountain Bluff and Grand Tower Drainage and Levee Districts were established as a result of the Flood Control Act of 1936. Subsequently, levee construction followed and the Oakwood Bottoms area was bisected from north to south by the Levee in 1945 (Figure 5). This separated the current-day OBGTR from the Big Muddy River floodplain, which initiated a hydrologic functionality change for lands west of the newly constructed levee system. This change created drier conditions that are preferred by oak trees, which subsequently further established and dominated the forest. The historic presence of oak species within the study area and surrounding landscape indicates the high ecological significance of this species from a habitat restoration and enhancement perspective.

In 1964 efforts to construct the OBGTR began after local public interest groups voiced their concerns about the need for waterfowl fall, winter, and spring migration habitat. The new OBGTR system began with the development of 12 units and the installation of four well pumps. By 1976, the OBGTR expanded to 22 management units with approximately 35 miles of berms, 35 miles of ditches, and seven well pumps within the 4,700-acre tract of land. Two other phases of restoration in the 1990s created water management capabilities and near-replication of historic natural flooding, along with the installation of two additional well pumps. Additionally, 72 acres of land were converted to manage moist soil. This action further divided the total management units into a total of 33 units (USFS 2014). Figure 6 shows the range of elevations within the study area as of 2015.

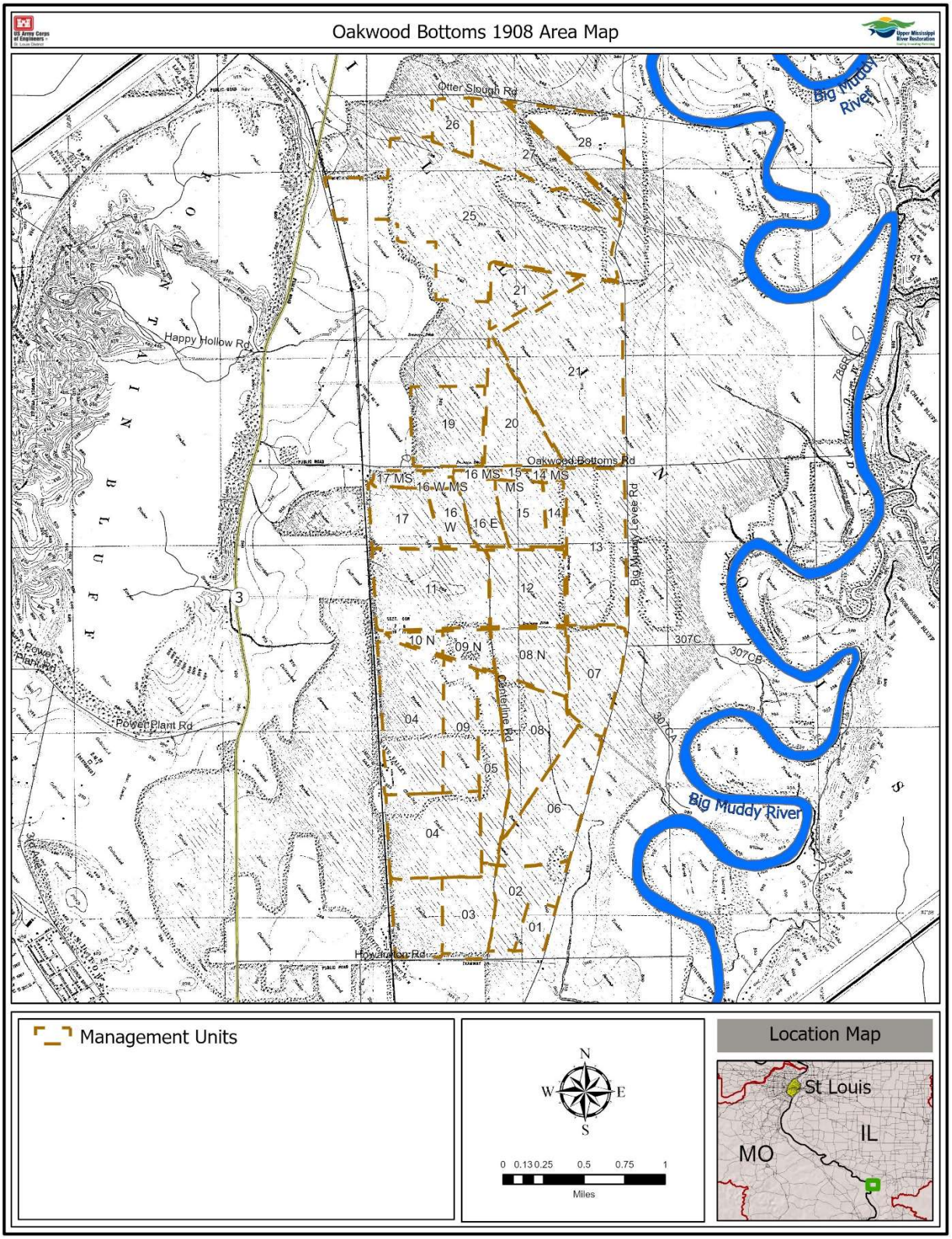

Figure 3. 1908 Board of Examination Map of Oakwood Bottoms Overlaid with Current OBGTR Boundary.

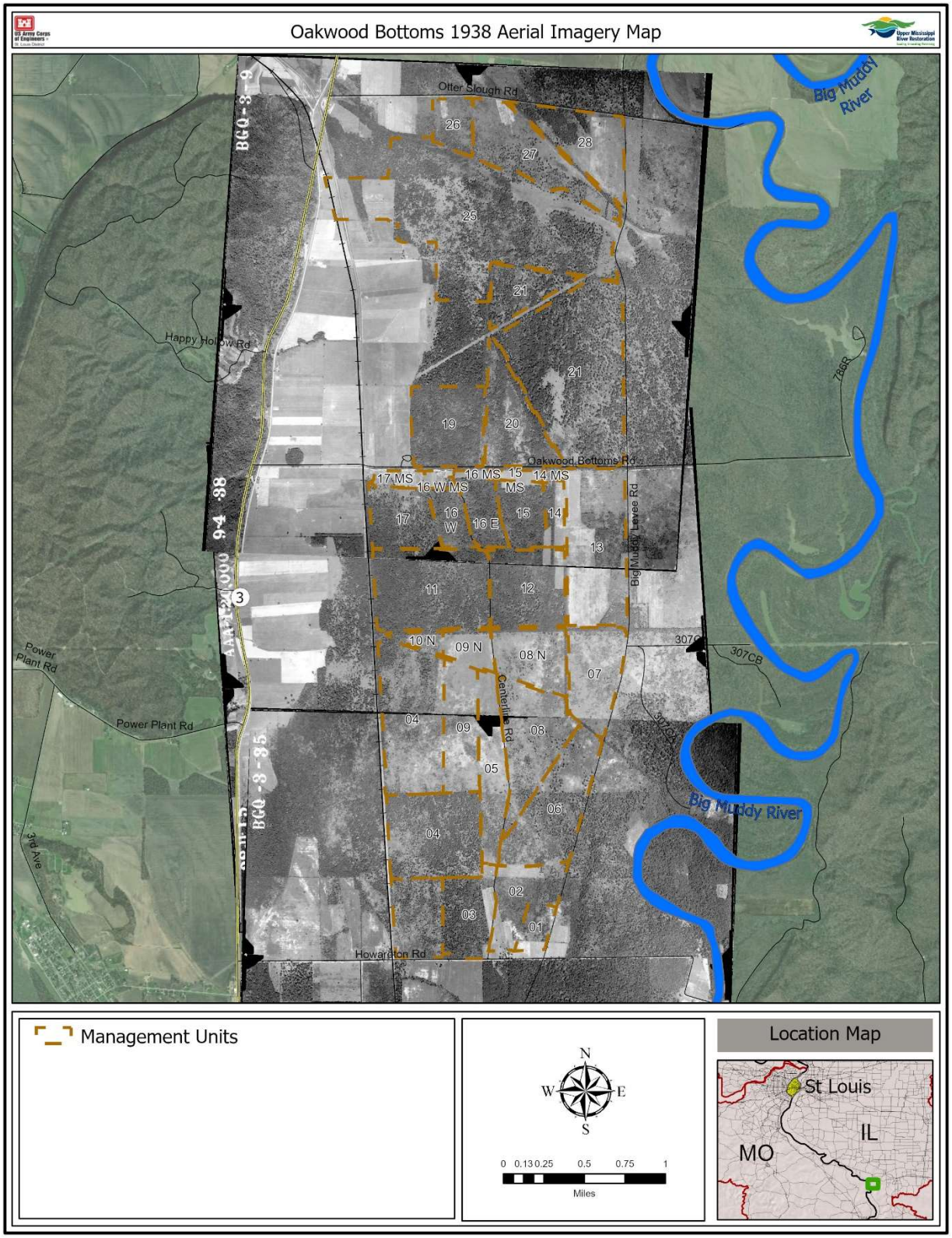

Figure 4. 1938 Aerial Image with Existing Water Management Infrastructure Including Drainage Ditches and Berms.

Figure 5. As-Built Drawing of Degognia and Fountain Bluff Levee and Drainage District and Grand Tower Drainage and Levee District System.

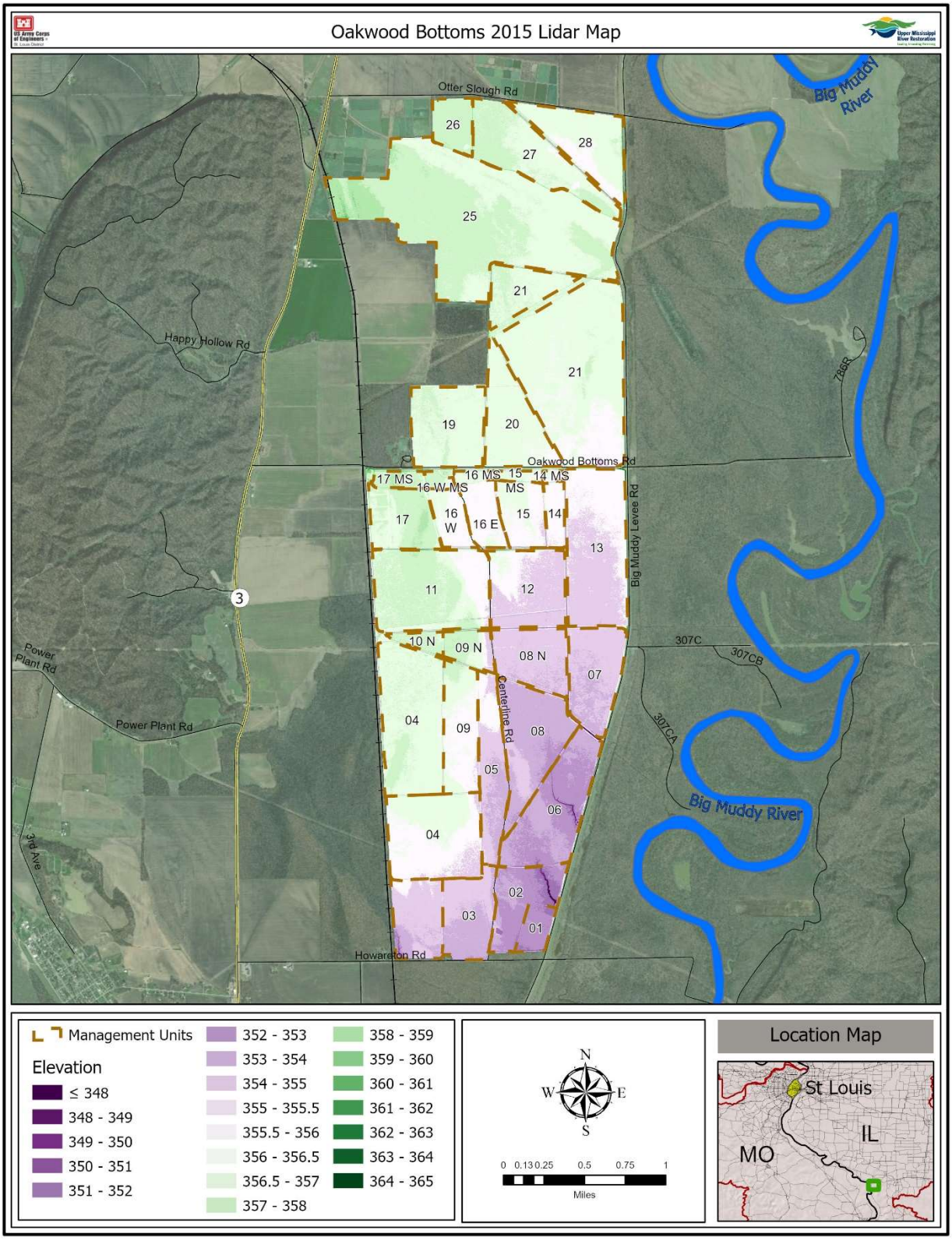

Figure 6. Topographic Elevation Map of OBGTR.

2.1 Current Management

Current management of the 4,700-acre OBGTR is guided by the Shawnee National Forest Land and Resource Management Plan (USFS 2006). The Shawnee National Forest is divided into 15 management area prescriptions. Each management area has specific management prescription that guides the on the ground management. The Oakwood Bottoms Management Prescription provides direction for bottomland-forest ecosystem located within the Mississippi River floodplain. The management emphasis provides flooded habitat for migratory and over-wintering waterfowl and other game and non-game species, including songbirds, raptors, reptiles, amphibians and other native wetland species (USFS 2006).

Desired land classifications and percentages relative to the OBGTR of each habitat type are outlined in Table 2. Figure 7 shows UMRR-LTRM land cover classifications within the study area in 2011.

Table 2. Oakwood Bottoms Composition Objectives Modified From The Shawnee National Forest Land And Resource Management Plan (USFS 2006).

Habitat Type	**Management Area**
Permanent Water Bodies	1%
Forest Openings for Moist-soil	2-4%
Bottomland Hardwood Types	91-95%[1]
Tree Age-Class Distribution Objectives	10-20% Age 0-9; 40-60% Age 30-60; 10-20% Age 60-80
[1] At least 60% oak types. This will be primarily pin oak, with other oak species, such as cherrybark, chinquapin and willow, where appropriate.	

The 33 management units are shown in

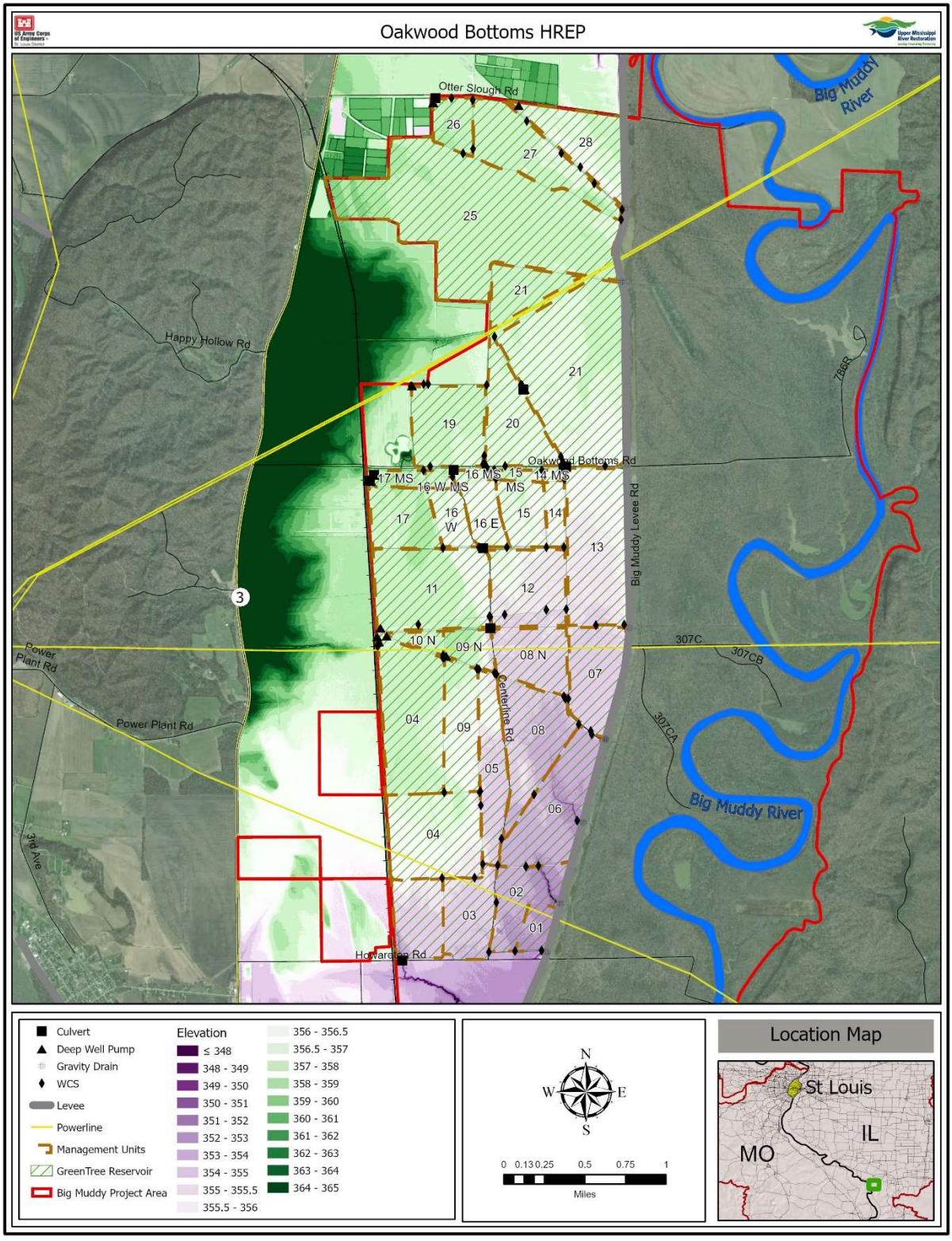

Figure 8, with the locations of Water Control Structures allowing flow between the units.

The OBGTR is annually flooded in the fall for migratory waterfowl habitat. The flooding typically starts near October 1 and continues through December until the management units have reached capacity. The typical filling period is approximately 45 days in duration to reach desired water elevations. Draining of the OBGTR can begin as early as January 15 but some management units may not be fully drained until May 1 (USFS 2006). Due to the complex and degraded infrastructure, draining necessitates water movement through multiple units to reach eight gravity drains through the Levee.

Management activities include prescribed burning, timber-stand improvement, reforestation, temporary road construction and maintenance, moist-soil areas/openings maintenance, berm, and ditch construction and maintenance, and controlled flooding. More details of site specific management of the OBGTR can be found in the Shawnee National Forest Land and Resource Management Plan (USFS 2006).

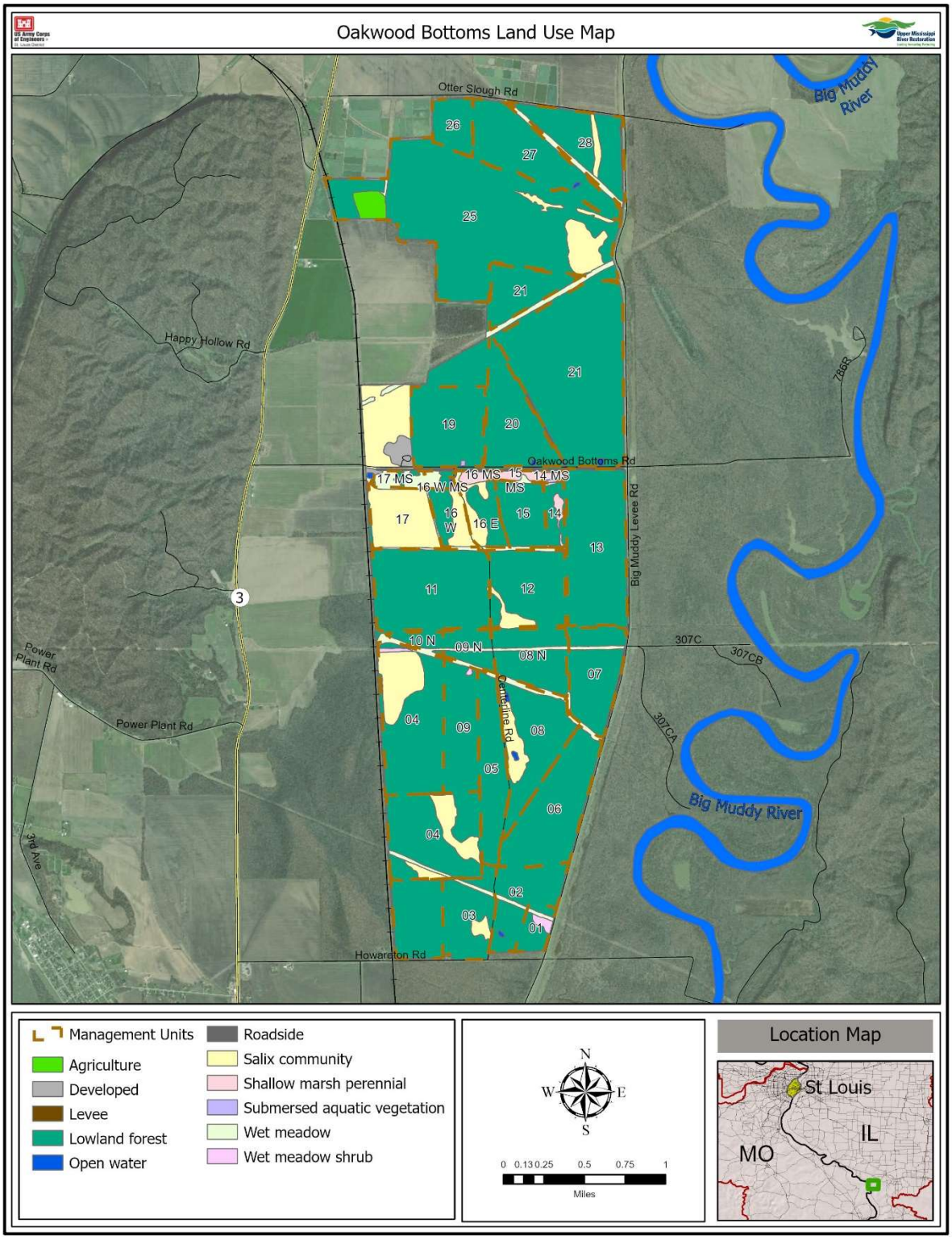

Figure 7. OBGTR 2011 LTRM Landcover Classification.

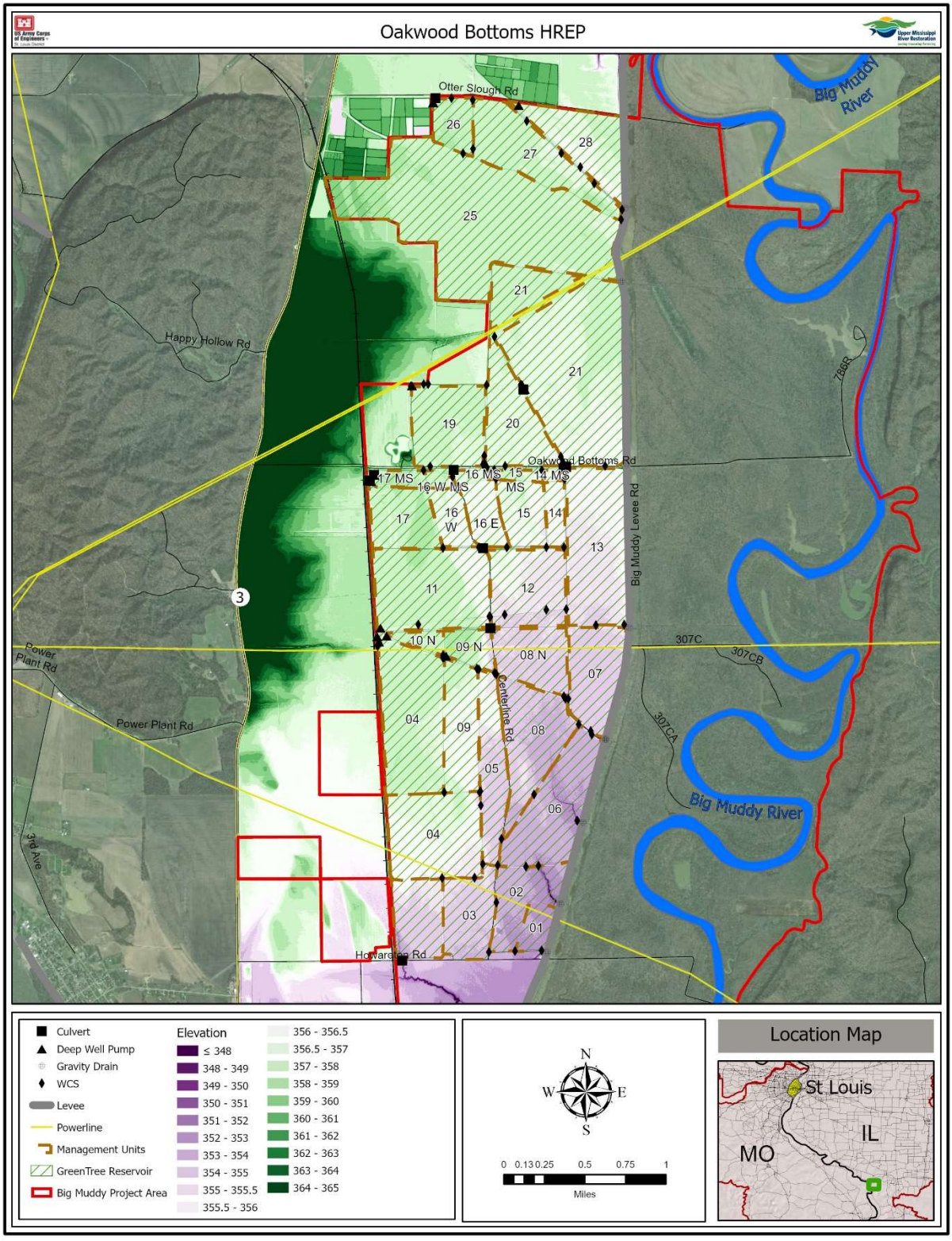

Figure 8. Topographic Elevation Map of OBGTR with Existing Water Control Structure Locations and Management Unit Boundaries.

Moist Soil Unit Management

Guidelines provided within the Oakwood Bottoms Wildlife Management Plan indicate up to 200 acres of permanent moist-soil openings should be provided, with a minimum size of five acres (Frederickson & Lauhban 1990; USFS 2006).

In 1995 the USFS in partnership with the National Wild Turkey Federation designed and constructed five moist soil units (MSUs). This created approximately 79 acres of moist soil habitat managed separately from the other bottomland forest dominant greentree reservoir units. An additional 17 acres of moist soil habitat are interspersed throughout management unit 14. Units 13-17 are designed with a direct water supply line that provides water directly to each unit. Water supply can be regulated within each unit by a gate valve. Stop logs and slide gates also control the water depth and ability to drain these units.

The MSUs are manipulated by water level management to encourage and promote growth of native herbaceous wetland flora. Mechanical disturbance is used on a two year interval/cycle to maintain plant diversity and reduce woody plant encroachment (USFS 2014). Native and non-native invasive species may be controlled through means of water level management or mechanical disturbance.

2.2 Hydrology & Hydraulics

In the 1800s, European settlement began and altered the watershed of Oakwood Bottoms. The largest alterations began in the late 1800s and early 1900s when the area was used primarily for agriculture. During this time, construction of drainage ditches occurred. This allowed for faster drainage of water on site than would have occurred naturally. In 1945, with the completion of the Grand Tower and Degognia Levee System, the natural hydrologic regime within Oakwood Bottoms was further altered through the disconnection of the floodplain and resultant loss of an extended floodplain inundation during the spring flood pulse. Ultimately, these changes to the floodplain created drier conditions that are preferred by oak trees.

The record flood events of 1993, 1995, and 2019 affected lands exterior and interior of the Levee. Flood waters interior of the Levee remained trapped within OBGTR through the summer due to closed gravity drains through the Levee due to external high water elevations. Figure 9 shows the February through March duration curve of the Mississippi River and Big Muddy River with gravity drains through the levee plotted by river mile and elevation. Figure 9 shows that approximately 33% of the time during February through March, some of the gravity drains through the levee are prohibited from freely draining by the Big Muddy River. During this time, water is trapped on the land-side of the levee. If this happens during the growing season, the trapped water negatively impacts forest health as trees become stressed or are killed. This then changes overall forest composition to include more water tolerant species. Figure 10 shows the average daily stages for two periods of record (1901-1960, 1961-2019) on the Mississippi River at Grand Tower. The plots for both periods of record show a general increase in stage during early spring through early summer. It is also interesting to note that, throughout the entire calendar year, average daily stages are higher for the

1961-2019 period than for the 1901-1960 period.

OBGTR is flooded around October 1 and drainage begins around January 15. Currently, there are 33 separate management units in OBGTR with 92 Water Control Structures, which consist of corrugated metal pipes, stop-log structures, and slide gates. The 33 management units are separated by earthen berms which vary in height but are approximately three to five feet tall, depending on their location.

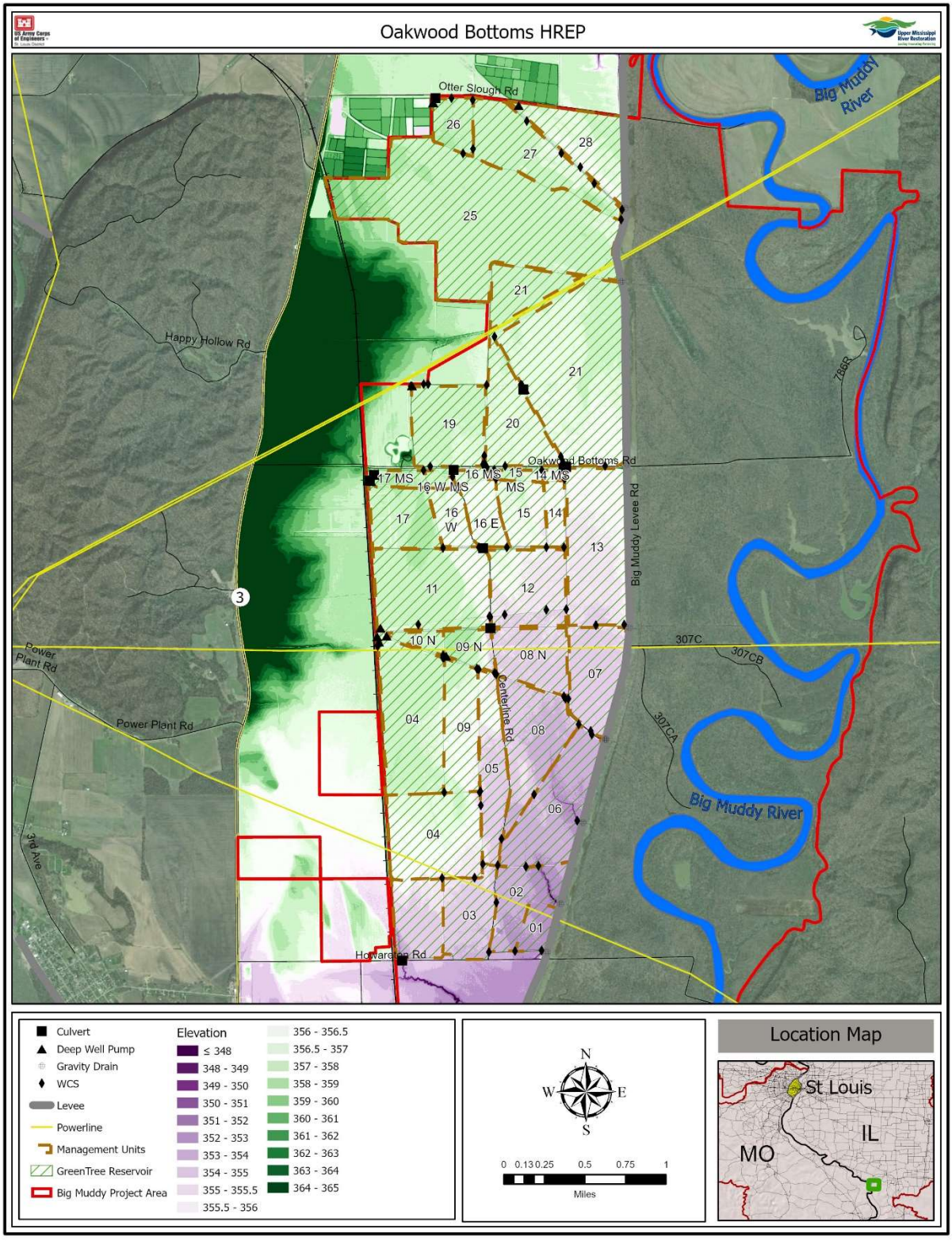

Figure 8 displays the current management units and structures overlaid on site

topography showing the location of existing water control structures, which total 115 structures. Currently, it takes the Forest Service approximately 45 days to drain the OBGTR in the spring because of the high number of units and associated water control structures.

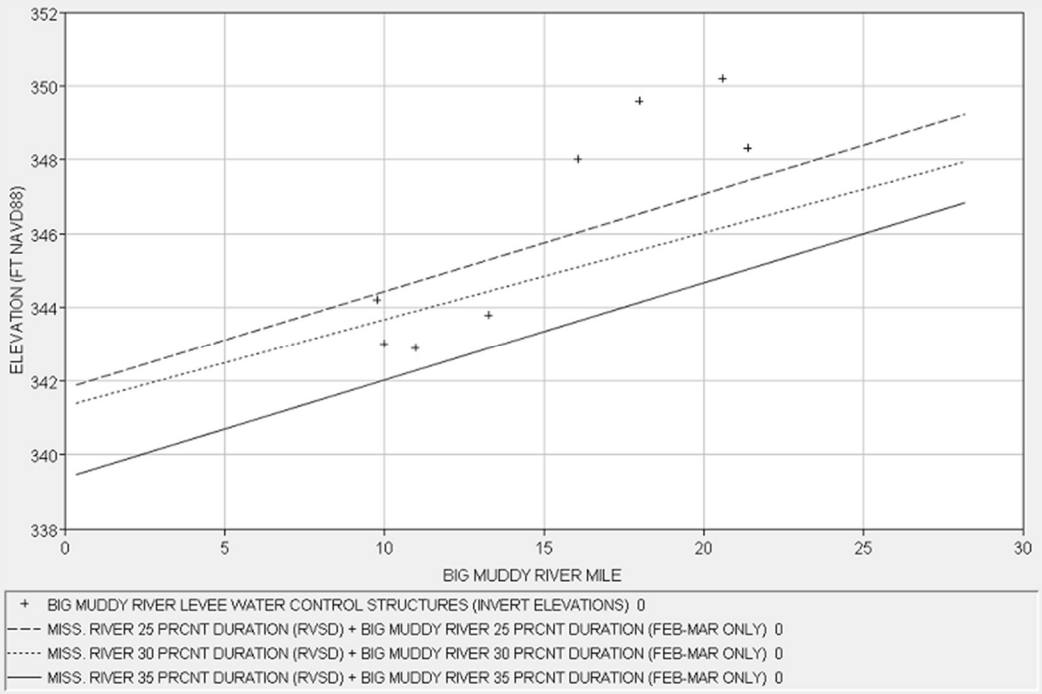

Figure 9. Duration Analysis for Period of 01 February-31 March and Invert Elevations of Levee Water Control Structures.

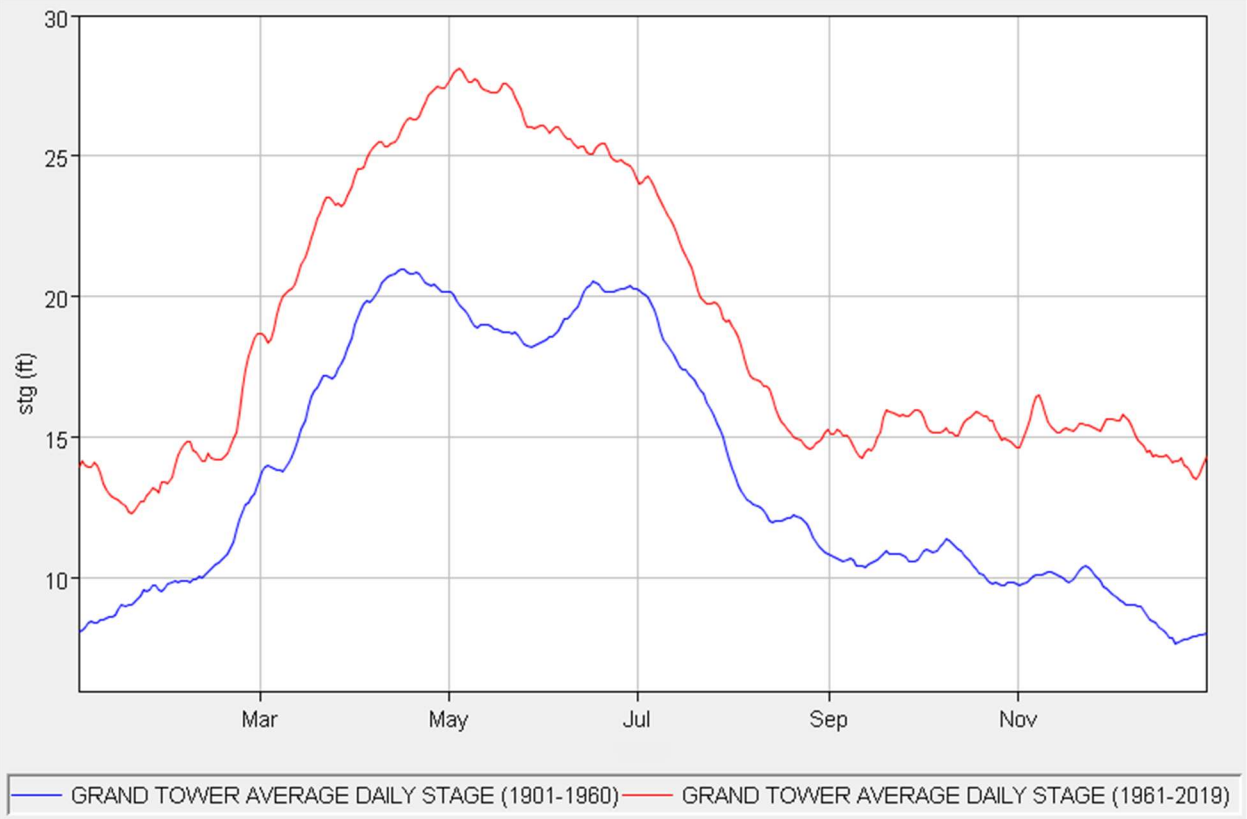

Figure 10. Mississippi River at Grand Tower Average Daily Stages for Two Periods of Record (1901-1960, 1961-2019).

2.3 Floodplain Forest

2.3.1 General

Based on the 2011 UMRR-LTRM land cover data, floodplain habitats within the study area include: bottomland forest, emergent wetland, developed recreation, levee, grass/road ditches and open water. The floodplain habitats described by the UMRR-LTRM data indicate that the study area is dominated by bottomland forest habitat. Maintained grass habitat, such as levees and road ditches, represent nearly ten percent of the study area. Emergent wetland habitat includes the MSUs as well as smaller inclusions with the bottomland forest habitat type. Several smaller interior ponds contain a small amount of open water habitat (0.04%); however, the amount of open water within OBGTR is greater during the periods when the management units are flooded for the waterfowl migration season (Nov-March).

2.3.2 Bottomland Hardwood Forest

2.3.2.1 2018 Forest Inventory Summary

The bottomland forest within the study area can broadly be defined as mature, which means that overall, the trees are near the end of their lifespan. Figure 13 shows the tree species composition of the study area with pin oaks being the dominant species at 33% of the total live and dead trees. Collectively, all oak species account for 46% of

total live and dead trees in the study area. Figure 14 shows the distribution of forest type within the study area. Approximately 77% of forest stands within the study area contain oak species. More than 50% of the forest stands (approximately 2,300 acres) of the study area are dominated by oaks greater than 80 years of age or older.

The oak-dominated stands are predominantly even-aged or two-aged stands. Even-aged stands are stands of trees where the age difference between the youngest and oldest trees is less than 20 percent. They are problematic because they experience little disturbance caused by the death of older trees, and so tend to restrict seedling recruitment to shade-tolerant species due to continuous low light levels on the forest floor. Within the highly altered OBGTR, excessive flooding during seasonal periods that does not mimic a natural flooding regime exacerbates the even-aged structure of the stands. The two-aged stands reflect the recent USFS forestry management of thinning and planting through the implementation of the *Big Muddy River Bottoms Habitat Improvement Project* (2007).

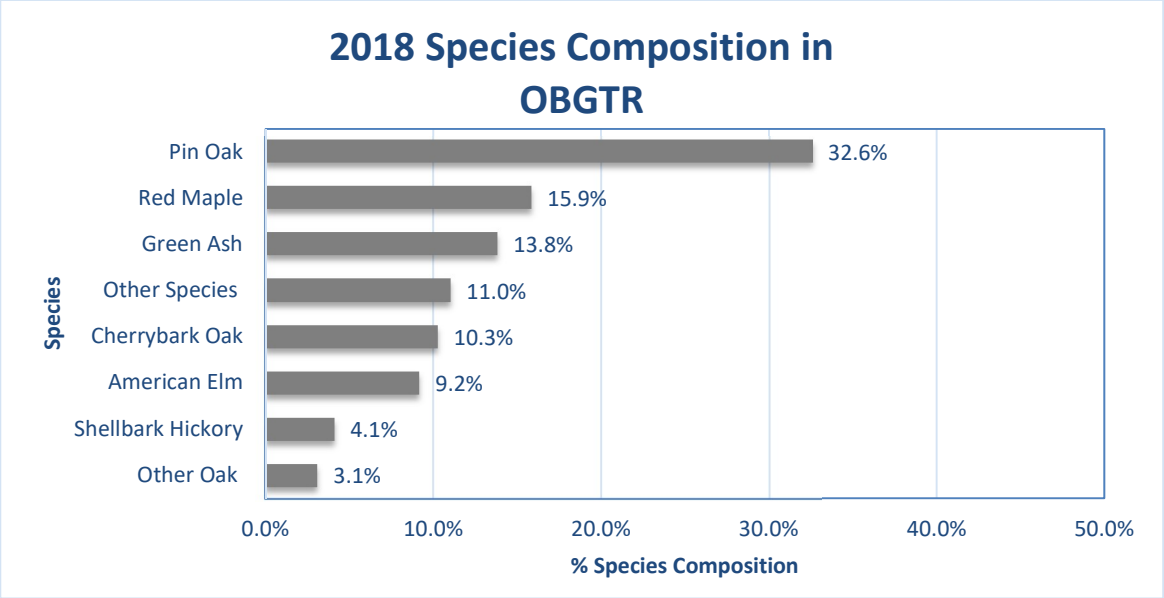

Figure 10. OBGTR Tree Species Composition, *2018 Forest Inventory Data.

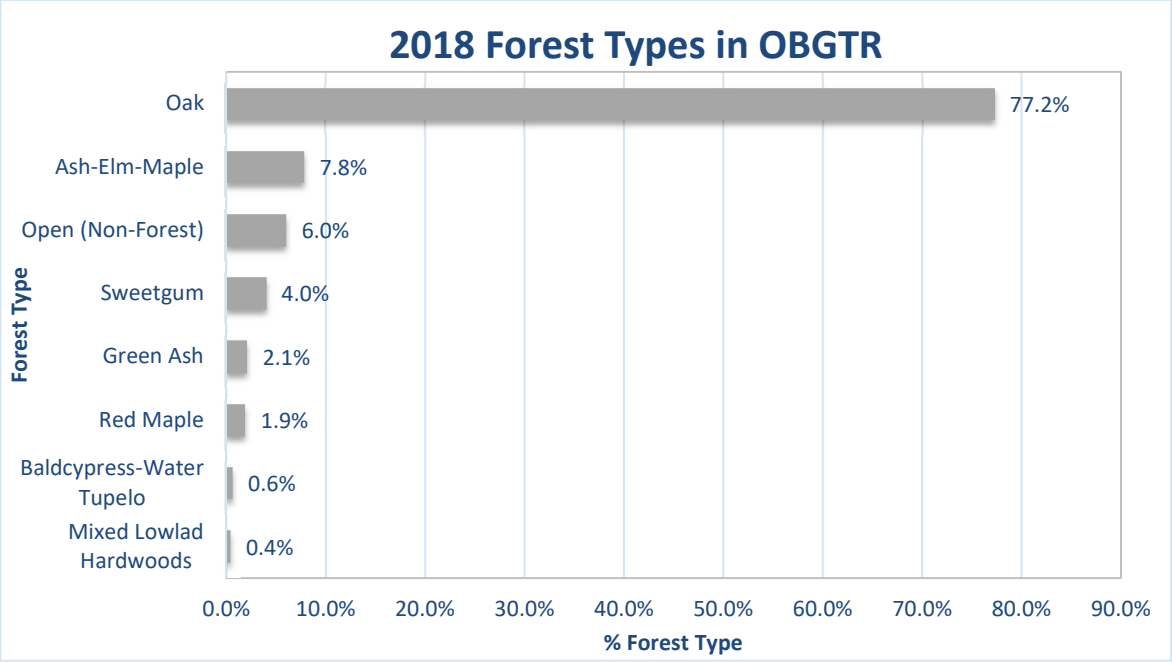

Figure 11. Forest Type Distribution within OBGTR, *2018 Forest Inventory Data.

2.3.2.1.1 Dead and Dying Trees

The proportion of dead and dying trees within the study area provides insight into the current forest health condition. The 2018 forest inventory data shows that nearly 11.3% of the forest is currently in a state of decline, which refers to trees that are exhibiting loose bark, heartwood or sapwood decay, or to dead or dying portions of individual tree canopy. Individual trees in a state of decline are typically in the process of dying, whether from old age or prematurely due to stressing factors. An average of 19 trees per acre are either standing dead snags or have recently succumbed to mortality, across all species.

As oak species comprise the majority of live and dead tree species within OBGTR (combined total of 46.0%, shown in Figure 123), similarly, 69.9% of the trees in decline are oak, primarily pin oaks. Pin oaks are dying due to a combination of factors including but not limited to age, insects, disease, and stressors such as fire and periods of prolonged flooding. The Shawnee National Forest Plan (2006) requires an oak component to exist within Oakwood Bottoms. Therefore, the lack of oak regeneration and failing oak overstory, the tallest and most mature tree layer, presents a problem for the future management objectives at Oakwood Bottoms. Action is required now to improve forest health and increase oak recruitment for the future of the site.

2.3.2.1.2 Age Class

Table 3 shows the existing tree age class distribution across all species for the study area. Stands over 80 years of age comprise the majority of the study area.

Table 3. OBGTR Existing Forest Age Class Distribution (2018 Forest Inventory).

AGE CLASS	% Existing Condition	Existing Condition (Acres)
0-9	6.0	275.4
10-29	1.3	61.6
30-60	19.6	898.5
61-80	16.7	767.0
81-100	46.1	2,113.5
100+	10.1	464.6

2.3.2.1.3 Regeneration and Recruitment

Within the OBGTR, the dominant tree seedling and sapling species identified consisted of green ash, red maple, and American elm, representing a combined total of more than 80% of the regeneration layer (Figure 12). These species are shade-tolerant, non-nut producing trees, are lower quality habitat for waterfowl and neotropical migrants. With the understory being non-oak (less than 10%), the forest community will transition to a degraded maple-ash-elm community in the future under the current management regime.

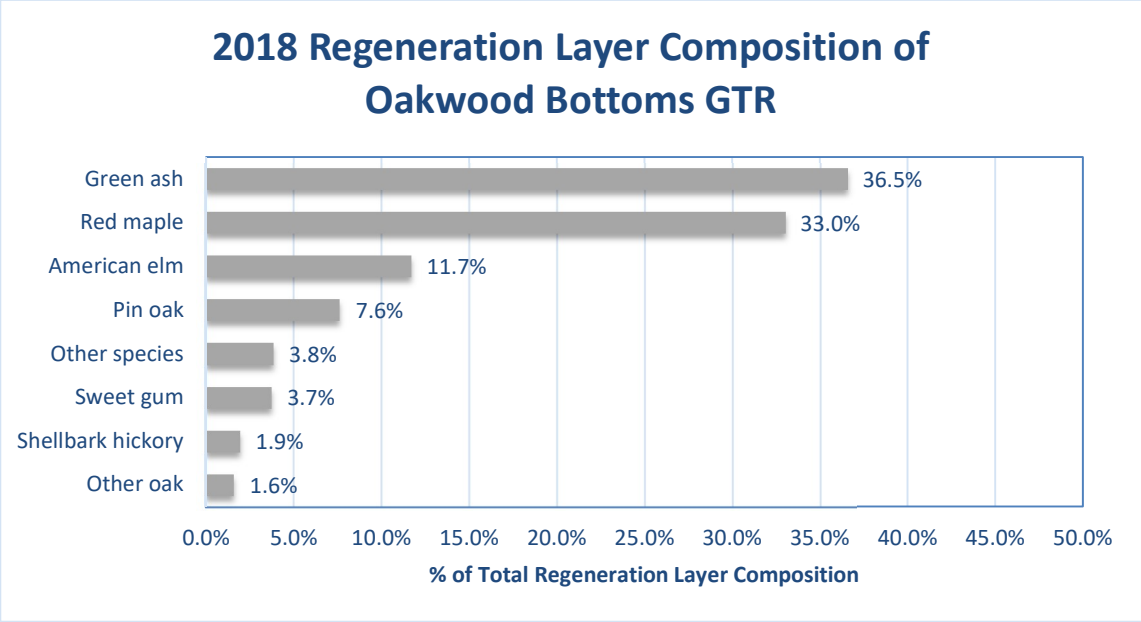

Figure 12. OBGTR Existing Tree Regeneration Species Composition.

2.3.2.2 Timber Management

The Oakwood Bottoms management area prescription outlined within the Shawnee National Forest Land and Resource Management Plan allows for timber management within Oakwood Bottoms by commercial or non-commercial means to meet objectives other than timber production. The USFS management objectives for Oakwood Bottoms area include wildlife habitat management; the enhancement of recreational or visual

quality; management of endangered, threatened or sensitive species; fuels management; pest management; control of non-native invasive species; prevention of significant resource loss; and/or protection of existing investments or developments (USFS 2006).

Forest stands within Oakwood Bottoms have been historically managed on 40-80 age rotations from USFS land acquisition until the mid-1980s. The 2007 Big Muddy River Bottoms Habitat Improvement Project proposed action included Timber Stand Improvement (TSI), prescribed burning, and reforestation. Figure 13 shows areas where the TSI has been implemented by year. The TSI concentrated on reduction in shade-tolerant species within the forest understory. Targeted non-desirable trees less than 9" diameter at breast height (DBH) were chainsaw felled to reduce competition and increase light levels to allow for the development of desirable species such as pin oak *(Quercus palustris)* and cherrybark oak *(Quercus pagoda)*, which are shade-intolerant. TSI actions were conducted from 2007-2018. Current plans from the 2018 Big Muddy River Bottoms Habitat Improvement Project II EA includes herbicide treatment of cut stumps within OBGTR, invasive species control and prescribed burning. Herbicide would further reduce the ability of non-desirable trees to re-sprout, maintaining a more consistent desirable forest structure necessary for recruitment of oak species. Herbicide treatment was implemented in the summer of 2018 within portions of OBGTR management units 2, 3, 4 and 10.

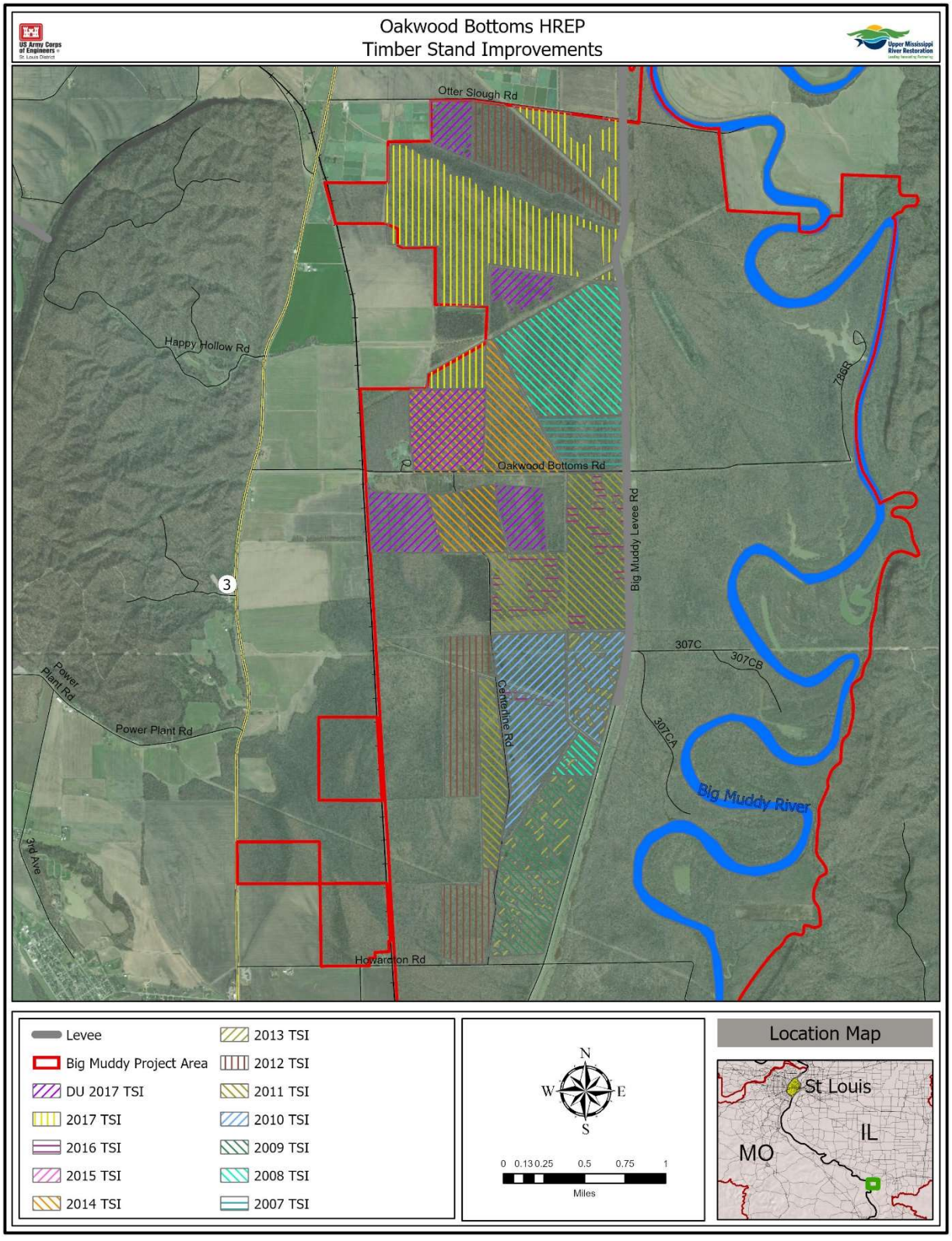

Figure 13. Locations of Previous Timber Stand Improvements (TSI) At OBGTR.

2.4 Aquatic & Wetland Resources

Wetlands serve as sources and sinks for multiple biological, chemical, and physical processes locally, as well as, on a landscape scale. Wetlands are often defined as having the presence of water, either at the surface or within the root zone; possessing unique soil conditions that differ from adjacent uplands; and supporting biota, especially vegetation adapted to wet conditions (Mitsch and Gosselink 2000). In the United States, over a period of 200 years, between the 1780s and the 1980s, the lower 48 states lost an estimated 53% of its original 221 million acres of wetlands. The wetlands that remain are degraded by fragmentation, siltation, altered hydrology, and the introduction of invasive species (Havera et al. 1997, CTAP 2001). Within the MMR, wetlands existed in an area that is now approximately 80% leveed for agricultural use (Theiling 2000). Each of these stresses has reduced the ability of remaining wetlands to perform their ecosystem functions, including the provision of sustainable, diverse, and abundant wildlife populations.

Oakwood Bottoms is a critical mid-migration feeding and resting area of the Mississippi Flyway. Emergent wetlands provide habitat diversity complimenting the mast-producing forage habitat provided by surrounding oak species. The USFS currently manages approximately 80 acres of MSUs within the OBGTR. Moist soils are a USFS-desired management objective, with a target of two to four percent of the management area as a whole. Water levels within these areas are managed to promote waterfowl habitat and provide foraging opportunities. Native herbaceous plant species within this habitat type produce forage for numerous dabbling duck species, specifically mallards and wood ducks that frequent the surrounding OBGTR. Due to water management limitations limiting the ability of the Forest Service to drain the moist soil units at the appropriate time and appropriate speed, the species composition within the MSUs is dominated primarily by cattails and perennial sedge (*Carex spp.).* These two species can aggressively dominate large areas, but provide little value to migratory waterbirds because they do not produce seed that can be eaten.

2.5 Geology and Soils

Geology. The Mississippi River has been the primary drainage system for central North America since the Late Mesozoic period (the last 150 million years). The oldest floodplain deposits are from the Pleistocene glacial outwash which contains sand, gravel, and silty sands (Heitmeyer 2008). The current Mississippi River floodplain, including the study area, has formed and reshaped through repeated cycles of deposition, erosion, and lateral migration of the Mississippi River.

Soils. The soil in the study area (Figure 14) has been characterized by the Natural Resource Conservation Service as primarily Darwin and Jacob silty clays, undrained, frequently flooded soils; Jacob silty clay, occasionally flooded soils; and Booker silty clay, occasionally flooded soils. The soils are found on 0 to 2 percent slope and frequently flooded for long durations. The hydrologic soil group represented within the study area has a class D rating. This rating indicates the soils have a slow infiltration rate (high runoff potential) when thoroughly wet. These soils consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a

clay layer at or near the surface, and soils that are shallow over nearly impervious material. Hydric soil characteristics were observed within the top 10 inches in various areas. Hydric soils have been documented throughout the study area, which are soils that are sufficiently wet to develop anaerobic conditions during the growing season. Hydric soils are necessary for wetlands and are able to support forests.

Photo 1. OBGTR Soil Sample, 2019.

The USACE has not performed a geotechnical study and site investigation within the boundary of the project and no subsurface documentation within the area was accessible for review. A few borings from the original design of Grand Tower Levee District dated 1953 were available from outside the boundary, but had very limited information.

A hand probe sample was taken at the southern end of M-6-BD-2 berm. The materials at this location were visually classified as lean clay between 1 and 3 feet below the ground surface elevation.

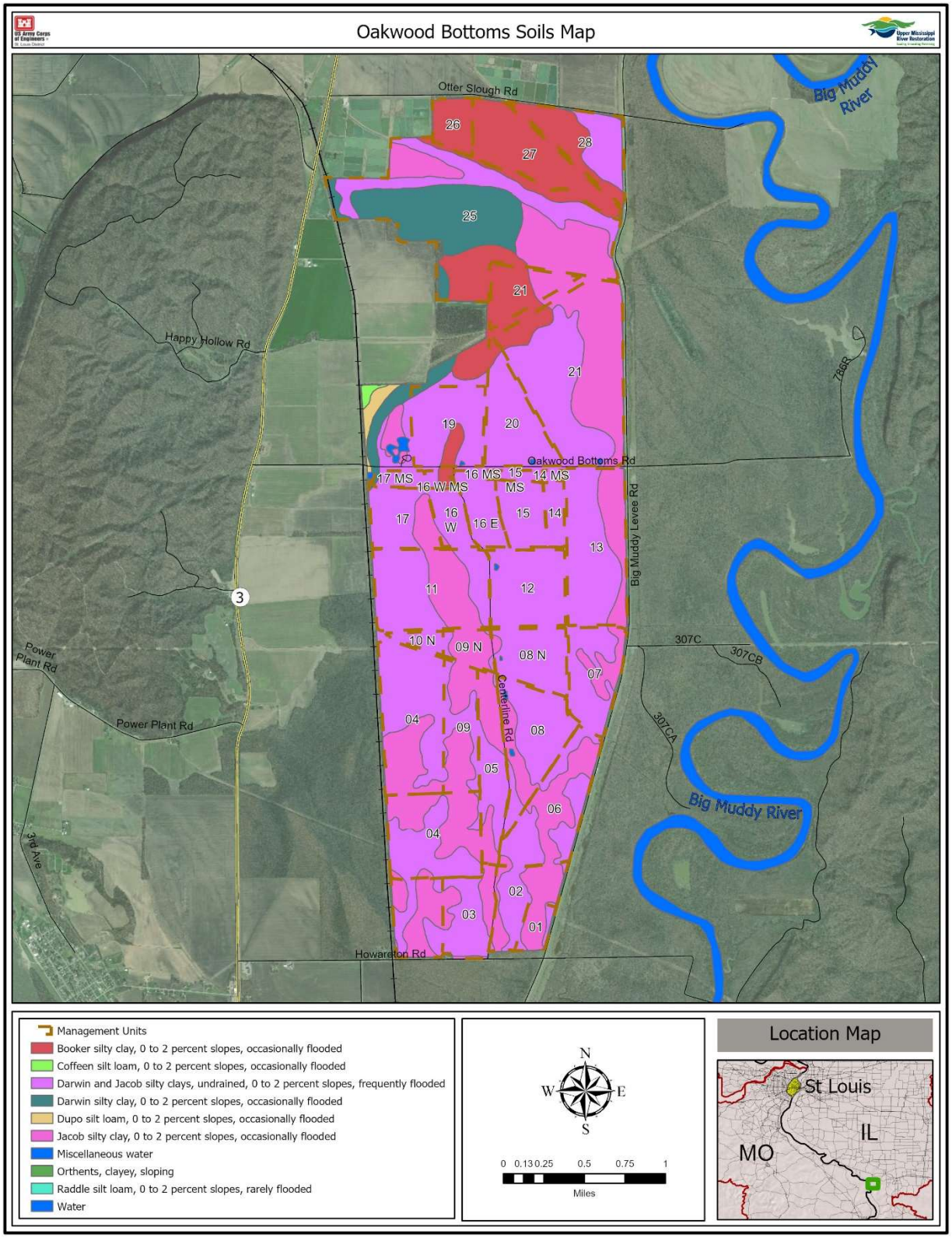

Figure 14. OBGTR Soil Classification.

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

Prime farmland is land considered to have the best combination of physical and chemical characteristics for producing food and feed. Jacob silty clay, Dupo silty clay, Booker silty clay and Darwin silty clay soil types are considered to have prime farmland characteristics. These soils tend to be slightly acidic to alkaline, with PH ranging from 4.7 to 7.0 respectively (USDA Web Soil Survey, 2020). The areas classified as prime farmland are not currently in agricultural production.

2.6 Wildlife

The OBGTR provides an array of habitat for a large number of waterfowl and neo-tropical migrant bird species, as well as, large terrestrial game species such as whitetail deer and wild turkey. Recreational hunting opportunities are provided within the OBGTR for these game species. The Forest Service manages a waterfowl refuge area within the OBGTR, to provide habitat for migrating waterfowl species during both fall and spring migrations. Hunting is not allowed within the designated refuge area, which during the 2019 waterfowl hunting season included the MSUs along Oakwood Bottoms Road as well as Units 11, 12, 13, 14, 15, 16E, 16W, and 17.

The Shawnee National Forest management direction outlined within the 2006 Shawnee National Forest Land and Resource Management Plan (SNFLRMP) provides guidance for wildlife management within OBGTR as follows.

2.6.1 Migratory Birds

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

Floodplain complexes and the habitat provided are highly important to migratory bird species such as neotropical migrants. Ongoing monitoring has yielded positive results showing that tree thinning is having a positive effect on the relative abundance of several forest bird species. Sixteen species of forest birds are showing a positive response to the thinning, including a number of species that are on the Species of Greatest Conservation Need (SGCN) list for Illinois (Red-shouldered Hawk (*Buteo lineatus*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Yellow-billed Cuckoo (*Coccyzus americanus*), Prothonatary Warbler (*Protonotaria citrea*), Kentucky Warbler (*Geothlypis formosa*), and Yellow-breasted Chat (*Icteria virens*)) (IWAP, 2016).

Neotropical migrants are bird species that breed in North America but migrate to wintering grounds in Mexico, Central and South America, and the Caribbean Islands. Populations of neotropical migrants have continued to decline over much of the last century. Much of this decline is due to habitat loss in areas used for wintering, breeding, and migration. Floodplain forests serve as some of the most densely populated and diverse avian habitat in North America with high species richness and high abundances (Best 1996, Knutson 1995, Twedt and Portwood 1997). In particular, the UMR serves as a major corridor for neotropical migrants within the Mississippi Flyway (Grettenberger 1991). It has also been documented that neotropical species

prefer foraging on insectivorous guilds associated with hard mast tree species occurring in the UMR (Gabbe 2002). Habitat fragmentation has contributed to declines in abundance of neotropical migrants within the UMR (Knutson 1995). Specifically, bird abundance and species richness declines associated with forest community species shifts from a higher composition of hard mast trees to a higher composition of flood tolerant tree species after the 1993 flood have been documented in the UMR (Knutson 1997). A study completed at Harlow and Wilkinson Islands demonstrated that lower bird species diversity is correlated with early successional forested habitat exhibiting a relatively high percentage of flood tolerant tree species (Knutson *et al* 2005).

This unimpounded reach is within the Mississippi Flyway, which had waterbird populations that were historically large and diverse (Bellrose 1968, 1980), with trade markets for ducks and geese being common as the greatest concentration of bird species in Illinois existed in this area (USACE 2009). Although most waterfowl species in North America have had an overall increase in populations since the 1950s, species like the northern pintail (*Anas acuta*), lesser scaup (*A. affins*), and greater scaup (*A. marila*) have seen a population decline (USFWS 2014). Species like these utilize valuable overwintering and migration habitats present in the MMR. Wetland habitat utilized by waterfowl has been in decline in the MMR. Specifically, bottomland hardwood forests along the Mississippi River in this region are famous for their ability to support large winter populations of waterfowl (Tiner 1984). Today, waterfowl numbers are highly concentrated in remnant wetland complexes (Heitmeyer 2008).

The area has been designated by the National Audubon Society as an Important Bird Area for waterfowl and wading birds and by the Central Hardwoods Joint Venture as a wetlands focus area in the Central Hardwoods Bird Conservation Region.

USFWS provided species lists for migratory birds of concern that may be affected by management measures implemented in the study area (Table 4).

Table 4. U.S. Fish and Wildlife Provided List of Migratory Birds of Concern with Potential to Exist in the Study Area.

Name / Level of Concern	Breeding Season
Bald Eagle *Haliaeetus leucocephalus*	Breeds Sep 1 to Jul 31
Blue-winged Warbler *Vermivora pinus*	Breeds May 1 to Jun 30
Cerulean Warbler *Dendroica cerulea*	Breeds Apr 23 to Jul 20
Eastern Whip-poor-will *Antrostomus vociferus*	Breeds May 1 to Aug 20
Kentucky Warbler *Oporornis formosus*	Breeds Apr 20 to Aug 20
Lesser Yellowlegs *Tringa flavipes*	Breeds elsewhere
Prairie Warbler *Dendroica discolor*	Breeds May 1 to Jul 31
Red-headed Woodpecker *Melanerpes erythrocephalus*	Breeds May 10 to Sep 10
Rusty Blackbird *Euphagus carolinus*	Breeds elsewhere
Semipalmated Sandpiper *Calidris pusilla*	Breeds elsewhere
Wood Thrush *Hylocichla mustelina*	Breeds May 10 to Aug 31

2.7 US Forest Service Resources

2.7.1 Regional Forest Sensitive Species

Through the development of the SNFLRMP, a list of Regional Forest Sensitive Species (RFSS) was developed for each county in which the Shawnee National Forest resides. The list of species is used to guide and inform management decisions.

Table 5 lists the Regional Forest Sensitive Species for the Shawnee National Forest Land and occurring in Jackson County, IL that may be affected by the proposed management measures. Biological Evaluations were prepared by the US Forest Service for the RFSS, Species of Viability Concern (SVC), and Management Indicator Species (MIS) occurring at OBGTR. The BEs can be found in Appendix F – *Habitat Evaluation* with more detailed information on the distribution, status, and potential impacts analysis.

Table 5. Forester Sensitive Species Known to Occur Shawnee National forest in Jackson County, IL.

Regional Forest Sensitive Species	Guild/Group
Timber rattlesnake (*Crotalus horridus*)	Reptile
Alligator Snapping Turtle (*Macrochelys temminckii*)	Reptile
Mississippi Green Watersnake (*Nerodia cyclopion*)	Reptile
Flat-headed Snake (*Tantilla gracilis*)	Reptile
Eastern Narrow-mouth Toad (*Gastrophryne carolinensis*)	Amphibian
Bird-voiced Treefrog (*Hyla avivoca*)	Amphibian
Illinois Chorus Frog (*Pseudacris streckeri illinoensis*)	Amphibian
Redspotted Sunfish (*Lepomis miniatus*)	Fish
Bantam Sunfish (*Lepomis symmetricus*)	Fish
Henslow's Sparrow (*Ammodramus henslowii*)	Bird
Cerulean warbler (*Dendroica cerulea*)	Bird
Migrant loggerhead shrike (*Lanius ludvicianus migrans*)	Bird
Swainson's warbler (*Limnothlypis swainsonii*)	Bird
Tri-colored Bat (*Perimyotis subflavus*)	Mammal
Little Brown Bat (*Myotis lucifugus*)	Mammal
Eastern Small-footed Myotis (*Myotis leibii*)	Mammal
Southeastern Myotis (*Myotis austroriparius*)	Mammal
Black Sandshell (*Ligumia recta*)	Invertebrate - Bivalve
Purple Lilliput (*Toxolasma lividum*)	Invertebrate - Bivalve
Short-tail Bactruid (*Bactrurus brachycaudus*)	Invertebrate - Crustacean
A Cave Oligate Isopod (*Caecidotea bicrenata whitei*)	Invertebrate - Crustacean
A Cave Isopod (*Caecidotea stygia*)	Invertebrate - Crustacean
Anomalous Spring Amphipod (*Crangonyx anomalus*)	Invertebrate - Crustacean
Bousfield's Amphipod (*Gammarus bousfieldi*)	Invertebrate - Crustacean
Indiana Crayfish (*Orconectes indianensis*)	Invertebrate - Crustacean
Kentucky Crayfish (*Orconectes kentuckiensis*)	Invertebrate - Crustacean
Bigclaw Crayfish (*Orconectes placidus*)	Invertebrate - Crustacean
Subtle Stygobromid (*Stygobromus subtilis*)	Invertebrate - Crustacean
Carinate Pillsnail (*Euchemotrema hubrichti*)	Invertebrate – Gastropod
Monarch (*Danaus plexippus*)	Invertebrate - Insect
Cavernicolous Springtail (*Sinella cavernarum*)	Invertebrate - Insect
A Millipede (*Ergodesmus remingtoni*)	Invertebrate – Other
A Cave Obligate Planarian (*Sphalloplana hubrichti*)	Invertebrate – Other
Appalachian bugbane (*Actaea rubifolia*)	Plant
Bradley's Spleenwort (*Asplenium bradleyi*)	Plant
Blackstem Spleenwort (*Asplenium resiliens*)	Plant
Sparselobe Grapefern (*Botrychium biternatum*)	Plant
Nottoway Valley Brome (*Bromus nottowayanus*)	Plant
American Bluehearts (*Buchnera americana*)	Plant
Broadwing Sedge (*Carex alata*)	Plant
Brome-like Sedge (*Carex bromoides*)	Plant
Cherokee Sedge (*Carex cherokeensis*)	Plant

Regional Forest Sensitive Species	Guild/Group
Giant Sedge (*Carex gigantea*)	Plant
Greater Bladder Sedge (*Carex intumescens*)	Plant
False Sop Sedge (*Carex lupuliformis*)	Plant
Black Edge Sedge (*Carex nigromarginata*)	Plant
Red Turtlehead (*Chelone obliqua var. speciosa*)	Plant
Soft Thistle (Cirsium carolinianum)	Plant
Finger Dogshade (*Cynosciadium digitatum*)	Plant
Greater Yellow Lady's Slipper (*Cypripedium parviflorum var. pubescens*)	Plant
Eastern Leatherwood (*Dirca palustris*)	Plant
French's Shootingstar (*Dodecatheon frenchii*)	Plant
Goldie's Woodfern (*Dryopteris goldieana*)	Plant
Wolf's Spikerush (*Eleocharis wolfii*)	Plant
Plain Gentian (*Gentiana alba*)	Plant
Arkansas Mannagrass (*Glyceria arkansana*)	Plant
Spiked Crested Coralroot (*Hexalectris spicata*)	Plant
American featherfoil (*Hottonia inflate*)	Plant
rock Clubmoss (*Huperzia porophila*)	Plant
Goldenseal (*Hydrastis canadensis*)	Plant
One-flowered False Fiddleleaf (*Hydrolea uniflora*)	Plant
Allegheny Stonecrop (*Hylotelephium telephioides*)	Plant
Butternut (*Juglans cinerea*)	Plant
Turk's-cap Lily (*Lilium superbum*)	Plant
Limber Honeysuckle (*Lonicera dioica var. glaucescens*)	Plant
Yellow Honeysuckle (*Lonicera flava*)	Plant
Southern Crab Apple (*Malus angustifolia*)	Plant
Guadeloupe Cucumber (*Melothria pendula*)	Plant
Illinois Wood Sorrel (*Oxalis illinoensis*)	Plant
American Ginseng (*Panax quinquefolius*)	Plant
White Wand Beardtongue (*Penstemon tubaeflorus*)	Plant
Heartleaf Plantain (*Plantago cordata*)	Plant
Grove Bluegrass (*Poa alsodes*)	Plant
Nuttall's Prairie Parsley (*Polytaenia nuttallii*)	Plant
Chestnut Oak (*Quercus montana*)	Plant
Maryland Meadowbeauty (*Rhexia mariana*)	Plant
Fewflower Nutrush (*Scleria pauciflora*)	Plant
Spring Lady's Tresses (*Spiranthes vernalis*)	Plant
Eastern Featherbells (*Stenanthium gramineum*)	Plant
American Snowbell (*Styrax americanus*)	Plant
Guyandotte Beauty (*Synandra hispidula*)	Plant
Pale False Mannagrass (*Torreyochloa pallida*)	Plant
Buffalo Clover (*Trifolium reflexum*)	Plant
Wood Wakerobin (*Trillium viride*)	Plant

Regional Forest Sensitive Species	Guild/Group
Threebirds (*Triphora trianthophora*)	Plant

2.7.2 US Forest Service DesignationsCongressionally Designated Areas

No congressionally designated areas exist within the project area. A candidate wild and scenic river, the Big Muddy River, is near the project area. The Shawnee National Forest Plan establishes a quarter-mile corridor along all candidate wild and scenic rivers be managed to retain the stream's classification-potential and eligibility for inclusion in the Wild and Scenic River system. The study area come within approximately one-third of a mile from the Big Muddy River. There are no potential wilderness areas nor inventoried roadless areas within or near the study area.

2.8 Illinois Resources of Concern

The IDNR EcoCAT Natural Heritage Database was accessed on 1 October 2019 and lists one Illinois Natural Area Inventory (INAI) Site as well as nine protected plant and or animal species in the vicinity (i.e., Jackson County, Illinois) of the study area. The INAI site is located outside of the study area, but is within close proximity (Table 6). The Illinois Natural History Survey has provided a list of species that could potentially exist within the study area (Table 7).

Table 6. INAI Sites Located within the Vicinity of the Study Area.

INAI Site	**Category**	**Location/County**
Fountain Bluff Geological Area	IV - Unusual concentrations of flora or fauna and high quality streams.	Jackson

Table 7. Illinois Species of Concern Potentially Occurring within the Study Area. List Provided by Illinois Natural History Survey.

Species	**State Status**
Timber rattlesnake (*Crotalus horridus*)	Threatened
Eastern wood rat (*Neotoma floridana*)	Endangered
Indiana bat (*Myotis sodalis)*	Endangered
Northern long-eared bat (*Myotis septentrionalis*)	Threatened
Gray bat (*Myotis grisescens*)	Endangered
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	Endangered
Manna grass (*Glyceria arkansana*)	Endangered
Swollen sedge (*Carex intumescens*)	Endangered
Cynosciadium (*Cynosciadium digitatum*)	Endangered
Winged Sedge (*Carex alata*)	Endangered
Finger Dogshade (*Cynosciadium digitatum*)	Endangered
Arkansas Mannagrass (*Glyceria arkansana*)	Endangered
One-flowered Hydrolea (*Hydrolea uniflora*)	Endangered
Pale Manna Grass (*Torreyochloa pallida*)	Endangered

Species	State Status
Smooth Softshell Turtle (*Apolone mutica*)	Endangered
Little Blue Heron (*Egretta caerulea*)	Endangered
Snowy Egret (*Egretta thula*)	Endangered
Mississippi Green Watersnake (*Nerodia cyclopian*)	Threatened
Marsh Rice Rat (*Oryzomys palustris*)	Not Listed
Flathead Snake (*Tantilla gracillis*)	Threatened

2.9 Bald Eagle

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 USFWS 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; rock promontories; rarely on the ground; and 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). Although mature trees fitting this description occur within study area, there are currently no known bald eagle nests within the study area.

2.10 Federally Threatened and Endangered Species

Bat species including the federally endangered Indiana bat (*Myotis sodalis*), the federally endangered gray bat (*Myotis grisescens*) he federally threatened northern long-eared bat (*Myotis septentrionalis*), and other floodplain species rely on the bottomland forest resources within the study area.

In compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, the USFWS provided a list of 5 federally threatened and endangered species that could potentially be found in the area (Jackson County, Illinois) via a letter dated 1 June 2019 (IPAC report) (updated 26 April 2020). See Appendix D - *Biological Assessment* for more details. The five species, federal protection status, and habitat can be found in Table 8. No critical habitat is located in the study area. The USFWS will provide a Draft Fish and Wildlife Coordination Act Report (FWCAR) for the OBGTR HREP which will be reviewed and concurred by the USFS and the IDNR (see Appendix A, *Coordination*). Additional up-to-date information will be provided in the USFWS draft FWCAR, which will be received prior to approval (Appendix A - *Coordination*).

Table 8. Federally Listed Species for the Study Area.

Name	Status	Habitat
MAMMALS		
Indiana Bat (*Myotis sodalis)*	FE	Hibernacula - caves and mines; Maternity and foraging habitat = small stream corridors with well-developed riparian woods; upland forest
Northern Long-Eared Bat (*Myotis septentrionalis*)	FT	Hibernacula - caves and mines; swarming in surrounding wooded areas in autumn; roots and forages in upland forests during spring and summer
Gray Bat (*Myotis grisescens*)	FE	Hibernacula - caves and mines; summer foraging habitat along rivers or lakes; roosts in caves scattered along rivers during the summer
BIRDS		
Least Tern (*Sterna antillarum*)	FE	Large rivers – nest on sandbars
FISHES		
Pallid Sturgeon (*Scaphirhynchus albus*)	FE	Mississippi and Missouri Rivers

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

2.11 Invasive Species (Executive Order 13112)

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 transfer from the study area.

The USFS identified an extensive list of invasive species that are likely to be present within the study area during analysis required for the Big Muddy River Bottoms Habitat Improvement II Project, which encompasses the spatial extent of the study area. The 2018 forest inventory data did not indicate the presence of invasive species. The vegetation survey of the MSUs also did not indicate the presence of invasive species. However, independent of field surveys, the potential of invasive species to exist and become a problem in the study area in future is understood.

Common invasive plant species likely to be present within the study area include winter creeper (*Euonymus fortunei*) and Japanese hops (*Humulus japonicus*). Winter creeper is native to China and commonly occurs within disturbed forests and woodland areas. The vine rapidly climbs up and over existing vegetation, outcompeting native vegetation for sunlight and nutrients. It can be dispersed through seed eaten by wildlife as well as water movement (Remaley 2005). Japanese hops is an herbaceous annual climbing vine native to East Asia that threatens floodplain forests and wetlands by forming a blanket of vegetation up to four feet thick, which smothers the existing vegetation. Its

seeds are dispersed primarily by means of wind, water and animals (MDC 2012).

Emerald ash borer has been observed throughout the region and continues to spread rapidly. Emerald ash borer, which is non-selective upon any ash (*Fraxinus* spp.) trees has the potential to decimate the entire ash tree population within the United States.

2.12 Water Quality

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

The UMRR-LTRM has been collecting and providing water quality data within various reaches of the Mississippi River reaches since the 1980s. Water quality is influenced by nonpoint source pollution from large agricultural watersheds adjacent to and north of the study area (RM 78-86), which contributes to high nutrient and suspended solids concentrations. The highest concentrations (> 500 mg/L) of Total Suspended Solids (TSS) in the UMR over a period from 1980 - 1999 were found below RM 200, within Hydrologic Unit Code (HUC 07140105) RM 0-118, adjacent to the study area. The high flows found within this stretch of the river along with high concentrations of TSS are mainly attributed to the turbid upstream inflows of the Illinois and Missouri Rivers (USEPA 2002).

The Big Muddy River watershed was evaluated and assessed for minimum water quality standards in the early 2000s. These water quality standards are developed and enforced by the state of Illinois in conjunction with the USEPA. Two sections (Kinkaid Lake and N12) within the upper Big Muddy River watershed are considered to be impaired in 2018 due to pH, mercury, manganese, sulfates and dissolved oxygen (DO) levels. Major contributing sources for elevated nutrient and pH levels are nonpoint source pollution from agriculture, stagnant stream conditions, and elevated in-stream temperatures. These areas are located within Jackson County, Illinois, approximately 8 miles north of the study area. Impaired waters listed under the CWA Section 303(d) have Total Maximum Daily Loads (TMDL) established to define the total amount of pollutants that may be discharged into a particular water body within any given day based on a particular use of that water body. TMDLs established for Kinkaid Lake include phosphorus, while TMDLs for section N12 include both manganese and sulfate (IEPA 2004).

2.13 Air Quality

The Clean Air Act of 1963 requires the USEPA to designate National Ambient Air Quality Standards (NAAQS). USEPA has identified standards for 6 pollutants: lead, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter (less than 10 microns and 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 Jackson County, Illinois currently meets all USEPA air quality standards and is not a designated maintenance area (USEPA 2018).

2.14 Greenhouse Gas Emissions and Climate Change

Climate change is a fundamental environmental issue, and is a particularly complex challenge given its global nature and inherent interrelationships among its sources, causation, mechanisms of action, and impacts. Analyzing a proposed management measure's greenhouse gas (GHG) emissions and how climate change may change a management measure's environmental effects can provide useful information to decision makers and the public. Climate change science is evolving, and is only briefly summarized here. In 1970 the Council of Environmental Quality estimated the level of atmospheric carbon dioxide to be 325 parts per million (ppm) (Council of Environmental Quality, 1970). Since 1970, the concentration of atmospheric carbon dioxide has increased at a rate of about 1.6 ppm per year (1970-2012) to approximately 400 ppm as of September 2016 (current globally averaged value) (U.S. Department of Commerce). Based on the United States Global Change Research Program as well as other scientific records, it is now well established that rising global atmospheric greenhouse gas emission concentrations are significantly affecting the Earth's climate (IPCC, 2014). A large body of scientific evidence indicates that increases in GHGs in the Earth's atmosphere are contributing to changes in national and global and climatic conditions (Melillo, 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.

2.14.1 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 UMR 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.

Summary of Future Climate Projection Findings:

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

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

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

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

2.14.2 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 the entire Missouri River watershed; and (2) local and

regional precipitation. In general, there is a seasonal pattern to the river's hydrology with peak flows typically occurring in the spring and early summer associated with rain and snowmelt followed by declining flows from early summer through early fall. In addition to the annual seasonal pattern of the river's hydrology, historical data shows an 11- to 15-year cycle of increasing discharge and flooding followed by declining flows and drought (Knox 1984; Franklin et al. 2003). Changes in hydrology (e.g., wet vs. dry periods) ultimately influence what floodplain habitats establish and are able to persist.

In terms of the study area, existing greenhouse gas emissions are related to public recreational use and the amount of visitation received throughout any given year. An estimated 2,000 vehicles visit the study area every year, commuting various distances. These vehicles consume an average of 1,065,398 gallons per year of gasoline or approximately 9,468 metric tons of carbon dioxide. This amount of consumption would be offset by preservation of 77.3 acres of forest (USEPA, 2015). The study area contains over 4,700 acres of forest that would not be converted to agriculture under the existing USFS management direction.

2.15 Hazardous, Toxic, and Radioactive Waste

A Phase I Environmental Site Assessment was prepared on 26 February 2019. The goal of the environmental site assessment process is to identify recognized environmental conditions (RECs) within a study area. The following is a brief synopsis of the report. Additional narrative is provided in Appendix C - Hazardous, Toxic, and *Radioactive Waste.*

USEPA's Enforcement and Compliance History Online (ECHO) database did not indicate any violations on the site. Generally, the study area contains no sites of interest, which pose significant environmental concerns. A Clandestine Drug Lab 1.2 miles east of Route 3 on Howardton Road was listed in the Orphan Summary of the Environmental Data Resources, Inc. (EDR) report. The Report indicates it was a dumpsite for drug making materials. This is a REC if drug making equipment was not cleaned up and properly dispose. No work is proposed in this area, so this REC should not effect this project. There were no observations made during the site visit that would be defined as REC. A listing of incidences are contained in Appendix C - *Hazardous, Toxic, and Radioactive Waste*. Questions for the manager of past spills that have occurred on any of these properties in the recent past is pending response.

2.16 Historical and Cultural Resources

The study area also has a low sensitivity for historic cultural resources given its geomorphological and environmental situation. Based on historical records, the area was very lightly settled in the historic period and only a small portion was ever cultivated. There are three known historic sites within the study area, but they are either ineligible for the National Register of Historic Places (NRHP) (i.e., Miller School) or not evaluated. Refer to Appendix E - *Historical and Cultural Resources* for more details.

In accordance with Section 106 and Section 101 of the National Historic Preservation Act, and 36 CFR 800.4, the Corps St. Louis District's tribal coordination efforts will be initiated in a letter to tribes as the project is further designed. Similarly, a letter report will

be sent to the Illinois State Historic Preservation Officer (SHPO). Correspondence for these activities will be included in the final report in Appendix A - *Coordination*.

2.17 Socioeconomic Resources

Recreational use within the study area is mainly characterized by waterfowl hunting opportunities. However, numerous other outdoor activities are available, including bird watching, fishing, camping, hiking, small and large game hunting, and nature viewing. The Big Muddy River offers river fishing and boating opportunities as well. The USFS lands throughout Jackson County offer numerous outdoor experiences for various recreational user groups.

The study area is located in Jackson County, Illinois. Jackson County has a population of 60,218 based on the 2010 U.S. Census Bureau estimate (U.S. Census Bureau, 2018). Based on the 2010 population estimate for Jackson County, 50% were female, 77.8% white, and 23.4% of all individuals have income in the past 12 months below the poverty level. Based on the 2012 American Community Survey, the median household income in Jackson County is $33,845 with an average household size of 2.32 people. The main industries providing employment in Jackson County include educational services and health care and social services (40.6% of workforce), retail trade (12.2% of workforce), and arts, entertainment, recreation, accommodation, and food services (9.7% of workforce). The unemployment rate for Jackson County is 4.7% as of July 2018 (Federal Reserve Bank of St. Louis, 2018).

Table 9. Household Income and Benefits for Jackson County, Illinois from 2010 Census Data.

Income and Benefits (In 2017 Inflation-adjusted Dollars)	Number of Households	Percent
Total households	23,942	23,942
Less than $10,000	4,109	17.20%
$10,000 to $14,999	1,710	7.10%
$15,000 to $24,999	3,497	14.60%
$25,000 to $34,999	2,401	10.00%
$35,000 to $49,999	3,092	12.90%
$50,000 to $74,999	3,393	14.20%
$75,000 to $99,999	2,110	8.80%
$100,000 to $149,999	2,010	8.40%
$150,000 to $199,999	931	3.90%
$200,000 or more	689	2.90%
Median household income (dollars)	36,008	
Mean household income (dollars)	56,162	

2.18 Aesthetic Resources

Aesthetic resources in the study area consist primarily of natural habitats. This includes forest, wetlands, sloughs, backwaters, and river habitats that serve as scenery for visitors. An approximately 3,500-acre upland bluff and ridge complex located between the Mississippi River channel and the study area provides an abrupt and scenic transition from the surrounding relatively flat landscape of the floodplain.

2.19 Noise Levels

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, trucks, and rail road traffic. The sound of firearms during hunting season is also commonplace.

A typical vehicle can produce 60-90 decibels (dB) of sound at a distance of 50 feet (USEPA 1974). A public boat ramp exists in close proximity to the study area introducing noise from recreational boat traffic. A pleasure boat's noise range can typically be between 65-115 dB (USEPA 1974). Locomotive noise can produce a range of 75-95 dB at a distance of 100 feet for all speeds (Lotz 1977). Freight locomotives frequently use the railway that borders the western edge of the OBGTR. Although a portion of the OBGTR is designated as a refuge, the majority of the study area is open for hunting. 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.

2.20 Environmental Justice (Executive Order 12898)

Under this Executive Order, a Federal agency "shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States." Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, and Pacific Islander. A minority population exists where the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population.

The standard unit of analysis for environmental justice is the census-designated block. Census block groups are geographic areas that are normally smaller than a size of city and provide city block or community-level census information. However, due to the rural location of the study area and the limited data, Jackson County and the State of Illinois were used.

In order to identify whether the potential alternatives may disproportionately affect minorities or impoverished citizens, an analysis was conducted utilizing census information provided from the U.S. Census Bureau 2010 Census. Due to the large geographic area of the authorized study area, the data are summarized at the county and state level in Table 10. The table shows that the combined minority population groups in Jackson County do not exceed 50% of the total population. The average income is above the poverty threshold.

Table 10. Population and Environmental Justice Characteristics within the Authorized Study Area.

Demographic information	Jackson County	State of Illinois
POPULATION		
Population Estimate (July 1, 2017)	58,284	12,802,023
Population, Census (2010)	60,218	12,830,632
AGE & SEX (July 1, 2016)		
Persons under 18	18.4%	22.6%
Persons over 65	15.0%	15.2%
Female persons	50.0%	50.8%
RACE & HISPANIC ORIGIN (July 1, 2017)		
White alone	77.4%	77.1%
Black or African American alone	15.2%	14.6%
Hispanic or Latino	4.4%	17.3%
Asian alone	3.8%	5.7%
American Indian/Alaskan native	0.5%	0.6%
EDUCATION (2012-2016)		
High school graduate or higher	92.3%	88.3%
Bachelor's degree or higher	35.9%	32.9%
INCOME & POVERTY (2016 dollars)		
Median household income (2012-2016)	$33,845	$59,196
Persons in poverty	23.4%	12.6%
BUSINESSES		
Unemployment rate (U.S. Bureau of Labor Statistics, 2018)	4.7%	4.2%

3 FUTURE WITHOUT PROJECT CONDITIONS

Forecasting the future is an essential part of the USACE planning process with the most important recurring forecasts being the future without project condition (FWOP) and the future with project condition (FWP). The purpose of the FWOP is the basis from which alternative plans are formulated and impacts are assessed (ER 100-02-1105) and can be defined as a story told about the future if the planning partnership takes no action (Yoe, 2012). The FWOP, considered the No Action Alternative, would not include any USACE project measures, and no additional costs to USACE would be generated.

A 50-year period of analysis was used to forecast the FWOP and FWP conditions. The economic period of analysis was limited to 50 years in accordance with USACE Regulations (ER 1105-2-100), even though management measures are anticipated to continue having beneficial effects beyond 50 years. The base year (the year when a proposed project is expected to be operational or, in this case, when construction is complete and benefits begin accruing) considered for this study is 2025, and the period of analysis continued until 2075.

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) Forest health would continue to degrade with the current hydrologic regime and water management infrastructure.
2) Oak tree species dominance would continue to decrease as shade-tolerant tree species recruit and develop, while mature oaks succumb to mortality.
3) Past and current management of water levels at the site has detrimentally impacted the native plant communities, and these communities will not naturally recover.
4) USFS will continue to maintain OBGTR as laid out in the Oakwood Bottoms Greentree Reservoir Operation Guide and Management Plan.
5) No substantial increases to USFS's budget for the study area's operation and maintenance will occur.
6) Public hunting and refuge areas will remain within the study area and waterfowl use will decrease proportionate to suitable habitat.

3.1 Hydrology and Hydraulics

As illustrated in **Error! Reference source not found.**, drainage of the study area is limited to times when the Big Muddy River is low and the gravity drains are open through the levee. Approximately 33% of the time during February through March, some of the gravity drains are prevented from freely draining by the Big Muddy River. The Mississippi River at Grand Tower yearly high stages from 1896 through 2019 are given in Figure 15. During this 124-year period, the yearly high stage varied from year to year. However, there is a general upward trend in the data. Several years having notable yearly high stages include 1973, 1993, 1995, 2016 and 2019. In long duration flood years, like 2019, the study area will remain inundated throughout the growing season. Structures and current berm configuration also limit the ability to effectively fill the OBGTR in the fall after the growing season ends and similarly the study area cannot be effectively drained in the spring prior to the growing season. These structures and berms have degraded severely since their installation in the 1960s and will continue to degrade as year-long inundation continues, which saturates berms and results in erosion of the berms. Many culverts are collapsed and berms are eroding due to increased saturation. The culverts will continue to clog with debris from wildlife without the ability to clean them out due to their small size, resulting in complete blockage. These structures and berms will continue to degrade until none are functional and water cannot be managed within the study area. Management of the OBGTR will further be hindered and the time in which water can be removed in the spring and added in the fall will likely be lengthened further. As more structures and berms become inoperable, the USFS will be unable to maintain the site, eventually leading to a complete lack of water management throughout the study area.

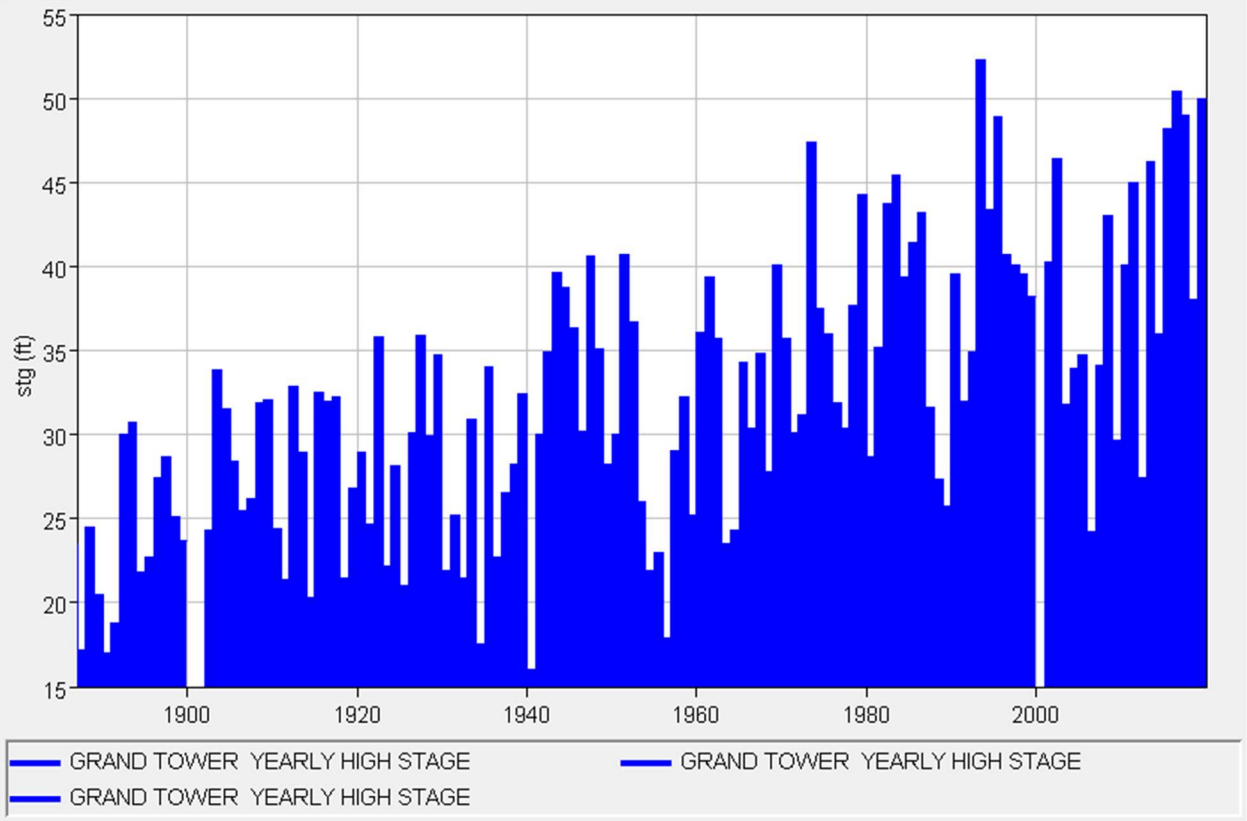

Figure 15. Mississippi River at Grand Tower Yearly High Stages during 1896 through 2019.

3.2 Bottomland Hardwood Forest

The high-risk forest stands within the study area include mature stands dominated by a high percentage of pin oak aged 80-100 years. Physiological maturity of pin oak *(Quercus palustris)* occurs at age 80-100 years (Burns, Honkala 1990), signifying a species compositional change within the next decade based upon current age of the dominant forest type if the lack of oak regeneration continues. At this point in which the pin oak forest reaches mortality, the seed source for oaks will disappear, resulting in a complete inability of the oak forest to regenerate itself through new seedlings. A maple, ash, elm forest will become dominant and will provide little benefit to resident and migratory wildlife. As the maple, ash, elm forest becomes established, restoring the oak forest will become nearly impossible without completely clearing the study area as oak species require favorable light conditions to regenerate and develop into saplings which is not present with a dense maple, ash, elm canopy. If floods similar to 1993, 1995, and 2019 continue to occur, the oak forest community will convert to maple, ash, elm at a faster rate, as these species are more water tolerant. The oak forest within the study area which is currently on the brink converting to maple, ash, elm will convert without the intervention of this project.

3.3 Emergent Wetland

The limited emergent wetland habitat within the study area would continue to degrade due to lack of effective water management. The emergent wetland, which is currently

lacking species diversity and is converting to woody species would continue without ability to be drained at the appropriate times and durations for proper MSU management. Conversely, as the inability of management continues, the emergent units cannot be filled fast enough in the fall to meet management objectives to provide migratory waterfowl habitat without simultaneously impacting the adjacent forest community. Without project, the emergent wetlands would completely convert to early successional forest consisting of maple, ash, elm, which provides little wildlife value but more specifically would limit migratory waterfowl habitat within the study area as well as the MMR region.

4 PROBLEMS AND OPPORTUNITIES*

Section 4 identifies the OBGTR resource problems, opportunities, objectives and constraints. Problem statements are concise characterizations of the broad issue addressed in the study. Opportunities are either related to solving the problem at hand or ancillary benefits. From the list of problems and opportunities, objectives for the study are drafted, and specific constraints for the study are identified.

4.1 Conceptual Model

A conceptual model (Figure 16) was developed to illustrate the interactions between drivers (i.e., climate, geology, ecological disturbance, and land use), essential ecosystem characteristics, and potential management measures. Essential ecosystem characteristics (EECs) are broadly defined categories of environmental features that are critical for sustaining ecological systems, and are valued by stakeholder interests (Nestler et al. 2010). Five EECs have been identified for the UMRS: Geomorphology, Hydrology and Hydraulics, Biogeochemistry, Habitat, and Biota (Lubinski and Barko 2003). The primary stressors for the study area are past and present land use, to include the Grand Tower and Degognia levee system. These stressors directly impact the Hydrology and Hydraulics EEC and the Habitat EEC. The potential measures were then identified to show how they interact with the various EECs.

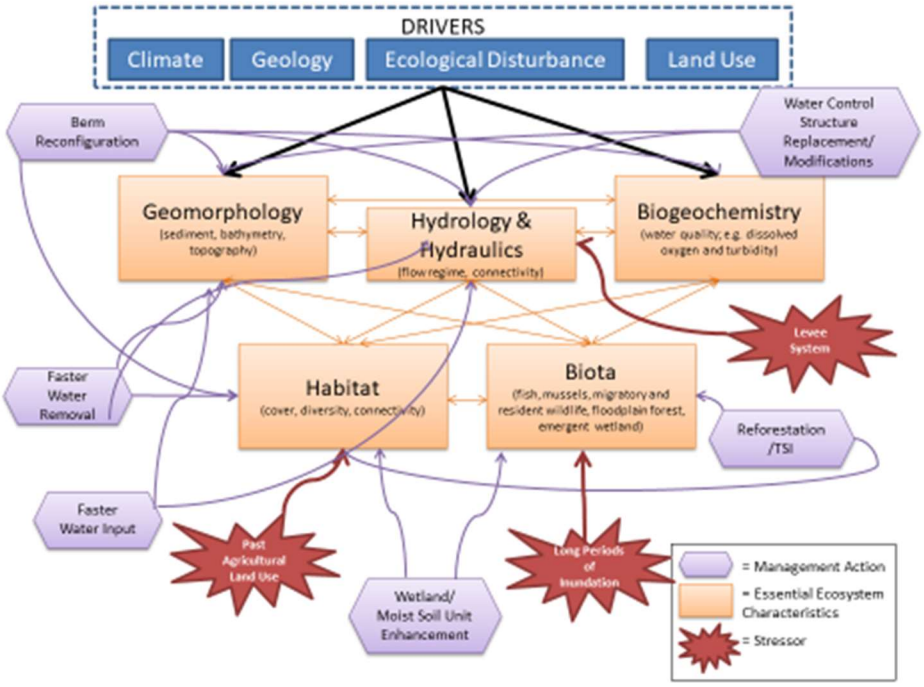

Figure 16. Conceptual Model for OBGTR HREP.

4.2 Problem Identification & Opportunities

There is a significant reduction in functional bottomland hardwood forest habitat and emergent wetland habitat in the OBGTR.

Problem 1: Unnatural water level fluctuations. Fluctuating water levels are important to creating and maintaining habitat for different plants and tree growth. As discussed in section 2, the levee system adjacent to the study area changed the function of the floodplain river dynamic. Currently, the land is managed to counter the loss of river connectivity to its floodplain; however, the current structure and processes do not mimic typical water levels at appropriate times, thereby reducing the ability of the study area to function for multiple habitat types, particularly bottomland hardwood forest and emergent wetlands.

Problem 2: Degraded forest community. Bottomland hardwood forest habitat are seasonally flooded forests located along waterways. These forests include a variety of tree and vegetative species making them an important component of the MMR ecosystem. While bottomland hardwood forest habitat has declined in the MMR due to logging and clearing for agriculture (Simons et al. 1975; Theiling 1998; USACE 2001) within the study area, the forest habitat has degraded (section 2.3.2) due to lack of hard-mast regeneration and recruitment, causing a forest community that has limited species and age diversity. The degraded forest community provides reduced habitat suitability for wildlife such as neotropical migrants, migratory waterfowl, and endangered bat species.

Problem 3: Reduction of emergent wetland within the study area. Land use practices within the past 100 years have limited the ability of the study area to sustain

emergent wetland communities. Historically emergent wetlands provided habitat for the diverse native wildlife species such as migratory waterfowl. Today, levees prevent the flood pulses from the Big Muddy River that would have spurred emergent aquatic vegetation growth. Because of this limitation, emergent vegetation is dependent upon water level management to drawdown areas in the spring or early summer and expose mudflat for emergent vegetation to germinate and grow. However, adequate water level management is not possible due to ineffective and undersized water control structures in the study area. Current water control structures do not have the capacity to quickly drain these wetland areas in the spring and fill them in the fall. The result is areas with remaining water where only non-desirable species remain. Recent vegetation surveys conducted by USACE staff in 2018 show that the emergent wetland areas are dominated by perennial species such as cattail (*Typha spp.*) and woody species such as willow (*Salix spp.*). These species provide little forage value for migratory waterfowl in that they do not produce seed that is available and palatable for consumption. The study area lacks emergent vegetation due to unreliable water level management.

Opportunities are positive conditions in the study area that may result from implementation of a federal project, such as the following:

- Increase areas with significant and unique forest community types.
- Restore the floodplain forest utilized by a variety of migratory and resident bird and wildlife species.
- Restore waterfowl migration habitat.
- Provide increased recreational opportunities in the study area, including waterfowl hunting, wildlife observation, wildlife photography, interpretation, and environmental education.
- Reduce the required manpower to operate and maintain existing infrastructure.
- Identify areas where there is ability to support the Shawnee National Forest Land and Resource Management Plan goals for OBGTR.
- Improve the resiliency of the OBGTR to effects of climate change.

4.3 Objectives

4.3.1 UMRR Program

The overarching UMRR program mission is *to work within a partnership among federal agencies, state agencies, and other organizations; to construct high-performing habitat restoration projects; to produce state-of-the-art knowledge through monitoring, research, and assessment; and to engage other organizations to accomplish the Upper Mississippi River Restoration Program's vision.*

The UMRR program vision is *a healthier and more resilient Upper Mississippi River ecosystem that sustains the river's multiple uses.*

4.3.1.1 UMRS Ecosystem Goals

Five system-wide UMRR objectives are (Galat, et al. 2007) to:

1. Manage for a more natural hydrologic regime;

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

4.3.1.2 UMRR Reach Objectives

The following documents the objectives for the unimpounded floodplain reach that apply to the OBGTR HREP.

1. Hydrology and hydraulics: Restore hydraulic connectivity.
2. Biogeochemistry: Enhance water quality conditions sufficient to support native aquatic biota and designated uses.
3. Geomorphology: Restore bathymetric diversity, and flow variability in secondary channels, islands, sand bars, shoals, and associated habitats.
4. Habitat: Restore riparian habitat; increase the extent and number of sandbars, mudflats, gravel bars, islands, and side channels towards a more historic abundance and distribution; restore large contiguous patches of native plant communities to provide a corridor along the UMR; restore floodplain wetland areas; restore degraded and rare native habitats.
5. Biota: Diverse and abundant native fish community; viable populations of native species throughout their range in the UMRS at levels of abundance in keeping with their biotic potential; reduced adverse effects of invasive species.

4.3.2 Study Objectives

Specific OBGTR HREP objectives, listed below, were established according to USACE planning guidance ER 1105-2-100. Many of these objectives are interrelated and will assist in meeting the overall UMRR goal. For the purpose of the Feasibility Report, the location for all objectives is generally defined as the study area. The duration of the planning period of analysis used to quantify costs and benefits is 50 years. This allows the team to evaluate over a longer range of time while keeping uncertainties associated with forecasting to a manageable level.

1. Increase regeneration of bottomland hardwood forest within the study area during the period of analysis.
2. Restore natural hydrologic conditions and function to the floodplain by emulating natural flooding and drainage regimes within the study area during the period of analysis.
3. Restore degraded wetland habitat within the study area for resident migratory wildlife during the period of analysis.

The relationship between objectives and the criteria to determine achievement of that objective is summarized in Table 11. It should be noted that not all criteria must be met in order to achieve the objective; the criteria are indicators of ideal conditions. Additional information can be found in Appendix H - *Monitoring and Adaptive*

Management Plan.

Table 11. OBGTR Objectives and Performance Criteria.

Objective	Performance Criteria	Rationale
1. Increase regeneration of bottomland hardwood forest within the study area.	• 80% survivorship of planted trees • At least 50% oak composition in understory/seedling layer by year 8	The performance criteria ensure a self-sustaining bottomland hardwood forest. By its very definition functioning bottomland hardwood forests include a natural diversity of tree species, ages, canopy heights, and understory vegetation.
2. Restore natural hydrologic conditions and function to the floodplain by emulating natural flooding and drainage regimes.	• Ideal surface water hydrology in 95% of the units as a whole by start/end of the growing season. Ideal surface water hydrology is not uniform and varies by elevation, soil type, and community composition, additional information can be found in appendix N.	The performance criteria ensure adequate drainage and filling of the site so that water is not impounded during the growing season.
3. Restore degraded wetland habitat in the study area for resident migratory wildlife.	• At least 80% species composition of annual plants in MSUs • Ability to remove water gradually and incrementally to support MSU plant species	The performance criteria ensure high quality emergent wetland habitat. These wetlands would support a variety of wetland-dependent species including migratory waterfowl.

4.4 Planning Constraints and Considerations

The following constraints and concerns were considered in plan formulation:

Constraints:

- Avoid impacts to the existing federal Degognia and Fountain Bluff Levee and Drainage District and Grand Tower Drainage and Levee District System.
- Avoid impacts to Ducks Unlimited Projects.

Considerations:

- Minimize impacts to existing flowage easements.
- Minimize impacts to natural areas that have special considerations/restrictions.
- Minimize impacts to public roads.

- Minimize impacts to adjacent railroad tracks.
- Minimize impacts to historical and archaeological sites located within the study area.
- Minimize negative impacts to private and public landowners.

5 ALTERNATIVE FORMULATION*

NEPA requires federal agencies to evaluate a range of reasonable alternatives to a proposed federal action.

5.1 Management Measures

A management measure is a feature (a structural element that requires construction or assembly on-site) or an activity (a nonstructural action) that can be used alone or combined with other management measures to form alternative plans. Management measures were selected to address study area problems and to capitalize upon study area opportunities. The management measures discussed below were identified from similar projects, subject matter experts, and meetings with state and federal resources agencies.

An overview of the project problems, stressors, objectives and potential management measures are provided in Table 12.

Table 12. Problems, Stressors, Objectives, and Potential Measures Considered.

Problems	Stressors	Objectives	Potential measures
Oak forest community is not naturally regenerating	• Trees are inundated by water during growing season • Detrimental prescribed fire use	Increase regeneration of bottomland hardwood forest within the study area.	• Timber stand improvement • Reforestation • Revised water management plan • Prescribed fire • Ridge construction
Unnatural floodplain water level fluctuations	• Water conveyance • Drainage capacity • Berm configuration	Restore natural hydrologic conditions and function to the floodplain by emulating natural flooding and drainage regimes.	• Setback levee • Berm modifications • Water Control Structures • Well Pumps • Revised water management plan
Degraded emergent wetland habitat	• Woody species encroachment • Water level management capability for aquatic vegetation	Restore degraded wetland habitat in the study area for resident migratory wildlife.	• Well Pumps • Water Control Structures • Plant aquatic vegetation • Revised water management plan • Revised duck season • Swale construction • Wetland allowed to convert to forest • Create or expand MSUs

Setback levee – a structural earthen embankment that is located at a further distance from the river channel than the existing levee in such a way to allow the river to meander more naturally. This measure would allow a portion of the floodplain to return to a more natural state.

Photo 2. Setback levee (photo courtesy of MVN-USACE).

Photo 3. Prescribed fire (photo courtesy of MVS-USACE).

Prescribed fire – a non-structural management measure, or action, that is a planned fire which assists in controlling invasive species and safely reducing excessive and outcompeting brush and/or trees.

Revised duck season – a non-structural management measure, or action, that would reduce the season or number of bag limits to help increase waterfowl population.

Photo 4. Revised hunting season (photo courtesy of USFS).

Ridge and swale - a structural measure consisting of parallel ridges alternating with wetland depressions.

Photo 5. Ridge and Swale (photo courtesy of MVS USACE).

Photo 6. Relief well (photo courtesy of NWO-USACE).

Relief wells – a structural measure consisting of a well which relieves pressure from under a levee by allowing water to be diverted in a controlled manner.

Moist Soil Unit (MSU) conversion to forest – a non-structural management measure, or action, that allows various plant successional stages.

Photo 7. MSU Conversion to Forest (photo courtesy of MVR-USACE).

Reforestation – a non-structural measure of planting and establishing a desired forest community by selecting appropriate tree species, spacing, and management.

Photo 8. Reforestation (photo courtesy of MVS-USACE).

Moist Soil Units (MSUs) – a structural method of creating/increasing the size of shallow-water areas impounded by levees that contain structures that allow flooding during fall and winter and dewatering during spring and summer.

Photo 9. Expanded MSU (photo courtesy of MVR-USACE).

Timber Stand Improvements (TSIs) –a non-structural management measure, or action, that can improve the composition, structure, condition, health and growth of even-age or uneven-age stands. Actions may include removing diseased or dying trees as well as thinning or pruning of less desirable trees.

Photo 10. Timber Stand Improvement (photo courtesy of MVS-USACE).

Revise Water Management Plan – a non-structural management measure, or action, to change current operation of existing infrastructure to provide sufficient water levels for existing habitat types.

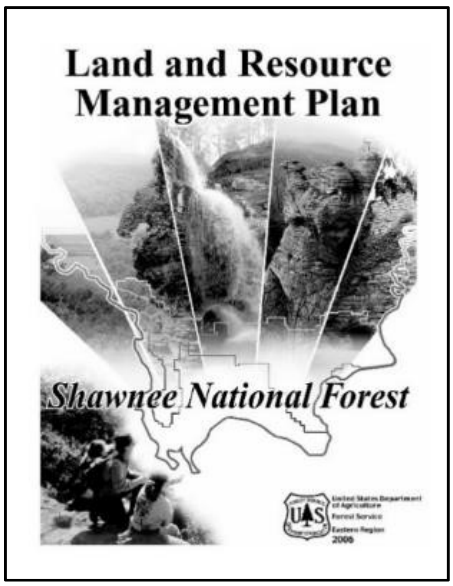

Photo 9. Revised Water Management Plan.

Photo 11. Berm modifications (photo courtesy of MVS-USACE).

Berm modifications – a structural measure to modify constructed embankments designed to pond water.

Well pump – a structural measure that allows water to be pumped out of the ground into various ponding areas using pressure from a submersible pump.

Photo 12. Well pump (photo courtesy of MVS-USACE).

Grade Control Structures – a structural measure built across a waterway to prevent erosion upstream.

Photo 13. Grade Control Structure (photo courtesy of MVS-USACE).

Channel excavation – a structural measure that removes existing soil to create a waterway for conveyance.

Photo 14. Channel excavation (photo courtesy of MVS-USACE).

Piping – a structural method of transporting water.

Photo 15. Piping (photo courtesy of NAO-USACE).

Wetland excavation – a structural measure that excavates soils to elevations that will support wetland habitat.

Photo 16. Wetland excavation (photo courtesy of MVS-USACE).

Aquatic plantings - a non-structural measure of planting and establishing a desired aquatic vegetation community by selecting appropriate vegetative species, spacing, and management.

Photo 17. Aquatic plantings (photo courtesy of MVR-USACE).

Pump station – a structural measure that has multiple facilities including pumps and equipment for pumping water in to or out to an adjacent river.

Photo 18. Pump station (photo courtesy of MVR-USACE).

Water Control Structure (ex. Stoplog, slide gate) – a structural measure placed in a berm or ditch to provides control of the stage or discharge of surface or subsurface water.

Photo 19. Water Control Structure (photo courtesy of MVR-USACE).

5.2 Screening of Management Measures

The USACE planning team screened and eliminated management measures early in the plan formulation process based on the following criteria. A measure may be included if it:

- Meets at least one study objective;
- Does not violate a constraint;
- Does not negatively impact other study objectives; and
- Is sustainable over the 50-year period of analysis functionality.

Table 13 summarizes the restoration measures considered, whether they were retained or screened from further analysis, and the rationale for the screening.

Table 13. Measures Considered and Screening Rationale.

Measure	Screened or Retained	Rationale	Type
Setback levee	Removed from Further Consideration	Not cost effective (inefficient); impacts existing federal project; not likely to benefit a significant portion of the study area	Structural
Prescribed fire	Removed from Further Consideration	Only effective under optimal conditions in select areas.	Nature-based
Revised duck season	Removed from Further Consideration	Not effective; no USACE authority	Non-structural

Measure	Screened or Retained	Rationale	Type
Ridge and swale construction	Removed from Further Consideration	Not effective nor naturally occurring in this area	Structural
Relief wells to add water	Removed from Further Consideration	Does not meet objectives; potential to damage to relief well; does not contribute a significant amount of water; potential timing conflict	Structural
Allow MSUs to convert to forest	Removed from Further Consideration	Negatively impacts objective 3	Natural
Grade Control Structures	Removed from Further Consideration	Does not meet objectives; flow not significant for grade control	Structural
Aquatic Plantings	Removed from Further Consideration	Not effective, seed bank exists	Nature-based
Expand MSUs	Combined with wetland excavation	Ineffective by itself	Nature-based
Timber Stand Improvements (TSIs)	Combined with Reforestation	Ineffective by itself	Natural
Revised Water Management Plan	Retained for Limited Application as Needed	Ineffective by itself	Non-structural
Berm modifications (add/remove/enhance)	Retained for Further Analysis	Meets all screening criteria	Structural
Well Pumps	Retained for Further Analysis	Meets all screening criteria	Structural
Internal Pumps	Removed from Further Consideration	Inefficient, more cost effective solution available	Structural

Measure	Screened or Retained	Rationale	Type
Channel modification (add/remove/enhance)	Retained for Further Analysis	Meets all screening criteria	Structural
Piping	Removed from Further Consideration	Inefficient, more cost effective solution available	Structural
Pump station	Retained for Further Analysis	Meets all screening criteria	Structural
Wetland excavation	Retained for Further Analysis	Meets all screening criteria	Structural
Water Control Structures	Retained for Further Analysis	Meets all screening criteria	Structural
Reforestation	Retained for Further Analysis	Meets all screening criteria	Non-structural

5.3 Alternative Formulation Strategies

To narrow the focus of all possible combinations of the remaining management measures, the USACE planning team developed formulation strategies to create alternatives. Each strategy is a single alternative.

1. No Action Alternative – This is defined as the alternative that no federal action takes place, and there would be no change from current management direction or level of management intensity. The resulting environmental effects from taking no action would be compared with the effects of implementing a proposed federal action.

2. Maximum Alternative – This strategy identifies historic conditions and then provides a set of measures recommended by subject matter experts that would restore conditions that would most closely mimic those historic conditions, given the current limitations of the site.

3. Forest Service Preferred Alternative – This strategy takes the set of measures recommended by subject matter experts to restore conditions that most closely mimic historic conditions and includes the USFS future management goals and

objectives as well as operation and maintenance considerations.

4. Minimum Alternative – This strategy identifies the smallest (least cost) plan which will address at least one study objective while making a measurable and cost-effective improvement to the future conditions. This plan would work with existing infrastructure as much as possible, possibly targeting improvements to forest and wetland areas in the worst condition, but not necessarily to ideal conditions. The management measures would focus on the units with the highest tree mortality (>15%), where smaller scale changes could make a larger impact. The areas with high tree mortality are areas with bottlenecks or other significant hydrology problems that with minimal effort could make a large impact to forest health.

5. Water Level Flexibility Alternative – This strategy focuses on addressing Objective 2 – Restore floodplain water level fluctuations within the study area during the tree growing season**.** This alternative assumes the primary problem is the ability to have natural floodplain water levels in the study area and, if corrected, the site may naturally restore without additional actions. This alternative would focus primarily on improving USFS's ability to control when/where/how much water moves, with few other actions. This plan would not remove structures, but would potentially add structures to improve when and how much water is moved.

6. Nonstructural Alternative –This plan is primarily nonstructural in nature, though limited structural measures are allowed. This plan would focus on wetland improvements and reforestation, with only minor structural changes if needed to improve water management.

7. Natural Succession Alternative – This strategy focuses on addressing Objective 1: Increase natural regeneration of bottomland hardwood forest within the study area. This alternative includes measures that improve forest community health to promote natural regeneration. This plan was developed by removing all the manmade structures with the exception of those berms or structures that are critical infrastructure (i.e. roads, access points). No tree planting or other reforestation would occur; the forest is expected to regenerate without human intervention.

Functional groups (Table 1Table 14) were created to succinctly align the remaining measures with the various formulation strategies. First measures, then formulation strategies were evaluated for inclusion or omission from the functional groups. As displayed in Table 14 the Maximum Alternative will include such measures as berm modifications, well pumps, water control structures, channels, pump station, reforestation, TSI, revised water management plan, and wetland excavation; the Forest Service Preferred Alternative will include such measures as berm modifications, well pumps, water control structures, channels, pump station, reforestation, TSI, revised water management plan, and wetland excavation; the Minimum Alternative will include such measures as berm modifications, well pumps, water control structures, channels,

reforestation, TSI, revised water management plan, and wetland excavation; the Water Level Management Alternative will include such measures as well pumps, water control structures, channels, pump station, and revised water management plan; the Nonstructural Alternative will include such measures as reforestation, TSI, revised water management plan, and wetland excavation; the Natural Forest Regeneration Alternative will include such measures as berm modifications and a revised water management plan.

Table 14. Measures Grouped By Function and Alternative Strategy.

Functional Group	Measures	Alternatives
Modifications to Management Units	Berm modifications – remove, enhance, add	Maximum Minimum Forest Service Preferred Natural Succession
Improve Water Inputs	Well pumps – new locations or increase size	Maximum
	Water Control Structures – new location or increase size	Forest Service Preferred
	Channels – new or altered	Water Level Flexibility
	Pump Station	
Improve Water Removal	Pump station	Maximum Forest Service Preferred
	Water Control Structures – new location or increase size	Minimum
	Channels – new or altered	Water Level Flexibility
Forest Improvements	Reforestation and TSI	Maximum Forest Service Preferred Minimum Natural Succession
Revise Water Management Plan	Revise Water Management Plan	All Alternatives
Wetland Improvements	Wetland excavation	Maximum Minimum

Functional Group	Measures	Alternatives
		Non-Structural

5.4 Initial Array of Alternatives

After the functional groups were used to determine the types of measures included in each alternative, the planning team completed site selection for these measures through a combination of methods including aerial imagery analysis, existing infrastructure, hydraulic analysis, and consultation with state and federal agencies familiar with the study area. Figure 17 through Figure 23 show the location of each measure type per alternative.

Berm Modifications. There are currently thirty-three management units. This measure would reduce the number of management units in the study area to restore a more natural and connected bottomland hardwood forest.

a. No Action. No action would result in the same number of management units. No AAHU gain or loss would be realized other than what may occur naturally. If no action is taken, it is anticipated that water levels and fragmentation will continue to substantially limit the habitat value of bottomland hardwoods in the study area.

b. Berm Modifications. This measure would reduce the number of management units currently in the study area to restore connectivity of the bottomland hardwood forest while still providing migratory feeding and resting habitat. This measure includes degradations, additions, or enhancements of berms in varying proportions described as follows:

Maximum Alternative – Management units would be reduced from thirty-three to fifteen by removing berms in management units 1, 2, 3, 4, 5, 6, 7, 8, 9, 11,12, 13, 14, 14MS, 15, 15MS, 16, 17, 18, 19, 21, 25, 27 and relocating or modifying berms in management units 4, 5, 6, 7, 8, 9, 10, 12, 13, 14,15, 19, 20, 21, 25, 27, and 28.

Forest Service Preferred Alternative – Management units would be reduced from thirty-three to sixteen by removing berms in management units 1, 2, 3, 4, 5, 6, 8, 9, 11, 12, 13, 15, 16, 17, 19, 21, 25, 27 and relocating or modifying berms in management units 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 19, 20, 21, 25, 27, and 28.

Minimum Alternative – Management unit berms would be reduced from thirty-three to twenty-five, since only management units with significant tree mortality would be modified. Berms would be removed in management units 4, 5, 6, 8, 9, 11, 12, 13, 14, 15, 16, 17 and relocated or modified in management units 1, 2, 3, 14, 15, 16, 17, 19, 20, 21, 25, 26, 27 and 28.

Natural Succession – All management unit berms would be removed throughout the study area to restore connectivity of the bottomland hardwood forest but would no longer provide migratory feeding and resting habitat.

Well Pump Facilities. This measure would allow flooding of the area in the fall

providing access to important food resources and feeding areas for migrating waterfowl.

a. No Action. No action would result in no additional water level management capability. No AAHU gain or loss would be realized other than what may occur naturally. If no action would be taken, it is anticipated that the inability for timely water level fluctuations will continue to substantially limit the habitat value of emergent wetlands in the OGBTR.

b. Well Pumps. This measure would involve construction of well pumps to fill various management units within OBGTR effectively. Pumps may be fitted to fill more than one management unit. The existing nine well pumps would remain. This measure would provide the capability to manipulate water levels in varying proportions described as follows:

Maximum Alternative – Five well pumps would be added to flood management units 5, 8, 9, 10, 11, 12, 2 and 3.

Forest Service Preferred Alternative – Four well pumps would be added to flood management units 5, 8, 9, 10, 11, and 12.

Water Level Flexibility Alternative – One well pump would be added to fill management units 21 and 20.

Water Control Structures. The study area currently has ninety-four existing water control structures. The size, location, and type of existing water control structures does not provide reliable water level management to the existing units limiting the quality and availability of habitat for migratory waterfowl and severely affecting the bottomland hardwood forests by its inability to remove excess water. Construction of interior channels are required to convey the water between the interior areas to the water control structures.

a. No Action. No action would result in no additional water control efforts. No AAHU gain or loss would be realized other than what may occur naturally. If no action is taken, it is anticipated that the inefficient water levels will continue to substantially limit the habitat value of emergent wetlands and bottomland hardwoods in the study area.

b. Water Control Structure Modifications. This measure would increase efficiency of the current water level management in the study area and restore functionality of the bottomland hardwood forest while still providing migratory feeding and resting habitat. This measure includes removal of water control structures in areas identified for berm removal, replacement of incorrect type or size of existing water control structures, and additional new water control structures in varying proportions described as follows:

Maximum Alternative – Eight water control structures would be added to existing or relocated berms, twenty-five water control structures would be removed, and twenty-nine water control structures would be replaced throughout the adjacent thirty-three management units.

Forest Service Preferred Alternative – Eight water control structures would be added to existing or relocated berms, twenty-seven water control structures

would be removed, and twenty-seven water control structures would be replaced throughout the adjacent thirty-three management units.

Minimum Alternative – Five water control structures would be added to existing berms, nine water control structures would be replaced, and no water control structures would be removed throughout the adjacent thirty-three management units.

Non-Structural Alternative – Four new water control structures would be added to south end of the study area in management unit 3.

Natural Succession Alternative – All water control structures would be removed throughout the study area.

Pump Station and Conveyance Facilities. This measure would allow water removal of the area in the late winter to substantially reduce tree mortality due to prolonged water exposure. Construction of interior channels are required to convey the water between the interior areas to the pump station.

a. No Action. No action would result in no additional water level management capability. No AAHU gain or loss would be realized other than what may occur naturally. If no action is taken, it is anticipated that uncontrolled water level fluctuations will continue to substantially limit the habitat value of bottomland hardwood forest and emergent wetlands in the study area.

b. Pumping Facility for OBGTR. This measure would involve construction of a pump station in the lower end of management unit 2. This measure would provide the capability to remove water more efficiently throughout the OBGTR.

c. Additional Pumping Facility for Northern Area of OBGTR. This measure would involve construction of a pump station in the lower end of management unit 28. This measure would provide the capability to more effectively remove water in the upper portion of the OBGTR.

OBGTR Reforestation. Reestablishment of native species would provide floodplain habitat diversity, improve the quality and quantity of bottomland hardwood forest, and increase feeding sources for migratory waterfowl.

a. No Action. No action would result in no change in existing land cover or land use practices on OBGTR. Assuming continuation of OBGTR current use, no AAHU gain or loss would be realized.

b. Conversion of berms to forested areas. This measure is dependent on degrading existing management unit berms. This measure includes planting native forest cover through active tree planting where berms have been degraded in varying proportions described as follows:

Maximum Alternative - 66 acres forest

Forest Service Preferred Alternative - 57 acres forest

Minimum Alternative - 31 acres forest

Natural Succession Alternative - 80 acres of forest

OBGTR Wetland Excavation. Reestablishment of emergent wetlands would provide floodplain habitat diversity, improve the quality and quantity of emergent wetland habitat, and increase feeding and resting area for migratory waterfowl.

a. No Action. No action would result in no change in existing land cover or land use practices on units 14MS, 15MS, 16MS, or 17MS. Assuming continuation of OBGTR moist soil unit use, no AAHU gain or loss would be realized for the 94-acre site.

b. Restore existing emergent wetlands. This measure would involve removal of woody vegetation, adjacent timber stand improvements, and discing/excavation of 14MS, 15MS, 16MS, and 17MS for the 94-acre site.

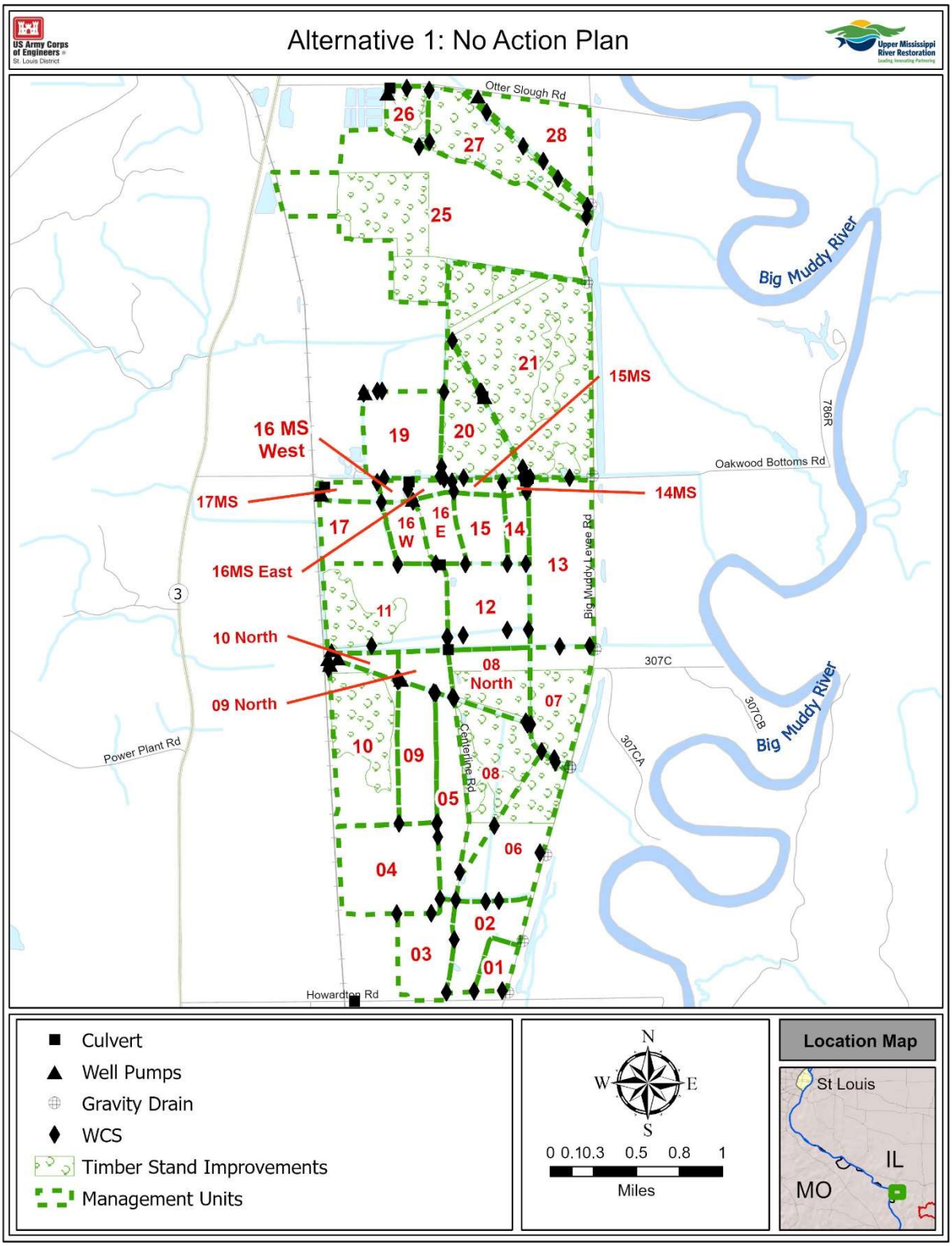

Figure 17. Alternative 1 – No Action.

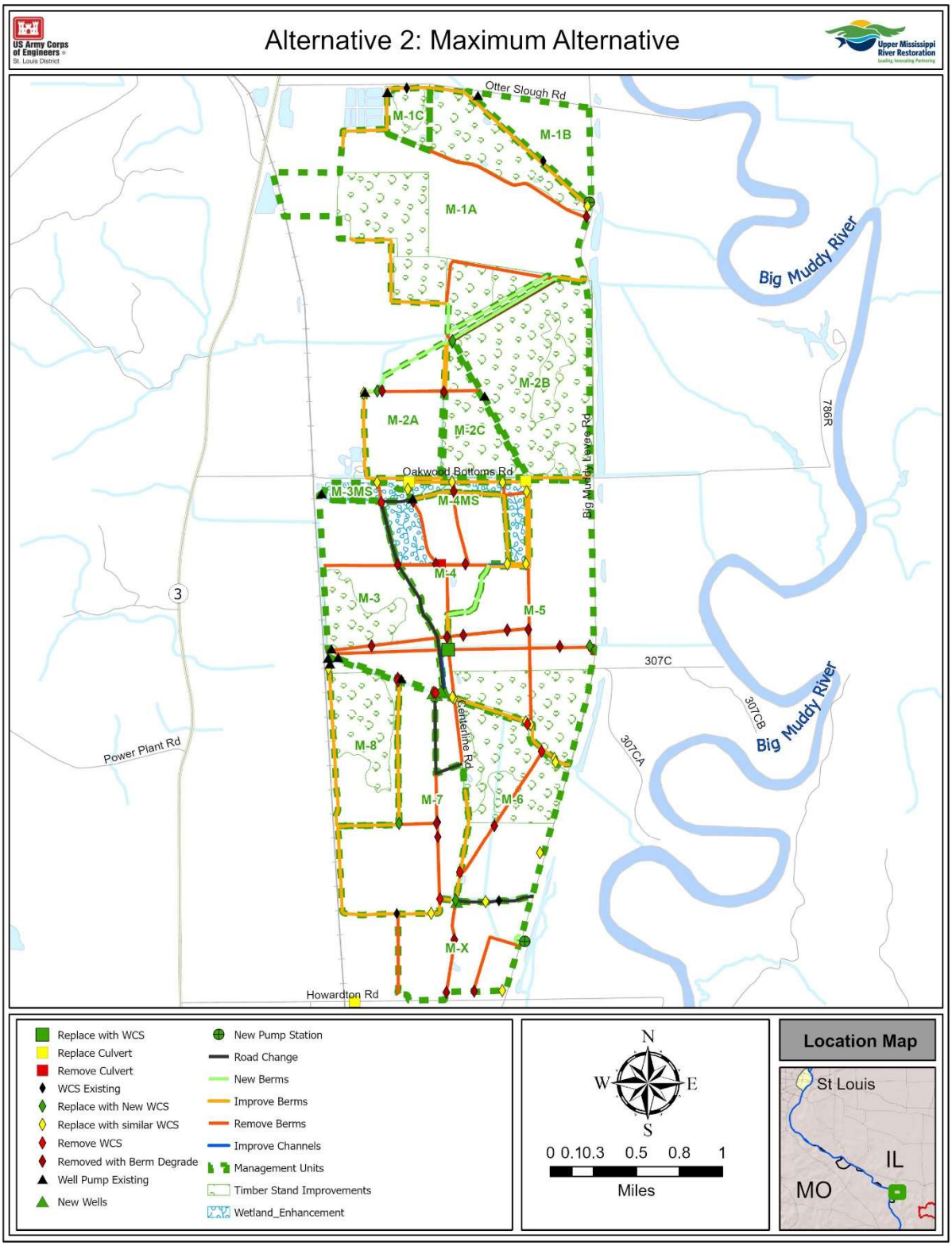

Figure 18. Alternative 2 – Maximum Alternative.

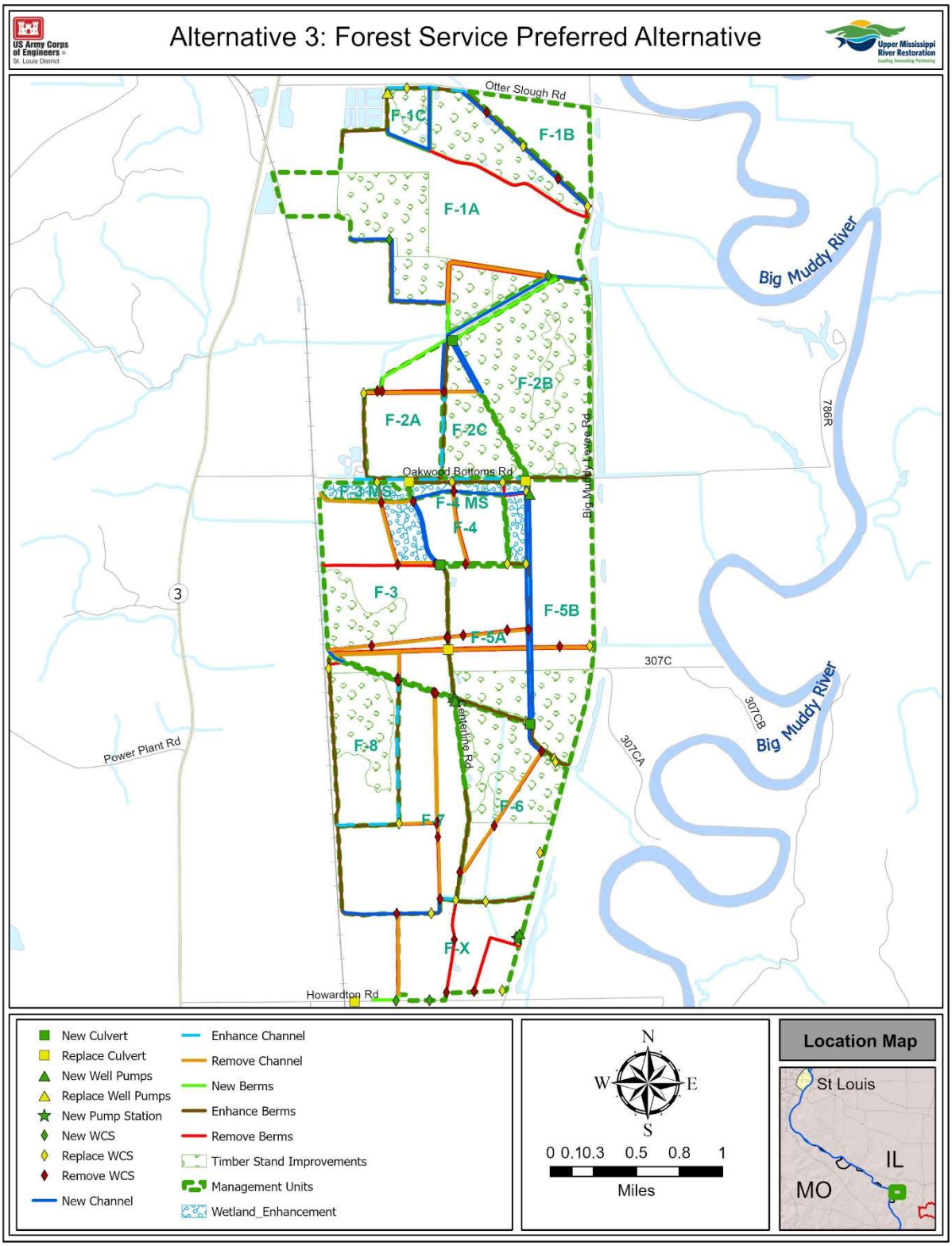

Figure 19. Alternative 3 – Forest Service Preferred Alternative.

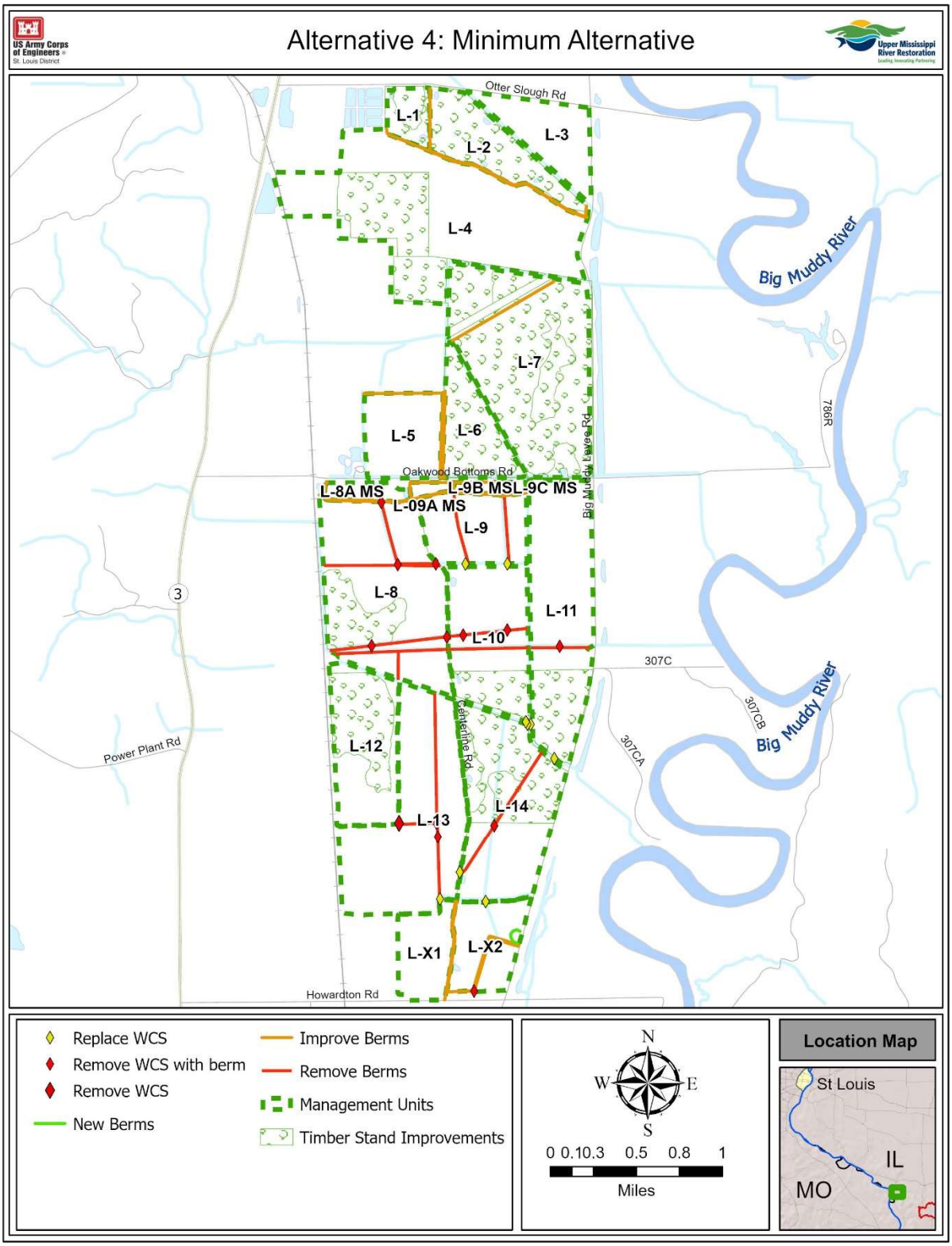

Figure 20. Alternative 4 – Minimum Alternative.

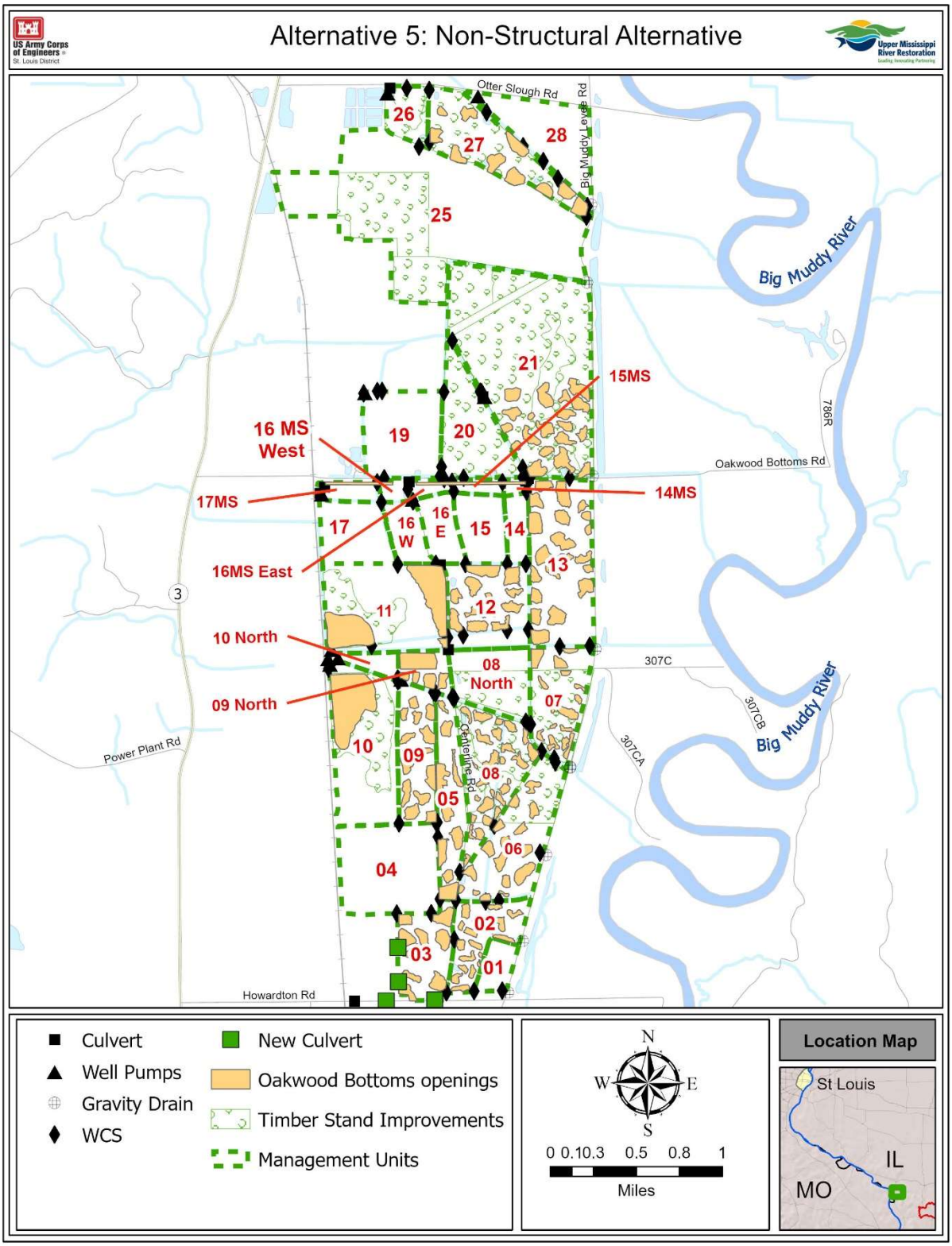

Figure 21. Alternative 5 – Non-Structural Alternative.

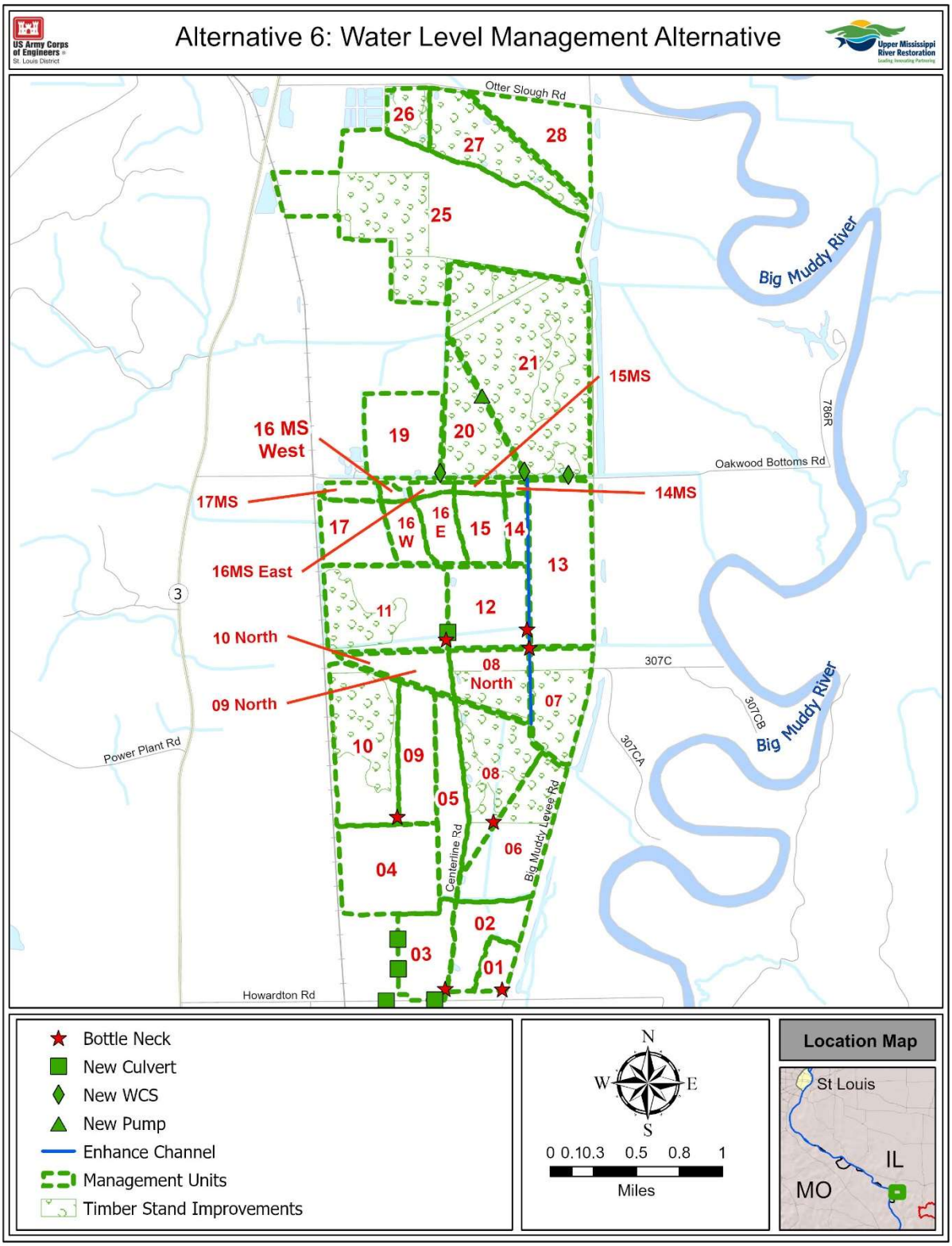

Figure 22. Alternative 6 – Water Level Management Alternative.

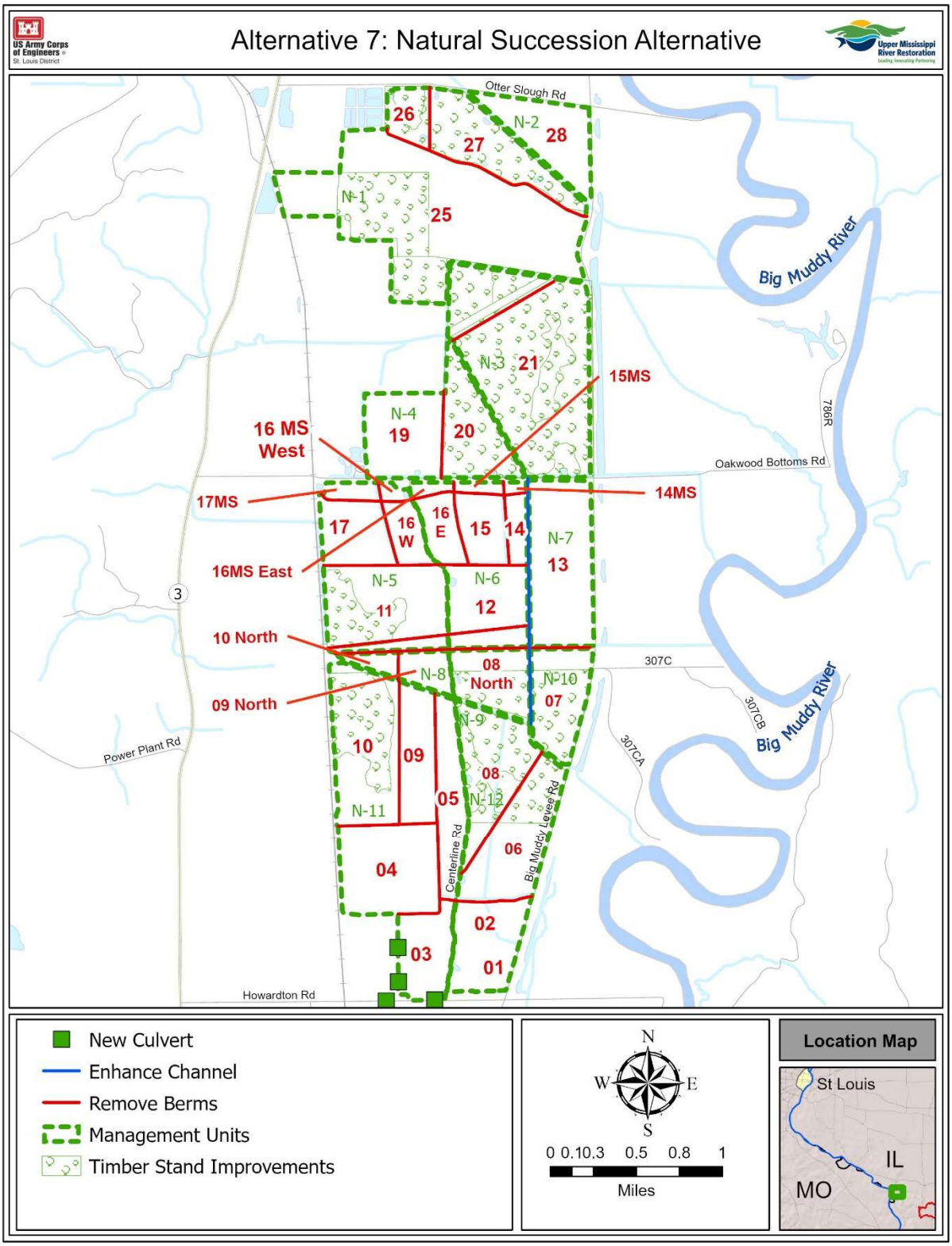

Figure 23. Alternative 7 - Natural Succession Alternative.

5.5 Initial Array of Alternatives Evaluation

Principles and Guidelines Criteria

Completeness: Extent to which the measure provides and accounts for all necessary investments or actions to ensure realization of the planning objectives.

Effectiveness: Extent to which the measure contributes to achieving the planning objectives.

Efficiency: Extent to which the measure is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment.

Acceptability: Workability and viability of the alternative plan with respect to acceptance by Federal and non-Federal entities and the public, and compatibility with existing laws, regulations and public policies.

The USACE planning team, along with the Federal Sponsor and subject matter experts, evaluated the initial array of alternatives based on the Economic And Environmental Principles And Guidelines For Water And Related Land Resources Implementation Studies (1983) Criteria; completeness, effectiveness, efficiency, and acceptability.

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 for each of the four screenings. Table 15 provides the ranking for each alternative.

Effectiveness: In order to measure the effectiveness of each alternative, the USACE planning team created metrics for each of the project objectives:

Bottomland Hardwood Habitat Objective Metrics – This metric provides 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 Metrics – This metric provides how well each alternative allows for the management of natural floodplain water level variability in the study area.

Emergent Wetland Objective Metrics – This metric provides 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 Real Estate, 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 was the viability of the alternative with respect to existing laws, regulations, and public policies. In order to measure the acceptability of each alternative, the USACE planning team created the metrics described below.

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 agency efforts.

Completeness: The USACE planning 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 USACE planning 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	EFFECTIVENESS			EFFICIENCY	ACCEPTABLE		COMPLETE
	Forest	Water Level Flex	Wetland	Minimizes cost relative to benefit	Minimizes USACE policy concern	Acceptable to federal, state and local entities	All items considered
No Action	Low	Low	Low	Low	High	Low	High
Maximum	High	High	High	Moderate	High	Moderate	High
Forest Service Preferred	High	High	High	Moderate	High	High	High
Minimum	Moderate	Moderate	Low	High	High	Moderate	High
Water Level Flexibility	Low	High	Low	Low	High	Low	High
Non-Structural	Low	Low	High	Moderate	High	Low	High
Natural Succession	Low	Low	Moderate	Moderate	High	Low	High

The USACE planning team used Table 15 to evaluate and compare the initial array of alternatives. The alternatives that will not be evaluated further and the accompanying rationale are listed below.

Water Level Flexibility: This alternative scored among the lowest of all the alternatives. This alternative will not be evaluated further because it does not address multiple objectives and is not cost effective since benefits would not be realized without also addressing the habitat degradation that has already occurred to the bottomland hardwood forest and emergent wetlands.

Non-Structural: This alternative scored among the lowest of all the alternatives. This alternative will not be evaluated further because similar management measures have been implemented by the USFS with minimal success. It is inferred this alternative is not effective since benefits would not be realized without also addressing the cause of the bottomland hardwood forest and emergent wetland habitat degradation.

Natural Succession: This alternative will not be evaluated further since it scored among the lowest of the alternatives in meeting study objectives. It is assumed if natural regeneration occurred it would be predominantly subpar tree species. Additionally, removing the ability of the USFS to manage water levels is not acceptable to USFS management objectives of OBGTR.

5.6 Final Array of Alternatives

The remaining alternatives were carried forward to the final array of alternatives, which were evaluated for consideration as the NER plan.

Alternative 1 – No Action Plan

Alternative 2 – Maximum Alternative

Alternative 3 – Forest Service Preferred Alternative

Alternative 4 – Minimum Alternative

6 ENVIRONMENTAL EFFECTS*

Section 2 identified the existing conditions of the resources at OBGTR. Section 6 describes the environmental consequences of the proposed action alternatives and is organized by the same resource topics as described in Section 2. The depth of analysis of the alternatives corresponds to the scope and magnitude of the potential environmental impact. This section provides the scientific and analytic basis for the comparisons of the best buy alternatives:

- No Action Alternative: No Action
- Minimum Alternative: Berm degrades, water control structure upgrades, reforestation, new berm construction
- Forest Service Preferred Alternative: Berm degrades, new berm construction, ditch enhancement, berm raises, reforestation, emergent wetland improvement, timber stand improvement
- Maximum Alternative: Berm degrades, new berm construction, ditch enhancement, berm raises, reforestation, emergent wetland improvement, timber stand improvement

The purpose of characterizing the environmental consequences is to determine whether the resources, ecosystems, and human communities of concern are approaching conditions where additional stresses will have an important cumulative effect (CEQ 1997).

The considered action alternatives (Minimum Alternative, Forest Service Preferred Alternative, and Maximum Alternative) would result in positive long-term benefits to aquatic habitat, wetland habitat, and floodplain forest in OBGTR (Table 16). No federally protected species would be negatively affected. Due to construction, the project would result in short-term decreases in water quality, air quality, and aesthetics and disturb the area wildlife and public use. Long-term benefits to area habitats would far outweigh the short-term impacts. No negative social or economic impacts would result. No impacts to historic and cultural resources are anticipated. Table 16 summarizes the environmental effects of the considered alternatives. Unless otherwise stated, only these potential effects are described and other effects are assumed to be the same across all action alternatives. When environmental effects of these alternatives are the same, they will be discussed collectively.

Table 16. Summary and Comparison of Environmental Effects of Considered Alternatives.

	Environmental Effects	No Action	Min	FS Preferred	Max
	Current Management	Negative	Positive	Positive	Positive
Natural Resources	Floodplain Habitat	Negative	Positive	Positive	Positive
	Hydrology & Hydraulics	Negative	Positive	Positive	Positive
	Aquatic & Wetland Resources	Negative	Positive	Positive	Positive
	Geology & Soils	No effect	No Effect	No Effect	No Effect
	Fish & Wildlife	Negative	Positive	Positive	Positive
	IL Resources of Concern	No Effect	Positive	Positive	Positive
	T&E Species	Negative	Positive	Positive	Positive
	Invasive Species	No Effect	Positive	Positive	Positive
	Water Quality	Negative	Positive	Positive	Positive
	Air Quality	No effect	No Effect	No Effect	No Effect
	HTRW	No effect	No Effect	No Effect	No Effect
	Historic & Cultural Resources	No effect	No Effect	No Effect	No Effect
	Socioeconomic	No effect	Positive	Positive	Positive
	Aesthetic	No effect	Positive	Positive	Positive
	Noise Levels	No effect	No effect	No effect	No effect
	Environmental Justice	No effect	No Effect	No Effect	No Effect

6.1 Current Management

Impacts of No Action Alternative – Within the study area, the OBGTR would continue to lack efficient and effective water management capabilities. The existing 115 structures would continue to degrade and prohibit efficient management of the OBGTR. Additionally, the existing 33 units would continue to prohibit a natural sheetflow, generally north to south, across the study area which would facilitate efficient and timely water filling and draining.

Impacts of Considered Action Alternatives – Positive impacts would result from the considered action alternatives. Overall, the total linear feet of berms would be reduced for the considered alternatives, resulting in less mowing and maintenance. Structures throughout the study area would be upgraded for better water management and lower

operation totaling 15 for the Minimum Alternative, 62 for the Forest Service Preferred Alternative, and 62 for the Maximum Alternative. The addition of the single pump station for the Forest Service Preferred Alternative and the two pump stations for the Maximum Alternative will reduce the overall time in which water is removed from the study area in the spring. The improvements would allow the Forest Service to achieve their water management goals as outlined in the OBGTR Operation Guide and Management Plan (Deaton, 2014).

6.2 Hydrology & Hydraulics

Impacts of No Action Alternative – Within the study area, the OBGTR would continue to lack efficient and effective water management capabilities. The lack of the capability to manage water throughout the study area will necessitate the Forest Service to continue to add water to the study area early during the growing season in order to have enough water at the start of waterfowl season, which typically starts in early November in the Illinois Department of Natural Resources designated South Central Zone, in which OBGTR is located. Similarly, the Forest Service would not have the capability to drain water efficiently in the spring. Water management in the spring will continue to be impacted by not having the capability to efficiently drain water throughout the site in order to reach the gravity drain locations through the Levee. Further, the study area will continue to be impacted by the inability to drain water when the Big Muddy River is high. As discussed in Section 2.2, approximately 33% of the time, on average, during February through March, some of the gravity drains are prevented from freely draining by the Big Muddy River. February through March is the time in which water is typically attempted to be drained from the site. Therefore, this alternative would have a negative effect on hydrology and hydraulics.

Impacts of Minimum Alternative – Positive impacts would result from the Minimum Alternative and the associated management measures. The berm degrades would total 33,800 linear feet throughout the study area. The locations of the existing berms that would be degraded currently inhibit water flow across the site and increase the time in which it takes the water to reach points in which it can drain through the Levee. The berm degrades would increase natural sheetflow throughout the study area in a general north to south manner when draining. Increased sheetflow and more efficient water movement would reduce the amount of time needed to effectively drain and fill the site. Therefore, this alternative would have a positive effect on hydrology and hydraulics. In addition, 2 dimensional modeling has shown that there would be no negative impacts to navigation and no impacts to flood heights. Refer to Appendix B – *Civil Engineering* for more details.

Impacts of Forest Service Preferred Alternative – The Forest Service Preferred Alternative differs from the Minimum Alternative in that there is an increase in berm degrades, which totals 61,900 linear feet. The increase in the amount of berm degrades would further improve the ability of the Forest Service to effectively and efficiently add and drain water throughout the study area and reduce the time it takes to

add water in the fall and drain water in the spring. The berm degrades would increase natural sheetflow throughout the study area in a general north to south manner when draining. Increased sheetflow and more efficient water movement would reduce the amount of time needed to effectively drain and fill the site. Water movement during filling and draining would also be improved with 11,300 linear feet of ditch enhancement. The Forest Service Preferred Alternative would also improve hydrology and hydraulics with the addition of six deep well pumps placed in various locations. See

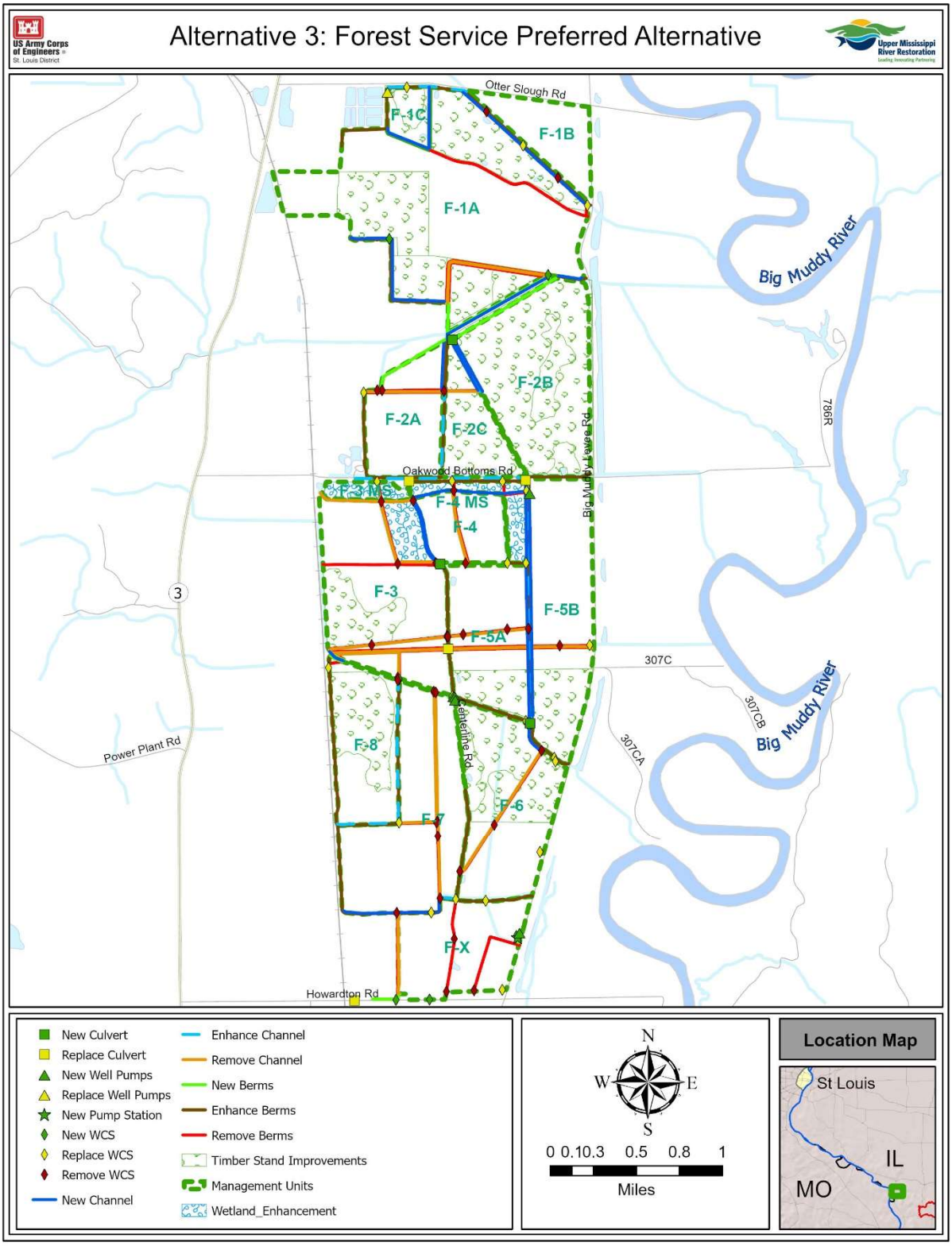
Alternative 3: Forest Service Preferred Alternative
US Army Corps of Engineers
St. Louis District
Upper Mississippi River Restoration
Otter Slough Rd
F-1C
F-1B
F-1A
Big Muddy River
F-2B
F-2A
F-2C
786R
Oakwood Bottoms Rd
Big Muddy Levee Rd
F-3 MS
F-4 MS
F-4
F-3
F-5B
F-5A
307C
307CB
307CA
Big Muddy River
Power Plant Rd
Centerline Rd
F-8
F-6
F-7
F-X
Howardton Rd
3
New Culvert
Replace Culvert
New Well Pumps
Replace Well Pumps
New Pump Station
New WCS
Replace WCS
Remove WCS
New Channel
Enhance Channel
Remove Channel
New Berms
Enhance Berms
Remove Berms
Timber Stand Improvements
Management Units
Wetland_Enhancement
N
W
E
S
0 0.10.3 0.5 0.8 1
Miles
Location Map
St Louis
IL
MO

Figure 19. The additional deep well pumps would give the Forest Service an increase in water volume when filling the units in the fall and reduce the time it takes to reach desired water elevations. The reduction in time to fill would then allow the Forest Service to postpone filling the units until after the growing season has completed, while still reaching desired water elevations by the start of waterfowl season. Additionally, the Forest Service Preferred Alternative would also include a pump station located on the southeastern side of current Unit 6, to drain over the Levee. The installation of a pump station would enable the Forest Service to drain the OBGTR independent of the Big Muddy River when it is high in the spring rather than relying on gravity drains that would be closed during this time. Approximately 33% of the time during February through March, some of the gravity drains are prevented from freely draining by the Big Muddy River. Therefore this alternative would have a positive effect on hydrology and hydraulics. In addition, 2 dimensional modeling has shown that there would be no negative impacts to navigation and no impacts to flood heights. Refer to Appendix B – *Civil Engineering* for more details.

Impacts of Maximum Alternative – The Maximum Alternative differs from the Minimum Alternative and Forest Service Preferred Alternative in that there is an increase in berm degrades, which totals 71,700 linear feet. The increase in the amount of berm degrades would further improve the ability of the Forest Service to effectively and efficiently add and drain water throughout the study area and reduce the time it takes to add water in the fall and drain water in the spring. As with the Minimum and Forest Service Preferred Alternatives, the Maximum Alternative would also improve natural sheetflow throughout the study area in a general north to south manner when draining. Increased sheetflow and more efficient water movement would reduce the amount of time needed to effectively drain and fill the site. Water movement during filling and draining would also be improved with 9,342 linear feet of ditch enhancement. The Maximum Alternative would also install six additional deep well pumps as the Forest Service Preferred Alternative, thereby reducing the time in which it takes for water to reach desired elevations in the fall. As with the Forest Service Preferred Alternative, the Maximum Alternative would also have a pump station located on the southeastern side of current Unit 6, to drain over the Levee. However, this alternative would have an additional pump station located in the northern portion of the OBGTR at current Unit 25. The additional northern pump station would more efficiently drain the portion of the OBGTR north of Otter Slough whereas with the Forest Service Preferred Alternative, water still would need to flow south through drainage ditches until it reaches the southern pump station. Therefore, the additional pump station north of Oakwood Bottoms Road would enable the Forest Service to reduce the time in which it takes to drain the OBGTR as compared to the Forest Service Preferred Alternative. The installation of the two pump stations would enable the Forest Service to drain the OBGTR independent of the Big Muddy River when it is high in the spring rather than relying on gravity drains that would be closed during this time. Approximately 33% of the time during February through March, some of the gravity drains are prevented from

freely draining by the Big Muddy River. Therefore this alternative would have a positive effect on hydrology and hydraulics. In addition, 2 dimensional modeling has shown that there would be no negative impacts to navigation and no impacts to flood heights. Refer to Appendix B – *Civil Engineering* for more details.

6.3 Floodplain Habitat

Impacts of No Action Alternative – Under the No Action Alternative, the forest community in the study area would continue to decline. The forest would continue to be stressed by water throughout the study area during the growing season. The continued stress is causing individual tree stress as well, further reducing the health of trees that are already in a mature state. As discussed in Section 2.3.2.1.2, over 56% of the trees in the study area are over 80 years old. For pin oaks, of which approximately 33% of the forest is composed, 80 years is nearing the end of their life. So, the added physiological stress of inundation during the growing season further reduces the lifespan of the already mature trees. As the hard mast trees in the study area continue to perish, they would continue to be replaced by more water-tolerant species such as maple, ash, elm species, which consist of approximately 81% of the regeneration layer. As such, it is a compounding effect in that as the oak trees are stressed, at the end of their typical lifespan, and there is little to no hard mast species represented in the regeneration layer, the forest will over a relatively short period of time convert to an ash, maple, elm community in which hard mast species are scarce or non-existent. The eventual limitation of a hard mast forest community not only limits that quality and quantity of a highly productive and beneficial forest community throughout the study area, but also throughout the MMR. Hard mast forest communities would continue to be extremely limited throughout the MMR and would not be able to provide the numerous benefits to the floodplain. Through the habitat evaluation and quantification process, the Grey Squirrel HSI which evaluated forest habitat, generated 1,620 AAHU for the Minimum Alternative, 1,648 AAHU for the Forest Service Preferred Alternative, and 1,593 AAHU for the Maximum Alternative (Appendix F – *Habitat Evaluation & Quantification*). Therefore, this alternative would have a negative effect on floodplain habitat.

Impacts of Minimum Alternative – Under the Minimum Alternative, the floodplain forested habitat would be expected to improve over time. The overall forest community would have improved hydrology from the berm degrades and upgraded water control structures. The improved hydrology would improve water filling and water draining times within the OBGTR, which would enable the USFS to wait until the growing season is complete before filling units and draining in the spring before the growing season starts. The improved water timing would improve the health of individual trees throughout the OBGTR, which would improve the overall forest, thereby improving regeneration of oak species. The ability to regenerate over existing conditions, which is no regeneration, would allow the forest to contain and oak proportion into the future. The berm degrades would improve approximately 4,464 acres of the overall forest within the OBGTR, as

evaluated. The footprint of the berms that would be degraded would be improved through reforestation of approximately 31 acres. This forest habitat is currently in a state of decline and would otherwise convert to a forest that is exclusively maple, ash, and elm.

Approximately 31 acres forested area would be cleared for the berm degrades and 0.7 acres for the berm creations. Reforestation would occur on the 31 acres cleared during the berm degrades. In addition, the forest community within the OBGTR area would be enhanced by the ability to properly manage water. Even though tree-clearing is proposed during construction, the benefits of large-scale reforestation efforts as part of the project would benefit the forest community in the short- and long-term. Therefore, this feature would not be considered an impact to wetlands. Through the habitat evaluation and quantification process, the Gray Squirrel HSI which evaluated forest habitat, generated 757.3 net AAHU over the No Action Alternative (Appendix J – *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on floodplain habitat.

Impacts of Forest Service Preferred Alternative – Under the Forest Service Preferred Alternative, the floodplain forested habitat would be expected to improve over time. The overall forest community would have improved hydrology from the berm degrades and upgraded water control structures. The improved hydrology would improve water filling and water draining times within the OBGTR, which would enable the USFS to wait until the growing season is complete before filling units and draining in the spring before the growing season starts. The berm degrades would improve approximately 2,828 acres of the overall forest within the OBGTR, as evaluated. The footprint of the berms that would be degraded would be improved through reforestation of approximately 57 acres. The forest habitat that is currently in a state of decline and would otherwise convert to a forest that is exclusively maple, ash, and elm. Additionally, the pump station located on the southeastern side of current Unit 6, to drain over the levee in this alternative would give the Forest Service the ability to remove water from the OBGTR independent of the Big Muddy River elevations. For example, in years such as 1993, the water within the OBGTR was unable to be removed and was impounded on site for the entire growing season, causing mortality to oak species that year as well as into future years. In 2019, a similar circumstance was realized when the water was not removed until August. Although the mortality has not yet been quantified, it is expected that mortality from this flood to the remaining oak species will be significant. With this alternative, the Forest Service would have the ability to prevent these circumstances and prevent additional oak mortality. Additionally, this alternative includes 1,608 acres of TSI, which would include thinning of non-desirable canopy tree species such as maple, ash, elm, removing mid-story non-desirable species, and oak and hickory seedling plantings. Although TSI was used as a management tool previously to improve regeneration, it was only marginally effective due to the existing problem of water impoundment during the growing season. With the combination of the improved water timing and TSI, the health of individual trees throughout the OBGTR

would improve, which would improve the overall forest, thereby increasing regeneration of oak species as well as preventing further mortality of oak species. The ability for the forest to regenerate over existing conditions, which is no regeneration, would allow the forest to contain a proportion of oak trees into the future and prevent further mortality due to water impoundment, this proportion of oak species would be expected to be larger than with the Minimum Alternative.

Approximately 57 acres forested area would be cleared for the berm degrades and 12 acres for the berm creations. Reforestation would occur on the 57 acres cleared during the berm degrades. Even though tree-clearing is proposed during construction, the benefits of reforestation efforts, TSI, and large-scale forest improvement as part of the project would benefit the forest community in the short- and long-term. Therefore, this feature would not be considered an impact to wetlands. Through the habitat evaluation and quantification process, the Gray Squirrel HSI which evaluated forest habitat, generated 1,647.7 net AAHU over the No Action Alternative (Appendix J – *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on floodplain habitat.

Impacts of Maximum Alternative – Under the Forest Service Preferred Alternative, the floodplain forested habitat would be expected to improve over time. The overall forest community would have improved hydrology from the berm degrades and upgraded water control structures. The improved hydrology would improve water filling and water draining times within the OBGTR, which would enable the USFS to wait until the growing season is complete before filling units and draining in the spring before the growing season starts. The berm degrades would improve approximately 2,828 acres of the overall forest within the OBGTR, as evaluated. The footprint of the berms that would be degraded would be improved through reforestation of approximately 66 acres. This habitat restoration forest habitat that is currently in a state of decline and would otherwise convert to a forest that is exclusively maple, ash, elm. The lower pump station in this alternative is similar to the Forest Service Preferred Alternative. However, the addition of a pump station in the upper portion of the OBGTR in existing Unit 25 would give the Forest Service the ability to remove water within the OBGTR independent of the Big Muddy River elevations. This would be an improvement over the Forest Service Preferred Alternative in that it would more efficiently drain water above Oakwood Bottoms Road. This would likely increase regeneration over the Forest Service Preferred Alternative. Additionally, this alternative includes 1,608 acres of TSI, which would include thinning of non-desirable canopy tree species such as maple, ash, elm, removing mid-story non-desirable species, and oak and hickory seedling plantings. Although TSI was used as a management too previously to improve regeneration, it was only marginally effective due to the existing problem of water impoundment during the growing season. With the combination of the improved water timing, two well pumps, and TSI, the health of individual trees throughout the OBGTR would improve, which would improve the overall forest, thereby increasing regeneration of oak species as well as preventing further mortality of oak species. The ability of the forest to regenerate

over existing conditions would allow the forest to contain an oak proportion into the future and by having the ability to prevent further mortality with water impoundment, this proportion of oak species would be expected to be larger than with the Minimum Alternative and Forest Service Preferred Alternative.

Approximately 66 acres forested area would be cleared for the berm degrades and 21 acres for the berm creations. Reforestation would occur on the 66 acres cleared during the berm degrades. Even though tree-clearing is proposed during construction, the benefits of reforestation efforts, TSI, and large-scale forest improvement as part of the project would benefit the forest community in the short- and long-term. Therefore, this feature would not be considered an impact to wetlands. Through the habitat evaluation and quantification process, the Gray Squirrel HSI which evaluated forest habitat, generated 1,381.3 net AAHU over the No Action Alternative (Appendix J – *Habitat Evaluation & Quantification*). Therefore, this alternative would have a positive effect on floodplain habitat.

6.4 Aquatic & Wetland Resources

Impacts of No Action Alternative –Without the project, the study area's aquatic resources would likely continue to deteriorate given the lack of capability to manage water. The MSUs would continue to transform from emergent wetland to forested wetland as woody encroachment continues. These conditions limit macro and micro-invertebrate production and sustainability for the wetland resources. Additionally, without the capability of proper water level management, the MSUs would continue to only support a low diversity complex of emergent aquatic vegetation. The emergent vegetation would continue to lack desirable MSU emergent species, which with proper management can provide large quantities of seed that can be utilized by migratory waterfowl during migration. Without the project, diverse wetlands able to support emergent vegetation for wildlife and migratory birds would continue to be limited. Through the habitat evaluation and quantification process, the wetland habitat considered for the Bullfrog HSI model generated 0 AAHU for the Minimum Alternative and 66.8 AAHU for the Forest Service Preferred and Maximum Alternative. Therefore, this alternative would have a negative effect on aquatic and wetland resources.

Impacts of Minimum Alternative – Short-term negative impacts to wetland resources, such as increased water turbidity, would be expected due to construction activities. However, these impacts would be localized and temporary in nature. In the long-term, the project would improve wetland resources. Specifically, improving water management capabilities will improve the overall forest wetland in the study area. This improvement would allow additional wildlife benefits not only within the study area but within the MMR. The increased wetland diversity would provide habitat for a suite of wetland dependent species.

Although forested wetlands within the study area would be impacted with the construction of the additional berms, this would account for approximately 0.7 acres.

These impacts would be offset by degrading 31 acres of existing berms. See Appendix I, *Clean Water Act* for more information on Section 404 Clean Water Act analysis. Overall, the wetland impacts would be outweighed by restoration of wetland habitat that otherwise would continue to lack wetland function and diversity. Therefore, this alternative would have a positive effect on aquatic and wetland resources.

Impacts of Forest Service Preferred and Maximum Alternatives – Short-term negative impacts to wetland resources, such as increased water turbidity, would be expected due to construction activities. However, these impacts would be localized and temporary in nature. In the long-term, the project would improve wetland resources. Specifically, improving water management capabilities will improve the overall forest wetland in the study area. Additionally, improving water management capabilities for the MSUs would improve the emergent wetland species diversity by increasing the number of MSU emergent plants, which produce seed for migratory waterfowl. The wetland improvement that would be restored with the MSU design would promote plant growth that would allow for improved habitat for macro and micro-invertebrates. This improvement would allow additional wildlife benefits not only within the study area but within the MMR. The increased wetland diversity would provide habitat for a suite of wetland dependent species.

Although wetlands within the study area would be impacted with the construction of the additional berms, this would account for approximately 11.8 acres for the Forest Service Preferred Alternative and 20.7 acres for the Maximum Alternative. These impacts would be offset by degrading 56.9 acres for the Forest Service Preferred Alternative and 65.8 acres for the Maximum Alternative. Additionally, improvement of approximately 94 acres of MSU habitat for the Forest Service Preferred Alternative and Maximum Alternative would occur. Overall, the wetland impacts would be outweighed by restoration of wetland habitat that otherwise would continue to lack wetland function and diversity. Through the habitat evaluation and quantification process, the wetland habitat considered for the Bullfrog HSI model generated 18.9 net AAHU for the Forest Service Preferred Alternative and the Maximum Alternative (Appendix J – *Habitat Evaluation & Quantification*). Therefore, these alternatives would have a positive effect on aquatic and wetland resources.

6.5 Geology & Soils

Impacts of No Action Alternative – No major impacts to geology and soils would be expected. Therefore, this alternative would have no effect on geology and soils.

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 No Action Alternative would not contribute to conversion of farmland to nonagricultural uses.

Impacts of Considered Action Alternatives – Temporary, minor impacts to geology and soils would be expected due to construction activities and project features.

Excavating the berms, water control structures, and MSUs would impact existing topography and drainage. However, the current geology and soils within the study area have already been altered. Thus, the alternatives would have no effect on geology and soils.

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 Considered Action Alternatives would not contribute to conversion of farmland to nonagricultural uses.

6.6 Wildlife

6.6.1 Migratory Birds

Impacts of No Action Alternative – Migratory birds would be negatively impacted by the existing degraded habitat. The forest community would continue to lack a diverse species structure, specifically with no hard mast tree species. This would continue to limit valuable habitat for migratory Neotropical migrants. Migratory waterfowl would also be negatively impacted by the lack of available forage within the study area to utilize during spring and fall migrations. Therefore, this alternative would have a negative effect on migratory birds.

Impacts of Considered Action Alternatives – The enhancement of the forest within the study area would improve habitat for migratory birds. The considered action alternatives would improve approximately 4,500 acres of floodplain forest with the regeneration of hard mast tree species over time. The increase of hard mast tree species would directly benefit Neotropical migrants, which have been shown to benefit from hard wood forests over other forest types. Additionally, the restoration of wetland habitat within the study area would directly benefit migratory waterfowl. Approximately 94 acres of restored emergent wetlands would be achieved with the Forest Service Preferred and Maximum Alternatives. These features would provide areas where emergent vegetation, which provides food for migratory waterfowl, could grow. These areas as well as the forested area would also serve as resting and loafing for migratory waterfowl. The considered action alternatives would provide wetland and high quality floodplain forest habitat that is currently limited throughout the MMR. Therefore, the considered action alternatives would have a positive effect on migratory birds.

6.7 US Forest Service Resources

6.7.1 Regional Forest Sensitive Species

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

Impacts of Considered Action Alternatives – The detailed analysis and Biological Evaluations (BE) of these species can be found in Appendix F – *Habitat Evaluation.* Implementation of the proposed action may result in direct adverse impacts to individuals, but should not contribute to the loss of species viability, nor cause a trend toward federal listing.

6.7.2 Congressionally Designated Areas

Impacts of No Action Alternative – No congressionally designated areas exist within the study area. A candidate wild and scenic river, the Big Muddy River, is near the study area. There will be no effect upon the Big Muddy River or its designation with the No Action Alternative.

Impacts of Considered Action Alternatives – No congressionally designated areas exist within the project area. A candidate wild and scenic river, the Big Muddy River, is near the project area. The Shawnee National Forest Plan establishes a quarter-mile corridor along all candidate wild and scenic rivers be managed to retain the stream's classification-potential and eligibility for inclusion in the Wild and Scenic River system. There will be no effect upon the Big Muddy River, within its one-quarter mile buffer, or its designation with the Considered Action Alternatives.

6.8 Illinois Resources of Concern

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

Impacts of No Action Alternative – The Illinois Natural Area Inventory (INAI) Site would likely continue with the No Action Alternative. However, this site is currently being degraded due to excess water during the growing season. No impacts are anticipated to the Illinois listed species under the No Action Alternative. Therefore no impacts to Illinois state resources of concern are anticipated with the No Action Alternative.

Impacts of Considered Action Alternatives – The INAI site is within the study area but outside of any excavation activities for any of the considered alternatives. The INAI site would likely benefit from the considered Action Alternatives due to the increased capability and efficiency of adding water in the fall and removing in the spring, outside of the growing season. The Illinois listed species would likely benefit from all Action Alternatives. The enhancement of the forest community diversity would likely improve habitat that can be utilized by these species over time. The improved wetland habitat from these proposed Action Alternatives would likely improve habitat that can be utilized by a variety of species of concern in Illinois. Construction activities would limit potential impacts to these species by implementing BMPs and avoiding where practical. Therefore, no negative impacts to Illinois resources of concern potentially occurring within the study area are anticipated under the considered action alternatives.

6.9 Bald Eagle

Impact of No Action Alternative – Under the No Action Alternative, potential bald

eagle habitat would be expected to persist within and outside of the study area. As there are currently no bald eagle nests or adjacent to the study area, impacts to bald eagle with the No Action Alternative are not expected.

Impacts of Considered Action Alternatives – Although no bald eagle nests exist within the study area, suitable nest trees exist within the vicinity of the study area. As such, the National Bald Eagle Management Guidelines would be implemented to minimize potential impacts and appropriate coordination with the USFWS would be conducted if a bald eagle nest were to be built prior to or during construction. Improvement of the forest resources within the study area would allow for successful regeneration of hard mast trees over time, thereby improving the overall forest community over a longer period with increased species and age diversity to yield suitable roost habitat through time and into the future. Therefore, positive impacts to the bald eagle with the Considered Action Alternatives are expected.

6.10 Federally Threatened & Endangered Species

In accordance with the Endangered Species Act, a list of federally threatened and endangered species was obtained from the USFWS. This satisfies the "request for species list requirements" for ESA Section 7 Consultation. The Indiana bat, northern long-eared bat, gray bat, least tern, and pallid sturgeon are listed as federally threatened or endangered in Jackson County, Illinois. The Corps prepared a Biological Assessment (Appendix J) and submitted it to the USFWS on 20 April 2020. Based on the information provided, the Corps determined the proposed project *May Affect, Not Likely to Adversely Affect* the Indiana bat, northern long-eared bat, and gray bat and will have *No Effect* on the pallid sturgeon and least tern. A concurrence letter from the USFWS would be received prior to final report submittal and information within the report and appendices will be updated accordingly (Appendix J – *Biological Assessment*).

6.11 Invasive Species (Executive Order 13112)

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

Impacts of Considered Action Alternatives – All considered action alternatives seek to restore ecosystem structure and function for native species and habitats. With this, it is anticipated native species should be able to better compete with existing invasive species and make the ecosystem less susceptible to future invasions. During construction, best management practices would be implemented to reduce invasion while the study area is being disturbed.

6.12 Water Quality

Impacts of No Action Alternative – The study area's water quality and water resources adjacent to the study area would likely remain similar to current conditions.

The upper Big Muddy River would likely continue to be considered to be impaired as in 2018 due to pH, mercury, manganese, sulfates and low dissolved oxygen (DO) levels. Therefore, this alternative would have a no effect on water quality.

Impacts of Considered Action Alternatives – Small-scale water quality improvements would be expected as a result of improved water management. Improvements to the forest health would increase the nutrient uptake capacity by the forest. The capture of nutrients from adjacent agricultural areas during local rainfall events would improve the water quality of the Big Muddy River outside of the study area by decreasing nutrient load. Further, the wetlands restored would act as filters, reducing the nutrient levels.

Short-term minor increases in turbidity are expected to occur due to construction activities within the OBGTR. These effects would be less than significant. Implementation of avoidance, minimization, and best management practices would be used. Therefore, the considered action alternatives would have a positive effect on water quality (See Appendix I – C*lean Water Act 404(b)1*).

6.13 Air Quality

Impacts of No Action Alternative – Air quality within the study area would likely remain similar to current conditions. Therefore, this alternative would have no effect on air quality.

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

6.14 Greenhouse Gas & Climate Change

Impacts of No Action Alternative – With No Action, greenhouse gas emissions for the Project are expected to be similar to current conditions. With the No Action Alternative, climate change could potentially impact the study area through increased frequency of high water events related to expected precipitation increase. High water events could increase the risk of the adjacent levee overtopping. Therefore, this alternative would have no effect on greenhouse gas and climate change.

Impacts of Considered Action Alternatives – With any of the considered action alternatives, minor greenhouse gas emissions due to equipment used for construction activities and transporting of material are expected. The designed features took into account potential impacts of climate change. Therefore, the considered action alternatives would have no effect on greenhouse gas and climate change.

6.15 Hazardous, Toxic, & Radioactive Waste

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

Impacts of Considered Action Alternatives – A short-term risk for a fuel spill during construction activities would exist for all alternatives. The contractor would be required to have a spill clean-up plan and utilize best management practices during construction. Over the 50-year period of analysis, no rises in risks for HTRW concerns are expected. No work is proposed in the area of the Clandestine Drug Lab 1.2 miles east of Route 3 on Howardton Road listed in the Orphan Summary of the EDR Report. So this REC should not affect the project. Therefore, this alternative would have no effect on HTRW.

6.16 Historic & Cultural Resources

Impacts of No Action Alternative – No impacts to cultural or historical resources are anticipated under the no action alternative because no construction activities would create disturbance. Therefore, this alternative would have no effect on historic and cultural resources.

Impacts of Considered Action Alternatives – The considered alternatives include a variety of features. Proposed features include berm degrades, water control structure removal and upgrades, reforestation, new berms, timber stand improvement, deep water wells, and a pump station. Some of these features would result in new ground disturbance. No features in any of the considered alternatives are expected to have a negative impact on the historic or cultural resources of the site due to past agricultural practices, past ground disturbances, and avoidance of known cultural resources.

Coordination with the Illinois State Historic Preservation Office (SHPO) is pending. The cultural resource survey plan will be implemented as presented in Appendix E – *Historic and Cultural Resources*.

A tribal consultation letter outlining the project will be sent to the 28 federally recognized tribes affiliated with the St. Louis District. Responding tribe correspondence will be documented in Appendix E – *Historic and Cultural Resources*. The USACE would provide and coordinate with any tribes requesting copies of cultural survey reports or any tribes that review and/or questions about the study. The District will continue to coordinate as the project goes forward.

In the event any cultural properties are located, these would be evaluated for National Register eligibility, in consultation with the Illinois Historic Preservation Officer, and appropriate mitigation completed before construction. If sites would be impacted, the

tribes who have indicated they have an interest in the area would be contacted, and consultation would take place. Should an inadvertent discovery of human remains occur, then Section 3 of the Native American Graves Protection and Repatriation Act (P.L. 101-601) would be followed on federal lands.

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

6.17 Socioeconomic

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

Impacts of Considered Action Alternatives – The considered alternatives have no measurable impacts on community cohesion, property values, industrial growth, life, health, safety, or privately-owned farms. In addition, 2 dimensional modeling has shown that there would be no negative impacts to navigation and no impacts to flood heights. Refer to Appendix B – *Civil Engineering* for more details. The increase in recreational use with these alternatives would likely increase community, regional, and business growth, and tax revenues.

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

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

For this project, the region and state impact areas are: Rural Area of the State of Illinois.
The economic impact modeling was performed on the Considered Action Alternatives, The current first cost was used but removed interest during construction, PED, and S&A to approximate a more accurate representation of total regional investment of $6,900,000 for the Minimum Alternative, $18,146,000 for the Forest Service Preferred Alternative, and $25,451,000 for the Maximum Alternative. Construction funds expended on various services and products are expected to generate additional economic activity featured in both output and jobs (Table 17). Therefore, the considered alternatives would have a positive effect on socioeconomics.

Table 17. Summary of the Regional Economic Impact of Action Alternatives.

Minimum Alternative					
Area	**Local Capture ($000)**	**Output ($000)**	**Jobs***	**Labor Income ($000)**	**Value Added ($000)**
Local Direct Impact		$4,360	35.9	$1,919	$2,449
Secondary Impact		$1,364	10.8	$412	$729
Total Impact	$4,360	$5,724	46.7	$2,331	$3,178
State Direct Impact		$5,734	56.8	$3,158	$3,788
Secondary Impact		$5,127	29.9	$1,738	$2,997
Total Impact	$5,734	$10,861	86.7	$4,896	$6,786
US Direct Impact		$6,881	77.0	$4,118	$4,659
Secondary Impact		$11,092	56.9	$3,437	$5,842
Total Impact	$6,881	$17,973	133.8	$7,555	$10,501
Forest Service Preferred Alternative					
Area	**Local Capture ($000)**	**Output ($000)**	**Jobs***	**Labor Income ($000)**	**Value Added ($000)**
Local Direct Impact		$11,466	94.5	$5,048	$6,442
Secondary Impact		$3,588	28.3	$1,082	$1,917
Total Impact	$11,466	$15,054	122.8	$6,130	$8,359
State Direct Impact		$15,081	149.4	$8,305	$9,964
Secondary Impact		$13,485	78.6	$4,571	$7,883

Total Impact	$15,081	$28,566	227.9	$12,876	$17,847
US Direct Impact		$18,096	202.4	$10,830	$12,253
Secondary Impact		$29,174	149.5	$9,039	$15,365
Total Impact	$18,096	$47,270	352.0	$19,869	$27,618

Maximum Alternative

Area	Local Capture ($000)	Output ($000)	Jobs*	Labor Income ($000)	Value Added ($000)
Local Direct Impact		$16,082	132.5	$7,080	$9,035
Secondary Impact		$5,032	39.7	$1,518	$2,689
Total Impact	$16,082	$21,114	172.2	$8,598	$11,724
State Direct Impact		$21,152	209.5	$11,648	$13,975
Secondary Impact		$18,913	110.2	$6,412	$11,057
Total Impact	$21,152	$40,065	319.7	$18,060	$25,031
US Direct Impact		$25,381	283.9	$15,190	$17,186
Secondary Impact		$40,918	209.7	$12,677	$21,550
Total Impact	$25,381	$66,299	493.6	$27,868	$38,736

* Jobs are presented in full-time equivalence (FTE)

6.18 Aesthetic

Impacts of No Action Alternative – A decline in aesthetics may occur due to the degrading forest habitat, creating a larger proportion of dead trees over time. However, this decline would be less than significant. Therefore, this alternative would have no major effect on aesthetic resources.

Impacts of Considered Action Alternatives – Aesthetics would be temporarily impacted by the presence of construction equipment, removal of trees, and the creation of noise, fumes, and dust during the implementation phase. Once the activities have been completed, none of the considered alternatives would likely be considered as aesthetically unpleasant, as the study area forest community would improve over time

as the forest community as regeneration of oak and hickory species within the study area is restored. As a result, impacts to aesthetics would be temporary, minor, and local in nature. Therefore, the considered action alternatives would have a positive effect on aesthetic resources.

6.19 Noise Levels

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

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

6.20 Environmental Justice

Executive Order 12898 requires the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies. Fair treatment means that no group of people, including a racial, ethnic, or a socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Meaningful involvement means that:

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

The District would comply with the provisions of the EO through coordination and the NEPA review process. No concerns regarding this EO are expected.

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

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

environmental effects on minority or low-income populations.

6.21 Man-Made Resources

The proposed project should not impact flood reduction levees in Illinois or Missouri. The project would not result in any significant change in floodplain storage. Navigation training structures on the Mississippi River would not be impacted by any considered action alternatives. Impacts to the navigation channel would not occur as a result of any considered action alternatives.

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

Temporary, unavoidable adverse impacts including increased turbidity and noise would result from construction activities. Turbidity and noise levels would return to normal when construction is completed. Seasonal construction restrictions recommended by USFWS and IDNR would be adhered to for protection of threatened and endangered species.

The loss of some benthic organisms currently inhabiting the footprint areas for the proposed new berm locations is a likely effect of all considered action alternatives. Following construction, benthic organisms should rapidly recolonize the excavated areas. The excavated areas would be re-vegetated after construction with native vegetation.

These probable and unavoidable adverse impacts could occur relating to any of the preceding discussed resources. These impacts would be minimized by implementation of avoidance, minimization and use of best management practices during construction.

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

Construction activities would temporarily disrupt fish, wildlife, and human recreational use in the immediate vicinity of the study area. Long-term productivity of natural resource management would benefit considerably by the construction of considered action alternatives. Long-term productivity would be improved through increased reliability of water management, which improves the overall forest health. These habitats provide more dependable reproduction, foraging, and resting areas for migratory, resident wildlife, and aquatic species. With the increased habitat diversity, both game and nongame species would benefit. In turn, both consumptive and non-consumptive users would realize heightened opportunities for recreational use. Negative long-term impacts are expected to be minimal.

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

Irreversible commitments are those that cannot be reversed, except perhaps in the extreme long run (Shipley 2010). Simply stated, once the resource is removed it can never be replaced. For the action alternatives considered, there are no irreversible

commitments to natural resources. This proposed project is in the planning stage. Money has been expended to complete this planning document and pre-project monitoring. No construction dollars, which are considered irreversible, have been expended for the project.

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

6.25 Compliance with Environmental Statutes

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

Table 18 provides a list of environmental protection statutes and other environmental requirements which were considered during the development of this report. The table reports the applicability or compliance as it relates to each statue and requirement for the current stage of planning.

Table 18. Federal Policy Compliance Status.

Federal Laws[1]	**Compliance Status**
Abandoned Shipwreck Act of 1987, as amended, 43 USC § 2101, et seq.	Full
American Indian Religious Freedom Act, as amended, 42 USC § 1996	Full
Archaeological and Historic Preservation Act, as amended, 54 USC § 312501, et seq.	Full
Bald and Golden Eagle Protection Act, as amended, 16 USC § 668, et seq.	Full
Clean Air Act, as amended, 42 USC § 7401, et seq.	Full
Clean Water Act, as amended, 33 USC § 1251, et seq.	Partial[2]
Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 USC § 9601, et seq.	Full
Endangered Species Act, as amended, 16 USC § 1531, et seq.	Partial[2]
Farmland Protection Policy Act, as amended, 7 USC § 4201, et seq.	Full
Federal Water Project Recreation Act, as amended, 16 USC §460l-12, et seq. and 16 USC § 662	Full
Fish and Wildlife Coordination Act, as amended, 16 USC § 661, et seq.	Partial[2]
Flood Control Act of 1944, as amended, 16 USC § 460d, et seq. and 33 USC § 701, et seq.	Full
Food Security Act of 1985, as amended, 16 USC § 3801, et seq.	Full

Federal Laws[1]	**Compliance Status**
Land and Water Conservation Fund Act of 1965, as amended, 16 USC § 460l-4, et seq.	Full
Migratory Bird Treaty Act of 1918, as amended, 16 USC § 703, et seq.	Full
National Environmental Policy Act, as amended, 42 USC § 4321, et seq.	Partial[2]
National Historic Preservation Act, as amended, 54 USC § 300101, et seq.	Partial[2]
National Trails System Act, as amended, 16 USC § 1241, et seq.	Full
Noise Control Act of 1972, as amended, 42 USC § 4901, et seq.	Full
Resource Conservation and Recovery Act, as amended, 42 USC § 6901, et seq.	Full
Rivers and Harbors Appropriation Act of 1899, as amended, 33 USC § 401, et seq.	Partial[2]
Wilderness Act, as amended, 16 USC § 1131, et seq.	Full
Executive Orders[3]	
Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, EO 12898, February 11, 1994, as amended	Full
Floodplain Management, EO 11988, May 24, 1977, as amended	Full
Invasive Species, EO 13112, February 3, 1999, as amended	Full
Protection and Enhancement of Environmental Quality, EO 11991, May 24, 1977	Full
Protection and Enhancement of the Cultural Environment, EO 11593, May 13, 1971	Partial[2]
Protection of Wetlands, EO 11990, May 24, 1977, as amended	Full
Recreational Fisheries, EO 12962, June 7, 1995, as amended	Full
Responsibilities of Federal Agencies to Protect Migratory Birds, EO 13186, January 10, 2001	Full
Trails for America in the 21st Century, EO 13195, January 18, 2001	Full

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

7 CUMULATIVE EFFECTS*

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

7.1 Cumulative Effects Overview

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

The Council on Environmental Quality (CEQ) issued a manual entitled *Considering Cumulative Effects Under the National Environmental Policy Act* (1997). This manual presents an 11-step procedure for addressing cumulative impact analysis. The cumulative effects analysis for the OBGTR HREP followed these 11 steps shown in Table 19. The following subsections are organized by the three main components–scoping, describing the affected environment, and determining the environmental consequences. The following section is summarized in Table 22 (at the end of this section).

Table 19. CEQ's Approach for Assessing Cumulative Effects.

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

7.2 Scoping for Cumulative Effects

7.2.1 Bounding Cumulative Effects Analysis

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

7.2.1.1 Identifying Geographic Boundaries

The geographic boundary for each resource is listed in Table 20. The geographic boundaries for each resource were determined by the distribution of the resource itself, and the area within that distribution where the resource could be affected by the project in combination with other past, present, and reasonably foreseeable actions.

Table 20. Geographic Boundaries for Cumulative Effects.

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

The Big Muddy River hydrology is affected by several inputs including the UMR, Missouri River, and Kaskaskia River. Thus a natural geographic boundary for several of the resources are identified in Table 20. For select resources, Jackson County was used for analysis, while for other resources the entire MMR and Big Muddy River watersheds for the area was used. There are also several protected areas within the MMR watershed, which are identified in Figure 24.

7.2.1.2 Identifying Timeframe

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

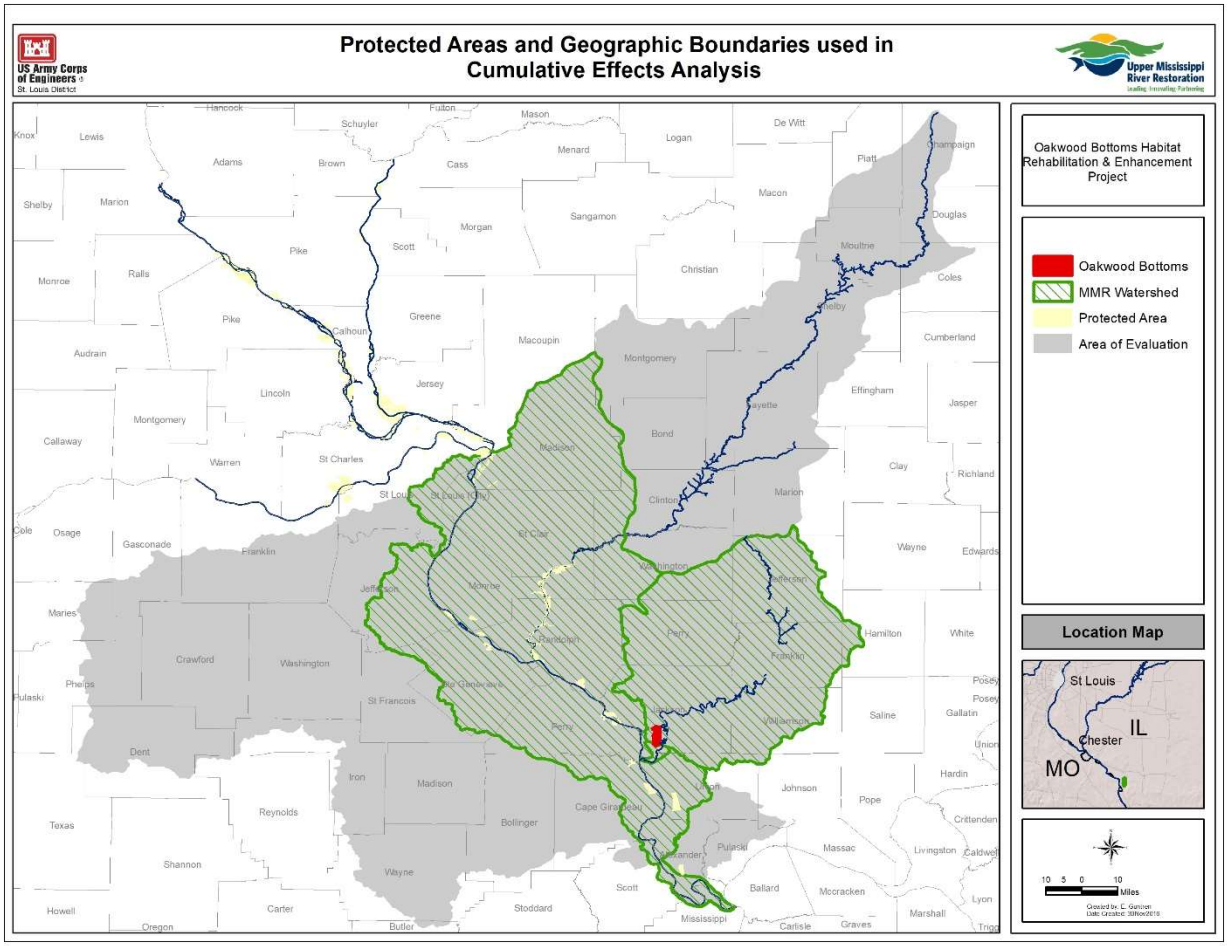

Figure 24. Geographic Boundary for Cumulative Effects for the OBGTR HREP, MMR Watershed HUC (Hydrologic Unit Code) 4.

7.2.2 Identifying Past, Present, and Reasonably Foreseeable Future Action

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

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

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

7.3 Cumulative Effects by Resource

The remainder of this section describes the cumulative effects analysis for each of the considered resources from Sections 2 and 7. Table 21 is a checklist identifying potential incremental cumulative effects on the resources affected by OBGTR HREP. Table 22 provides the cumulative effects analysis which includes the past, present, and reasonably foreseeable actions that might impact each resource category identified to have an incremental cumulative effect. A summary of the cumulative effects is provided at the end of this section (Table 22). If a resource is not identified to have any cumulative effects, then this resource was not discussed in detail. The cumulative effects analysis discussed future conditions as follows:

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

Table 21. Checklist for Identifying Potential Cumulative Effects of OBGTR.

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

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

7.3.1 Floodplain Habitat

Past actions have degraded forest resources within the MMR and Big Muddy watersheds through floodplain disconnection, floodplain constriction, clearing of forested areas, agricultural practices, increased water input to the system, altered hydrology due to dam construction upstream on the Mississippi River, and spread of invasive species. Resource managers have projected the continued decline and identified a need for improved management of floodplain forests within the MMR (Theiling *et al.* 2000). Land management activities have occurred in the "Protected Areas" shown in Figure 25, which are composed of state and federally owned public land. Much of the public land had previously been cut off from the floodplain by private levees protecting agricultural

land. Future restoration projects in the region include:

- Crains Island HREP
- Harlow Island HREP

Without Project: It is assumed that the forest community would continue to lack regeneration of hard mast species. As discussed in Yin 1999, the forest seedling community throughout the region resembles overstory forest composition, which suggests that silver maple, cottonwood, and willow species would be maintained for the next 70 years. Even-aged low species and structural diversity forest communities (e.g., cottonwood and silver maple) would persist throughout the region, also limiting the establishment of hard mast species. Even-aged forests would continue to provide little habitat diversity and value over time. The lack of hard mast species would continue to provide little habitat benefits for wildlife. Without the Project, it is anticipated that the forest community in the study area would convert over time to maple, ash, elm, which provide little benefits to ecosystem structure and function.

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

7.3.2 Aquatic Resources

Past and present actions have degraded aquatic and wetland resources within the Middle Mississippi River. Many cumulative effects are discussed in WEST (2000) and the Supplemental Environmental Impact Statement (SEIS), which are incorporated by reference and will not be repeated here (USACE 2017).

USACE would continue the operation and maintenance of the 9-foot navigation channel project. This includes continuation of dredging, placement of material, and construction and maintenance of river training structures. The USACE Master Plan for the Mississippi River (RM 300-0) identifies all known plans for new channel improvement structures and revetments or modifications to existing structures and revetments within the St. Louis District USACE through the year 2018. In summary, the assessment acknowledges the changes brought about by the construction of the 9-foot Navigation Channel Project in conjunction with other impacts occurring throughout the watershed resulting in declines in fish, aquatic vegetation, and backwaters/secondary backwaters.

Without Project: The emergent wetlands within the study area would continue to degrade due to lack of water management capabilities. The continued deterioration of aquatic resources would have a negative impact on the MMR region.

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

the considered action alternatives, would improve wetland resources that benefit the MMR region.

7.3.3 Wildlife

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

Without Project: The continued deterioration of the physical habitat (both floodplain forest and wetland) within the study area would have negative impacts on the management of the study area and its contribution to wildlife resources within the MMR watershed. With no improvements and the lack of ability to effectively manage water for ecosystem function and health, wetland wildlife use of the study area is expected to decline. Degraded and complex infrastructure dictates that management on the study area includes large amounts of time needed for operation while impacts to the forest still occur due to the inability to effectively remove water. It is also expected that with the declines in wildlife use within the refuge, the public use of the study area would also decline, especially waterfowl hunting.

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

7.3.4 Illinois Resources of Concern

Several Illinois species of concern are identified for Jackson County, Illinois (see sections 2.7 and 7.7 above). These species have been adversely impacted by habitat loss, fragmentation, degradation, and conversion throughout the range of each of these species. Several of these species (*i.e.*, pallid sturgeon, northern long-eared bat, and Indiana bat) prefer floodplain and aquatic habitats. These habitat types have been dramatically lost throughout the Upper Mississippi River Basin (Theiling *et al.* 2000). Present and future actions, including the considered action alternatives, are aimed to offset these past negative actions to Illinois species of concern caused by habitat loss,

fragmentation, degradation, and conversion.

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

Considered Action Alternatives: No negative cumulative impacts would be expected from any of the considered action alternatives. The considered action alternatives aim to restore and improve the ecosystem which would provide positive effects to the Illinois species of concern using the study area. The considered action alternatives, along with other present and foreseeable future restoration projects, should counter some of the long-term adverse impacts to the Illinois species of concern, such as habitat fragmentation and loss, and the general declines of these species.

7.3.5 Threatened & Endangered Species

The federally listed threatened and endangered species discussed in sections 2.9 and 7.9 above have been adversely impacted by habitat loss, fragmentation, degradation, and conversion throughout the range of each of these species (i.e., Indiana bat, northern long-eared bat, least tern, and pallid sturgeon). Present and future actions, including the considered action alternatives, are aimed to offset some past negative actions to threatened and endangered species caused by habitat loss, fragmentation, degradation, and conversion.

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

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

7.3.6 Water Quality

Past actions have degraded water quality within the MMR and Big Muddy River watersheds, past and present laws and regulations have led to improved water quality; however, site-specific problems would likely persist into the future. Adjacent to the study area, the water quality of the upper Big Muddy River suffers from pH, mercury, manganese, sulfates and low dissolved oxygen (DO) levels. Present and future actions, including the considered action alternatives, are aimed to offset these past negative actions and improve the water quality within the study area, which would improve the water quality within the MMR and Big Muddy River watersheds.

Without Project: The study area's water quality would likely remain similar to current

conditions. The interior water bodies would continue to have pH, mercury, manganese, sulfates and low DO levels.

Considered Action Alternatives: No negative cumulative impacts to water quality would be expected long-term. Increases in suspended sediment may be seen during construction and dredging activities within the OBGTR, but would be localized and temporary in nature. In addition, the features proposed would to improve water quality with increased nutrient uptake.

Table 22. Cumulative Effects Analysis for Identified Resources Summary of Cumulative Effects.

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

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action
Air Quality	Increasing human populations and industrialization result in deterioration of air quality. Establishment of Clean Air Act, NEPA, USEPA, air quality standards improve conditions. Attainment status in work area.	Continued population growth and development result in increased potential for air quality impacts. Continued regulation enforcement and societal recognition. Continued attainment status in work area.	Continued population growth and development result in increased potential for air quality impacts. Continued regulation enforcement and societal recognition. Continued attainment status in work area.	Minor and local impacts due to use of agricultural machinery and urban areas in the vicinity	Temporary, minor, local impacts to air quality due to use of construction equipment.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action
Geology, Soils & Prime Farmland	Increasing human populations and industrialization result in loss of prime farmland and increased pressure on marginal lands	Population growth and development result in increased potential for prime farmland impacts.	Population growth and development result in increased potential for prime farmland impacts.	No loss of prime farmland within the study area are not anticipated.	No direct or indirect conversion of prime or unique farmland to nonagricultural use.
Demo-graphics & Environmental Justice	Rural land with relatively low population densities and relatively high percentage of population living below poverty level.	Continued rural land with low population densities.	Continued rural land with low population densities.	Likely no change from present.	Potential for business economy to benefit with proposed action
Fish and Wildlife (including threatened and endangered species)	Loss of floodplain forest community diversity due to clearing and constriction; in MMR, loss of floodplain habitat due to levees, agriculture, urbanization; USACE, other federal, state, and private habitat restoration and land management. programs reverse habitat loss; introduction of exotic species/reduced native species biomass; recognition of T&E species through Endangered Species Act; listing of multiple T&E species in Mississippi River; implementation of District Biological Opinion Program	Maintenance of current habitat conditions due to maintenance of 9-foot navigation channel; habitat restoration and land management. through USACE, other federal, state, and private programs; native species continue to be impacted by exotic species; continued implementation of Biological Opinion Program	Continued maintenance of habitat conditions due to maintenance of 9-foot navigation channel; continued habitat restoration and land management through USACE, other federal, state, and private programs; new exotic species likely to be introduced; continued implementation of Biological Opinion Program	Fish and wildlife associated with floodplain forest in the vicinity of the work area expected to be similar to current conditions. T&E bat species may be impacted over long period of time as the number of available roost trees declines; may affect but not likely to adversely affect threatened and endangered species	Improved floodplain forest community over time as well as improved wetland habitat would likely benefit T&E species; may affect but not likely to adversely affect threatened and endangered species anticipated

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action
Historic and Cultural Resources	Historic and cultural resources subjected to natural processes and manmade actions (e.g., erosion, floodplain development); recognition of importance of historic and cultural resources through National Historic Preservation Act (and others)	Historic and cultural resources continue to be impacted by human activities as well as natural processes; continued societal recognition of importance of historic and cultural resources	Historic and cultural resources continue to be impacted by human activities as well as natural processes; continued societal recognition of importance of historic and cultural resources	Unlikely to affect known any known historic and cultural resources	No known historic resources would be affected. Impacts to unknown historic and cultural resources unlikely.
Climate Change & Greenhouse Gas Emissions	Increasing human populations and industrialization result in increased greenhouse emissions. Establishment of Clean Air Act, NEPA, USEPA, air quality standards improve conditions	Continued population growth and development result in increased potential for increased greenhouse gas emission impacts. Continued regulation enforcement and societal recognition	Continued population growth and development result in increased potential for increased greenhouse gas emission impacts. Continued regulation enforcement and societal recognition. Increased precipitation and frequency of high water events	Possible decrease in greenhouse gas absorbing capacities as floodplain forest continues to decline	Minor greenhouse gas emissions due to equipment used for construction activities. Forest community restoration could potentially decrease future greenhouse gas emissions by increasing the ability to absorb CO_2

8 ALTERNATIVE EVALUATION AND COMPARISION

Principle and Guideline Accounts to facilitate alternative evaluation

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

The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources.

The regional economic development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output and population.

The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts

The USACE planning team evaluated the final array of alternatives using the four Economic And Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (1983) criteria as defined in Section 5.5, study opportunities and constraints (section 4), and the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies accounts, and its support to existing significant resources.

8.1 Habitat Benefit Evaluation

The USACE planning team further evaluated the final array of alternatives by quantifying habitat benefits by assessing existing conditions, forecasting future conditions, and comparing each alternative to the No Action Alternative. The evaluation was conducted by a multi-agency team, which included representatives from the USFS, USFWS, and USACE. Habitat benefits were quantified through the use of the Habitat Evaluation Procedures (HEP; (USFWS, 1980)).

8.1.1 Habitat Evaluation Procedures

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

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

(AAHU). Net AAHU are used as the output measurement to compare the alternatives for the proposed Project.

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

8.1.2 Average Annual Net Benefits

Table 23 lists the calculated net average annual habitat benefits for the final array of alternatives to be evaluated.

Table 23. Net Average Annualized Habitat Units (AAHU).

Alternative	Forest Habitat Net AAHU	Wetland Habitat Net AAHU	Total Net AAHU
No Action	0	0	0
Minimum Alternative	757	0	757
Forest Service Preferred Alternative	1,156	27	1,183
Maximum Alternative	1,355	26	1,381

8.2 Alternative Cost Evaluation

Table 24 provides a breakdown of costs for each alterative in the final array. The USACE planning team used parametric costs, or rough order of magnitude costs, at October 2019 price levels to estimate costs for construction, monitoring and adaptive management (MAM), and OMRRR. Standard percentages for Pre-construction Engineering & Design as well as Construction Management were used (Appendix G – *Cost Estimate*). An abbreviated risk analysis was performed to inform a contingency amount for each alternative and interest during construction (IDC) was calculated using base year 2023 and a two year construction schedule starting at the middle of the construction using the 2020 2.75% discount rate for all alternatives. The project and OMRRR costs were annualized over a 50-year period utilizing the FY 20 discount rate of 2.75%. No lands, easement, right of ways, relocations or disposals were identified so were not included in Table 24**Error! Reference source not found.**.

Table 24. Final Array of Alternatives Economic Cost (Cost is Represented in $1000s using October 2019 Price Levels and the FY 20 2.75% Discount Rate).

Alternative	Project First Costs				IDC[3]	Annualize Construction Cost	Annualize OMRRR
	Construction	Cont.	MAM	PED/ SA[4]			
1 -NA	$0	$0	$0	$0	$0	$0	$0
2-Maximum	$17,810	$6,958	$963	$4,506	$1,215	$1,175	$280
3-Forest Service Preferred	$12,797	$5,173	$980	$3,307	$864	$856	$215
4-Minimum	$5,035	$2,041	$476	$1,323	$345	$342	$176

8.3 Cost Effective & Incremental Cost Analysis of Alternatives

To assist the USACE planning team in identifying the National Ecosystem Restoration Plan (the alternative that reasonably maximizes habitat benefits compared to cost), the final array of alternatives average annual habitat units and annualized costs (including the no action) were entered into the Institute for Water Resources-Planning Suite; a water resources investment decision support tool for evaluation of actions involving monetary and non-monetary cost and benefits. The purpose was to analyze the cost effectiveness of each alternative and perform an incremental cost analysis on cost effective alternatives. Cost effective alternatives are plans that have the greatest benefit of all alternatives at that cost. A secondary analysis on the subset of cost-effective alternatives identifies superior financial investments, called “Best Buys,” through analysis of incremental costs. Best Buys provide the greatest increase in AAHU for the least increase in cost. The first Best Buy is the most efficient plan, producing benefits at the lowest incremental cost per unit. If a higher level of benefit is desired, then the second Best Buy becomes the most efficient plan for producing additional benefit, and so on.

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

1) AAHU for all analyzed species were assumed to have equal value in comparing alternative plans.

[3] IDC assumes 2 year construction period

[4] Pre-construction engineering and design costs (PED) and Construction Management is denoted as Supervision and Administration (SA) costs

2) Alternatives analysis was limited to alternatives that at a minimum partially meet the study objectives
3) Feature dependencies were determined prior to alternatives being input to IWR-Plan software and CE/ICA being run.

Table 25. Results of the Cost Effective Incremental Cost Analysis on the Final Array of Alternatives (Average Annual Habitat Unit Benefits, Annualized Cost, Incremental Output (AAHU), Incremental Cost, and Cost Per Average Annual Habitat Unit.

Alternative	Total Project First Cost	Net Average Annual Habitat Units	Annualized Cost[5]	Cost per Average Annual Habitat Unit	Incremental Output (AAHU)	Incremental Cost per Unit of Output
1 – No Action	$0	0	$0	$0	0	$0
2 – Maximum	$30,519,000	1381	$1,455,000	$1,054	198	$1,939
3 – Forest Service Preferred	$22,257,000	1183	$1,071,000	$905	426	$1,298
4 – Minimum	$8,874,000	757	$518,000	$684	757	$684

Table 25, Figure 25, and Figure 26 display that all alternatives in the final array are both cost effective and “Best Buy” plans (including the No Action plan).

[5] The annualized cost was calculated using the annualized construction and OMRRR costs from Table 24.

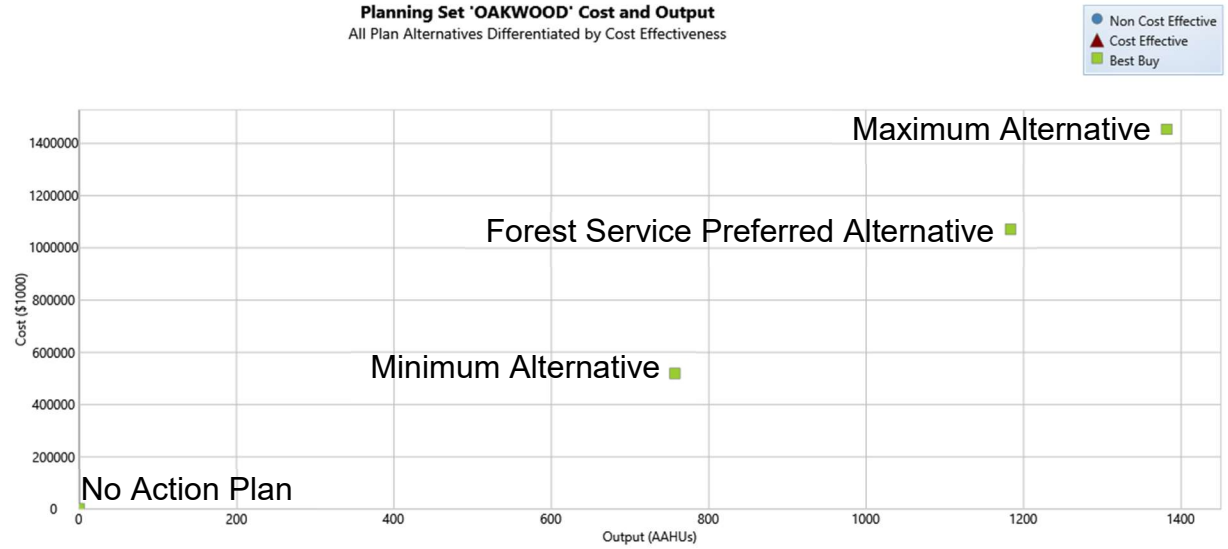

Figure 25. Cost Effectiveness of the Alternatives Included in the Final Array.

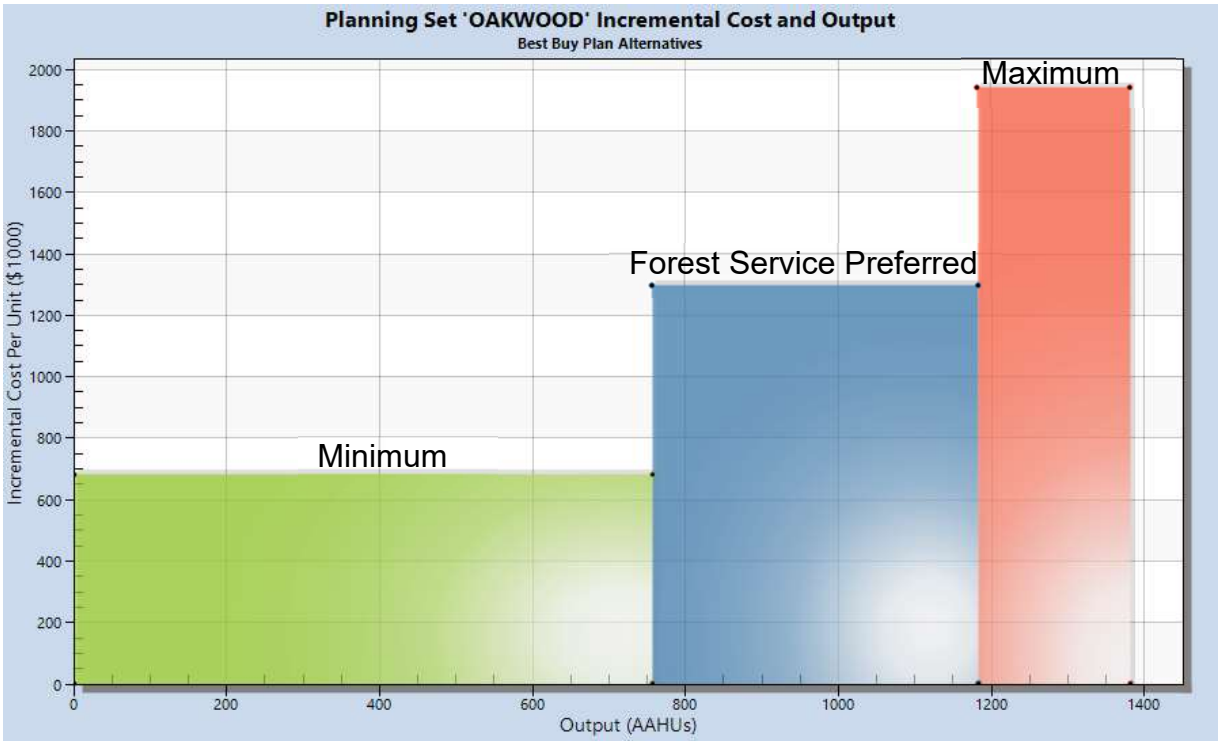

Figure 26. Incremental Cost Analysis of the Cost Effective Alternatives.

The first Best Buy, No Action Plan, is the lowest incremental cost but produced no benefit. The next Best Buy, *Alternative 4 – Minimum Alternative,* is $684 per average annual habitat unit, this is an incremental annual cost increase of $518,000 for 757 average annual habitat units. The third Best Buy, *Alternative 3 – Forest Service Preferred Alternative* costs $905 per average annual habitat unit and is an incremental cost increase of $553,000 for 426 additional average annual habitat units. The final Best

Buy, *Alternative 2 – Maximum Alternative* costs $1,054 per average annual habitat unit and offers an additional 198 average annual habitat units for $384,000 average annual dollars.

The *Alternative 4 - Minimum Alternative* achieved a significant increase in habitat functionality for a relatively low cost, $684 per average annual habitat unit, however, it did not accomplish the study objective to restore degraded wetland habitat nor did it fully achieve the objective to increase regeneration of bottomland hardwood forest. Since not all objectives were met fully or partially by the minimum alternative, an evaluation was done to determine if the next Best Buy alternative, *Alternative 3 – Forest Service Preferred Alternative,* maximized benefits compared to costs. Based on the relatively low cost per average annual habitat unit, $905, and the ability to substantially achieve all study objectives, alternative 3 appeared to reasonably maximize benefits compared to costs. To ensure the next increment of benefit for the additional cost was not warranted a comparison of *Alternative 3 – Forest Service Preferred Alternative* to the final Best Buy, *Alternative 2 – Maximum Alternative* was completed. While *Alternative 2 – Maximum Alternative* is a relatively low cost per average annual habitat unit at $1,054, however the cost to achieve the additional 198 AAHU rose exponentially and the additional benefits were not deemed necessary to achieve the study objectives. Therefore *Alternative 3 – Forest Service Preferred Alternative* is identified as the NER plan, or the plan that reasonably maximized benefits.

8.4 Evaluation Criteria

Each alternative in the final array was independently evaluated by metrics for each of the USACE four screening criteria: Completeness, Effectiveness, Efficiency, and Acceptability. A score of “high” signifies the metric was met considerably, a score of “moderate” denotes the metric was met moderately, and a score of “low” indicates the metric was minimally met, if at all. Table 26 displays the scores to facilitate alternative comparison.

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

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

Efficiency. All alternatives in the final array were given a high efficiency since all were identified as incrementally justified Best Buy options.

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

The efficacy in which alternatives met Objective 1, Increase regeneration of bottomland hardwood forest within the study area during the period of analysis was measured by the amount of floodplain forest habitat units achieved. If the alternative contributed over

1,000 AAHU, it was given a high score, alternatives that contributed between 500-999 AAHU were given a moderate score, and all other alternatives were given a low score.

The efficacy in which alternatives met Objective 2, Restore natural hydrologic conditions and function to the floodplain by emulating natural flooding and drainage regimes within the study area during the period of analysis, was also measured by the amount of floodplain forest habitat units achieved. Alternatives that were able to model achievement of ideal surface water hydrology in 95% of the units as a whole by start/end of the growing season received a high score. Sites that achieved ideal surface water hydrology for 80% or more of the units as a whole by start/end of the growing season were given a moderate score, and alternatives whose sites achieved lower than 80% ideal surface water hydrology were given a low score.

The efficacy in which alternatives met Objective 3, Restore degraded wetland habitat within the study area for resident migratory wildlife during the period of analysis, was measured by the amount of wetland habitat units achieved. Alternatives that produced over 15 emergent wetland average annual habitat units were given a high score, alternatives that contributed from 5-15 habitat units were given a moderate score, and all other alternatives were given a low score.

8.5 Evaluation of Opportunities and Constraints

Each alternative in the final array was independently evaluated using metrics for the most prevalent opportunities and constraints. A 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. Table 26 displays the scores to facilitate alternative comparison.

Opportunities.

Resiliency to climate change was measured by an alternative’s ability to achieve benefits during extreme conditions (flood and drought). It is assumed that alternatives that have the ability to remove water via pump stations during high water events allows the project to achieve benefits during extreme conditions. Based on hydraulic analysis a pump station on the southern end will allow a significant portion of the water to be removed when water levels are high enough to close the gravity drains in the levee. To remove the remaining water in the northern units an additional pump station is needed. Therefor alternatives that were able to achieve benefits in all conditions were rated high, alternatives that were able to perform under certain extreme conditions but not all were considered to be moderately resilient, and alternatives that would not achieve benefits under extreme conditions were rated with a low score.

Each alternative was evaluated on its ability to meet applicable Shawnee Forest management goals for the OBGTR. Alternatives that successfully met all the applicable Shawnee Forest Management goals were scored high. Alternatives that met the forest objectives but not the moist soil unit objectives for the OBGTR were scored as moderate. Alternatives that did not meet the OBGTR forest or moist soil goals were ranked low.

OMRRR considerations were evaluated utilizing labor and cost requirements. Alternatives that would alleviate current labor requirements and minimally increase OMRRR costs were rated high. Alternatives that either alleviated current labor requirements but increased costs substantially or did not alleviate labor but also did not increase costs were ranked as moderately optimizing OMRRR. Alternatives that did not reduce labor requirements and substantially increased costs were ranked low for OMRRR optimization.

Recreation was measured by an alternatives ability to increase human enjoyment of the study area, specifically potential birdwatching and duck hunting opportunities were evaluated. The area is currently utilized for recreation so alternatives that supported the current recreation opportunities were considered to moderately meet recreation opportunities. Alternatives that would increase the amount of human use or enjoyment of those utilizing the area were ranked as high for meeting recreation opportunities. Alternatives that would decrease the current recreational use were ranked as low.

Constraints. It is not anticipated that any of the alternatives violate the study constraints so no alternatives scored low. However, alternatives that avoided the constraints were ranked high at avoiding a constraint and alternatives that need further design or coordination were given a moderate score.

8.6 Evaluation Accounts

Each alternative in the final array was independently evaluated using the four Principles and Guideline accounts (Section 8): National Economic Development, Environmental Quality, Regional Economic Development, and Other Social Effects. A 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. Table 27 displays the scores to facilitate alternative comparison.

In terms of **National Economic Development (NED)** effects of the alternatives, all action alternatives would have an economic cost to the nation to achieve the non-monetized environmental output of goods and services provided by the restoration of wetland and floodplain forest habitats described in the report. Other effects in the NED account include small increases in recreation (due to projected increased bird watching and hunting activity). These small changes in NED effects are described qualitatively in more detail in the environmental effects section, but were not quantified. While the non-monetized habitat benefits are captured in the EQ account, the NED effects are displayed as the annualized project cost and annualized projected OMRRR. A reduction in project cost is assumed to increase the National Economic Development to the nation therefore alternatives that are less than $1million annually were considered to have a high NED effect, alternatives more than $1 million but less than $4 million annually were considered moderate, and alternatives above $4 million annually were considered to substantially increase the cost to the nation creating a low economic benefit to the nation. Rating thresholds were based loosely on the annualized USACE Continuing Authorities Program (CAP) cost limits and mandatory independent external peer review thresholds.

Regional Economic Development (RED). All action alternatives would have a positive impact on the regional economy. Based off of Recons estimates (Section 6.17), it is assumed the percentage of Federal expenditure to regional benefits are similar and not useful as comparison criteria.

Environmental Quality (EQ). It is anticipated that all alternatives would have a positive effect on ecological resources. Impacts to potential cultural sites have been avoided and aesthetics are expected to be enhanced by all alternatives since they increase the functionality of the forested floodplain and emergent wetlands. Potential temporary adverse effects could result from construction activities (e.g., land disturbance, emissions, tree clearing), but construction BMPs will be strictly adhered to, such that any and all adverse effects are temporary and minimal. Consequently, environmental quality of alternatives were ranked on AAHU output. Alternatives that had net benefits higher than 1,000 AAHU scored high, alternatives with net benefits from 500-999 scored moderate, and all other alternatives ranked low.

Other Social Effects (OSE). All alternatives assume positive social impacts; specifically reforestation for aesthetics and wetland for hunting. Alternatives scored high for OSE if they scored high in effectiveness for Objective 1 and 3, alternatives that scored high in one objective for effectiveness but not the other scored a moderate, and a low if the alternative did not score high in effectiveness for either objective.

8.7 Resource Significance

As defined in section 1.7, the Mississippi River and its floodplain is a significant resource to the nation. All of the action alternatives in the final array are assumed to contribute positively to the significant resources in the study area.

Institutional - The efficacy in which alternatives supported institutionally significant resources was measured by how many Acts or Laws the alternative supported. Alternatives that were able to achieve benefits for resources supported in multiple Acts or Laws were rated high, alternatives that were able to achieve benefits for resources supported in at least one Act or Law was rated as moderate, and alternatives that did not achieve benefits for any resources supported in an Act or Law was rated with a low score.

Public - The efficacy in which alternatives supported publically significant resources was measured by whether the alternative supported recreation and/or Ducks Unlimited goal to conserve, restore, and manage wetlands. Alternatives that were able to achieve benefits for both recreation and Duck Unlimited were rated high, alternatives that were able to achieve benefits for at least one publically supported resource was rated as moderate, and alternatives that did not achieve benefits for either publically supported resource were rated with a low score.

Technical - The efficacy in which alternatives supported technically significant resources was measured by an alternatives ability to restore scarce, biodiverse, representative, declining, fragmented, and critical habitat. Alternatives that were able to

achieve benefits for critical or scarce resources that are characteristic of the area and support diverse biota were rated high. Alternatives that were able to achieve benefits for declining resources that are characteristic of the area and support diverse biota were rated as moderate. Alternatives that did not achieve benefits for any technically significant resources were rated with a low score.

Table 26. Final Array of Alternatives Evaluation Criteria, Opportunities, and Constraints.

Alternative	Acceptable	Complete	Effective			Efficient	Maximize Opportunities				Avoid Constraint
			Objective 1	Objective 2	Objective 3		Resilient	Forest Objectives	OMRR	Recreation	Existing federal levee
1 - No Action	High	High	Low	Low	Low	High	Low	Low	Low	Moderate	High
2 - Maximum	High	High	High	High	High	High	High	High	Moderate	High	Moderate
3 - Forest Service	High	High	High	High	High	High	Moderate	High	Moderate	High	High
4 - Minimum	High	High	Moderate	Moderate	Low	High	Low	Moderate	Moderate	Moderate	High

Table 27. Final Array of Alternatives P&G Evaluation Accounts and Supports Existing Significant Resources

Alternative	P&G Evaluation Accounts				Resource Significance		
	NED	EQ	RED	OSE	Institutional	Public	Technical
1- No Action	High	Low	Low	Low	Low	Low	Low
2 - Maximum	Moderate	High	Moderate	High	High	High	High
3 - Forest Service	Moderate	High	Moderate	High	High	High	High
4 - Minimum	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

8.8 Alternative Selection

The restoration of the entire OBGTR would result in an increase in the functionality of the declining bottomland hardwood forest habitat and scarce emergent wetland habitat, as described previously, directly benefitting the UMRR goals.

Implementing Alternative 2 - Minimum Alternative (berm modifications (113,400 cy), water control structure removal (9 ea) and addition (10 ea), and 31 acres of reforestation) would achieve a significant increase in habitat functionality, however, it does not restore degraded wetland habitat nor fully achieve an increase in bottomland hardwood forest restoration. This alternative supports the institutionally significant resource as identified in the Fish and Wildlife Coordination Act, as amended (16 U.S.C.§ 661), the publically significant resources as identified in the *Shawnee National Forest Land and Resource Management Plan* (2006), and would reduce the decline in bottomland hardwood forest resources that are characteristic of the OBGTR and supports biodiversity.

Implementing Alternative 3 – Forest Service Preferred Alternative (berm modifications (186,600 cy), water control structure removal (29 ea) and addition (33 ea), well pumps (4), pump station (1), channel excavation (52,000 cy), approximately 60 acres of reforestation, and 97 acres of wetland excavation) would achieve a significant increase in bottomland hardwood habitat functionality as well as restore degraded wetland habitat. This alternative supports the institutionally significant 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), and the publically significant resources as identified in the *Shawnee National Forest Land and Resource Management Plan* (2006) as well as the Ducks Unlimited goals, and would reduce the decline in bottomland hardwood forest resources that are characteristic of the OBGTR as well the restoration of scarce emergent wetlands will improve the functionality of declining resting and feeding habitat for migratory waterfowl.

Implementing Alternative 4 – Maximum Alternative (berm modifications (240,300 cy), water control structure removal (24 ea) and addition (41 ea), well pumps (5), pump stations (2), channel excavation (52,000 cy), 66 acres of reforestation, and 97 acres of wetland excavation) would achieve a significant increase in bottomland hardwood habitat functionality as well as restore degraded wetland habitat. This alternative supports the institutionally significant resource as identified in the 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), and the publically significant resources as identified in the *Shawnee National Forest Land and Resource Management Plan* (2006) as well as the Ducks Unlimited goals, and would reduce the decline in bottomland hardwood forest resources that are characteristic of the OBGTR as well the restoration of scarce emergent wetlands will improve the functionality of declining resting and feeding habitat for migratory waterfowl.

Alternative 3 – Forest Service Preferred Alternative was identified as the NER plan, or the plan that reasonably maximizes benefits compared to cost. In addition to being the NER plan, Alternative 3 effectively and efficiently meets the study objectives, is complete, acceptable, and optimizes several opportunities while avoiding the existing levee system. As a result of this, a review of the four accounts, and the alternatives ability to support existing significant resources Alternative 3 – Forest Service Preferred Alternative is the recommended plan since it reasonably maximizes ecosystem restoration benefits at an acceptable cost while meeting the Federal objective.

9 RECOMMENDED PLAN (PROPOSED ACTION)

The Recommended Plan section describes additional design and detailed cost of alternative 3 – Forest Service Preferred Alternative, the NER plan. Alternative 3's initial design (Section 5.4) was optimized after it was identified as the recommended plan. Several key items that informed the design include avoidance of culturally sensitive areas, hydraulic modeling which identified efficiencies in the design by adding less water control structures, additional well-pumps and drainage channels, and re-grading moist soil units. Refinement of TSI locations identified the need for selective tree and woody debris clearing areas. More information on the analysis conducted during feasibility and recommendations prior to construction can be found in Appendix B - *Civil Engineering* and Appendix K-*Hydraulics and Hydrology Analysis.*

The Recommended Plan (figures 27-43) for feasibility includes:

- Berm construction and associated earthwork (approximately 9 acres)
- Berm enhancement and associated earthwork (approximately 55 acres)
- Berm deconstruction and associated earthwork (approximately 94 acres)
- Remove 62 water control structures
- Install 1 pump station
- Install 6 well pumps
- Install 30 water control structures
- Excavate 19 acres of channel
- Excavate/re-grade 87 acres of emergent wetlands
- Reforestation (approximately 94 acres)
- Selective clearing and woody debris removal (approximately 128 acres)
- Additional Timber stand improvements (approximately 1,600 acres)

Construction of the recommended plan offers an opportunity to mimic pre-levee conditions that would emulate river floodplain functionality, thereby increasing the quality and quantity of bottomland hardwood forest and emergent wetland habitat. Restoration of the study area offered by the recommended plan is preferred among the other plans because of the improvements to the recognized significant resources (institutional, public, and technical) in comparison to cost.

The OBGTR will be able to emulate a more natural flood and drainage regime by modifying the existing water control structures, well pumps, channels, and berms as well as adding a pump station. The ability to manage water levels will ensure water is at an optimal depth during the migratory season and removed prior to the growing season

supporting long-term benefits to migratory waterfowl and other species. 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).

Moist soil units, or emergent wetlands, will be restored by excavation and grading. This complements the significant public resources identified in the *Shawnee National Forest Land and Resource Management Plan* (2006) and the Ducks Unlimited goal to conserve, restore, and manage wetlands and associated habitats for North America's waterfowl.

Reforestation, TSI to include selective tree and woody debris removal, and water level management will improve the structure of the bottomland hardwood forest, thus preventing a continued decline in the diversity and age class of the forest. This, in turn, will improve the biodiversity of the area. In addition, the restoration of scarce emergent wetlands through excavation and TSI will improve the functionality of declining resting and feeding habitat for migratory waterfowl. All of these improvements would extend beyond the study area and is expected to improve the connectivity of the Mississippi Flyway.

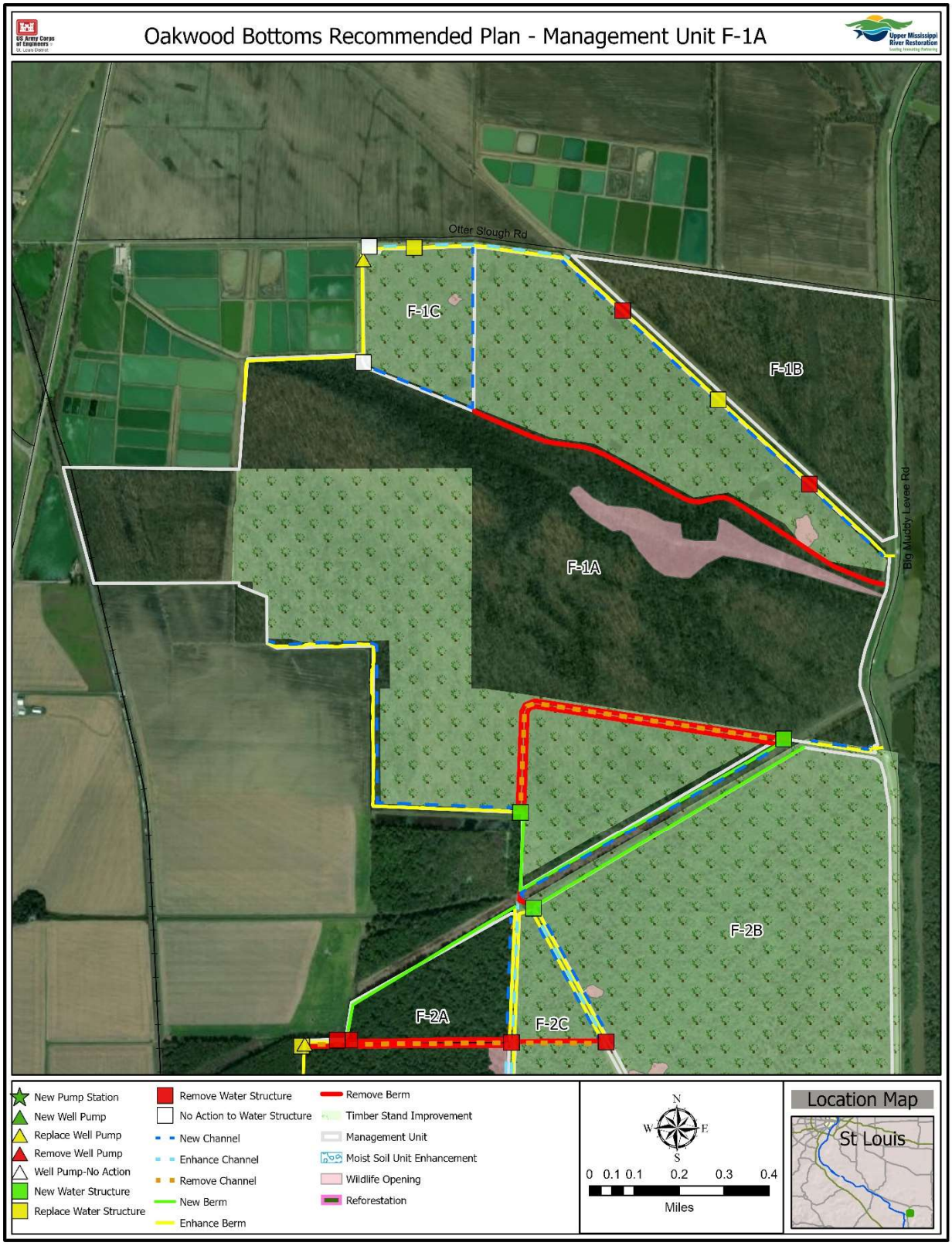

Figure 27. Recommended Plan – Management Unit F1A

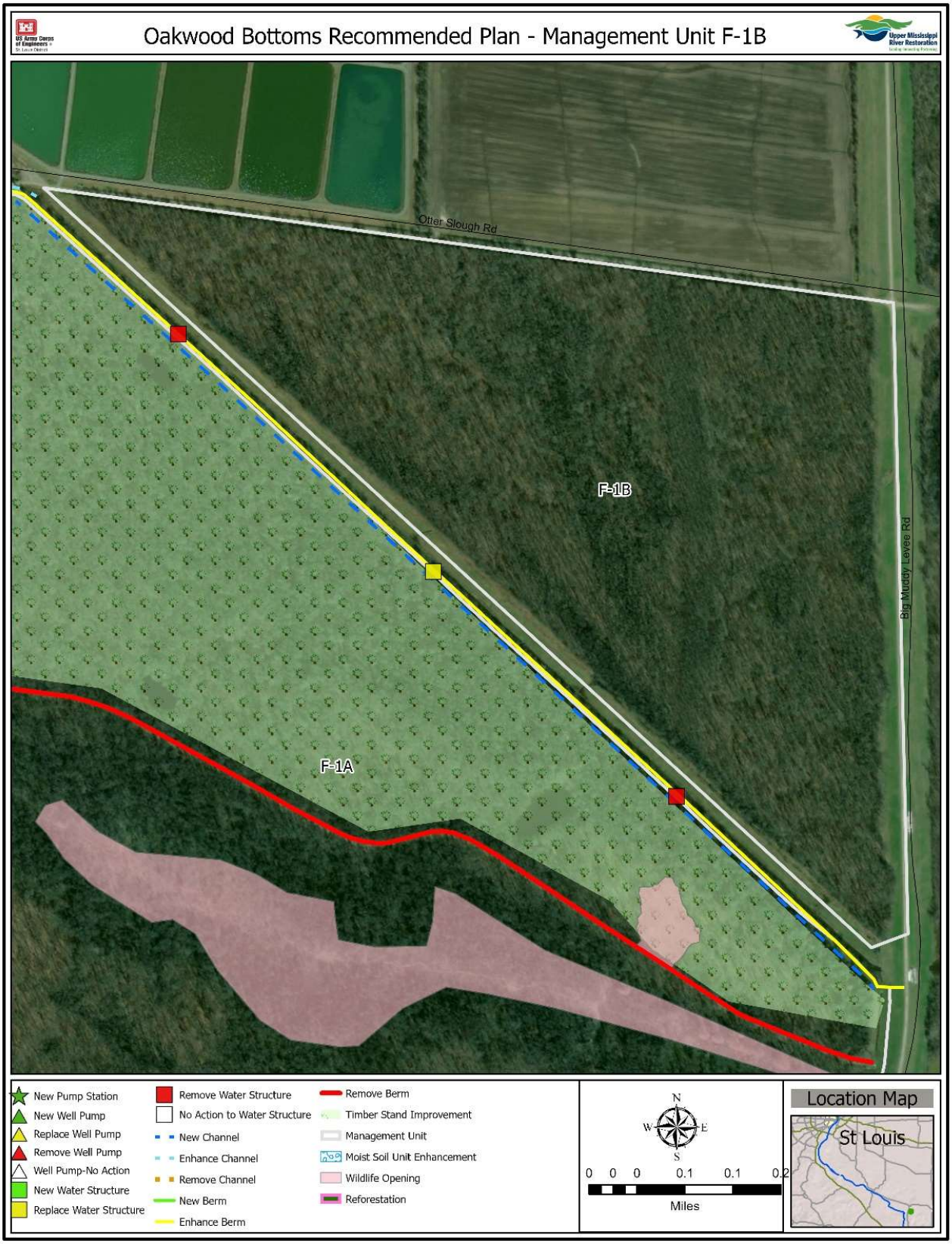

Figure 28. Recommended Plan – Management Unit F1B

Figure 29. Recommended Plan – Management Unit F1C

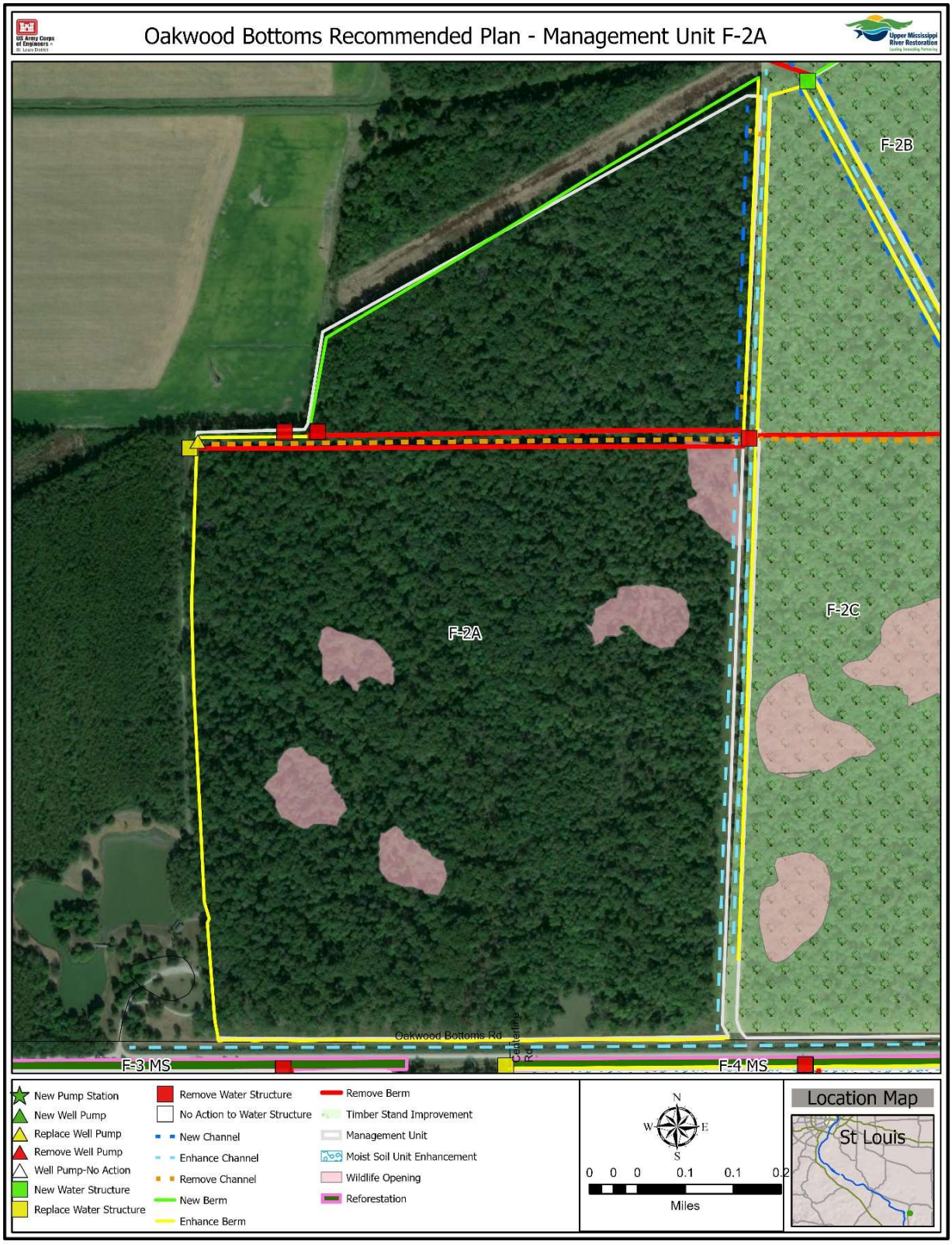

Figure 30. Recommended Plan – Management Unit F2A

Figure 31. Recommended Plan – Management Unit F2B

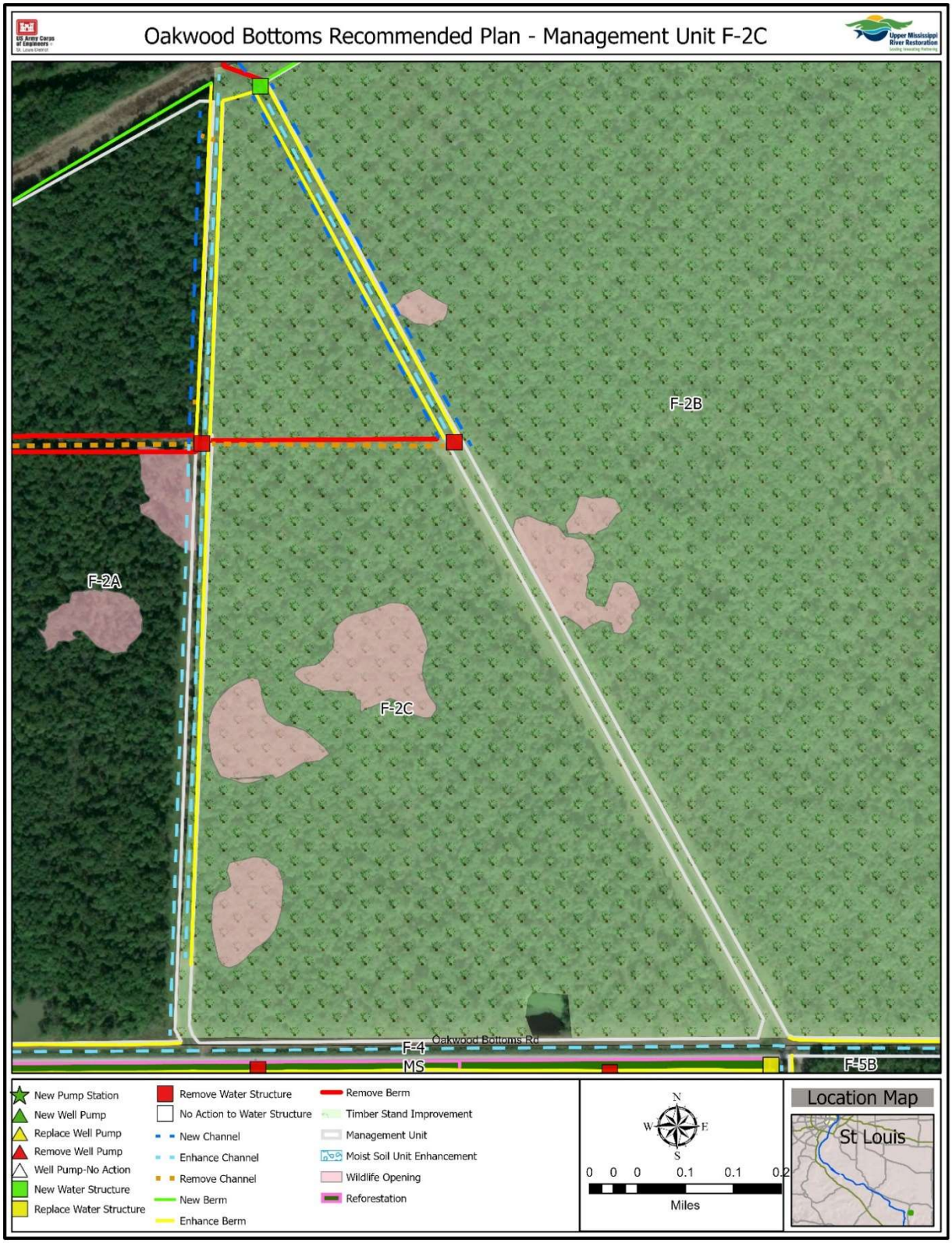

Figure 32. Recommended Plan – Management Unit F2C

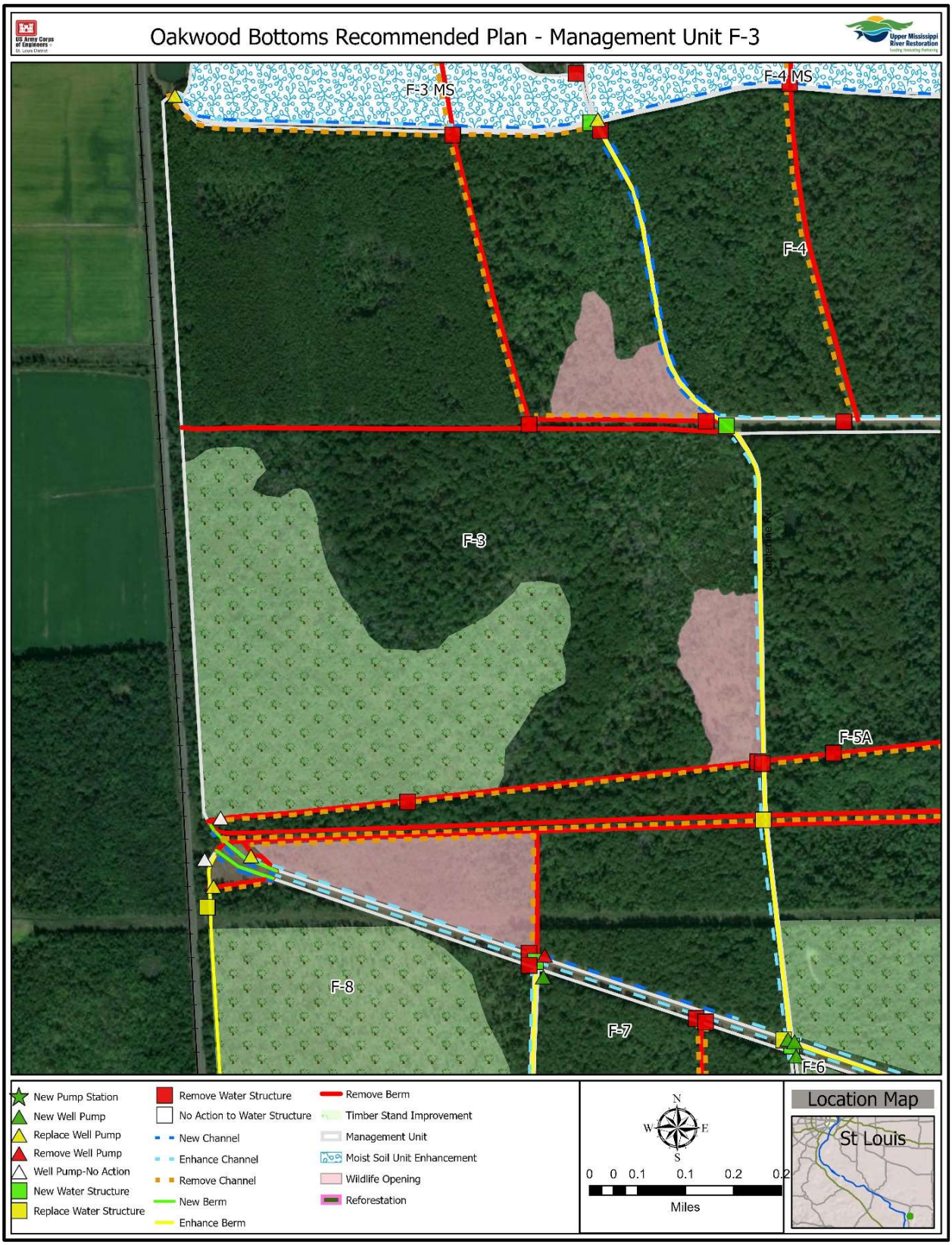

Figure 33. Recommended Plan – Management Unit F3

Figure 34. Recommended Plan – Management Unit F3MS

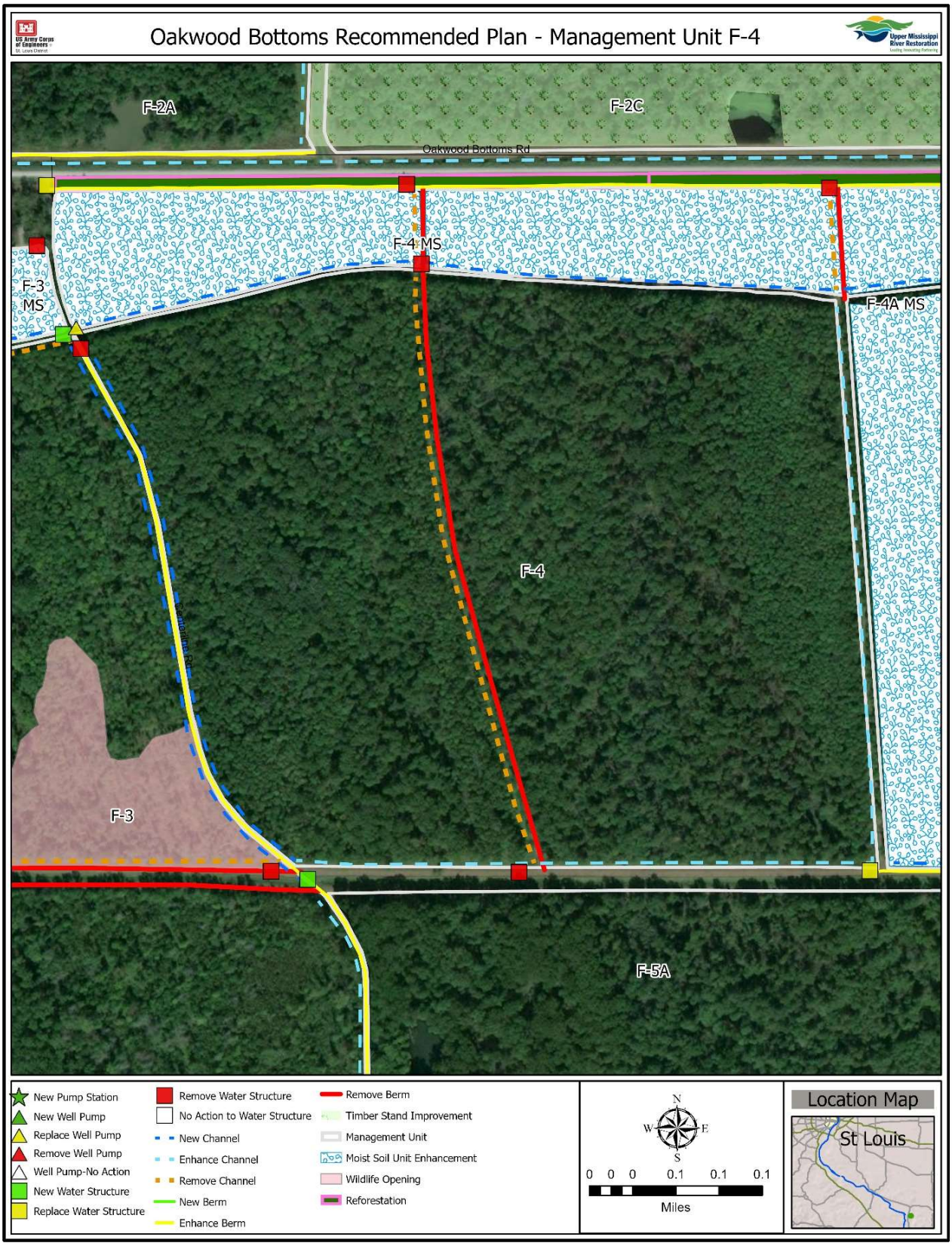

Figure 35. Recommended Plan – Management Unit F4

Figure 36. Recommended Plan – Management Unit F4AMS

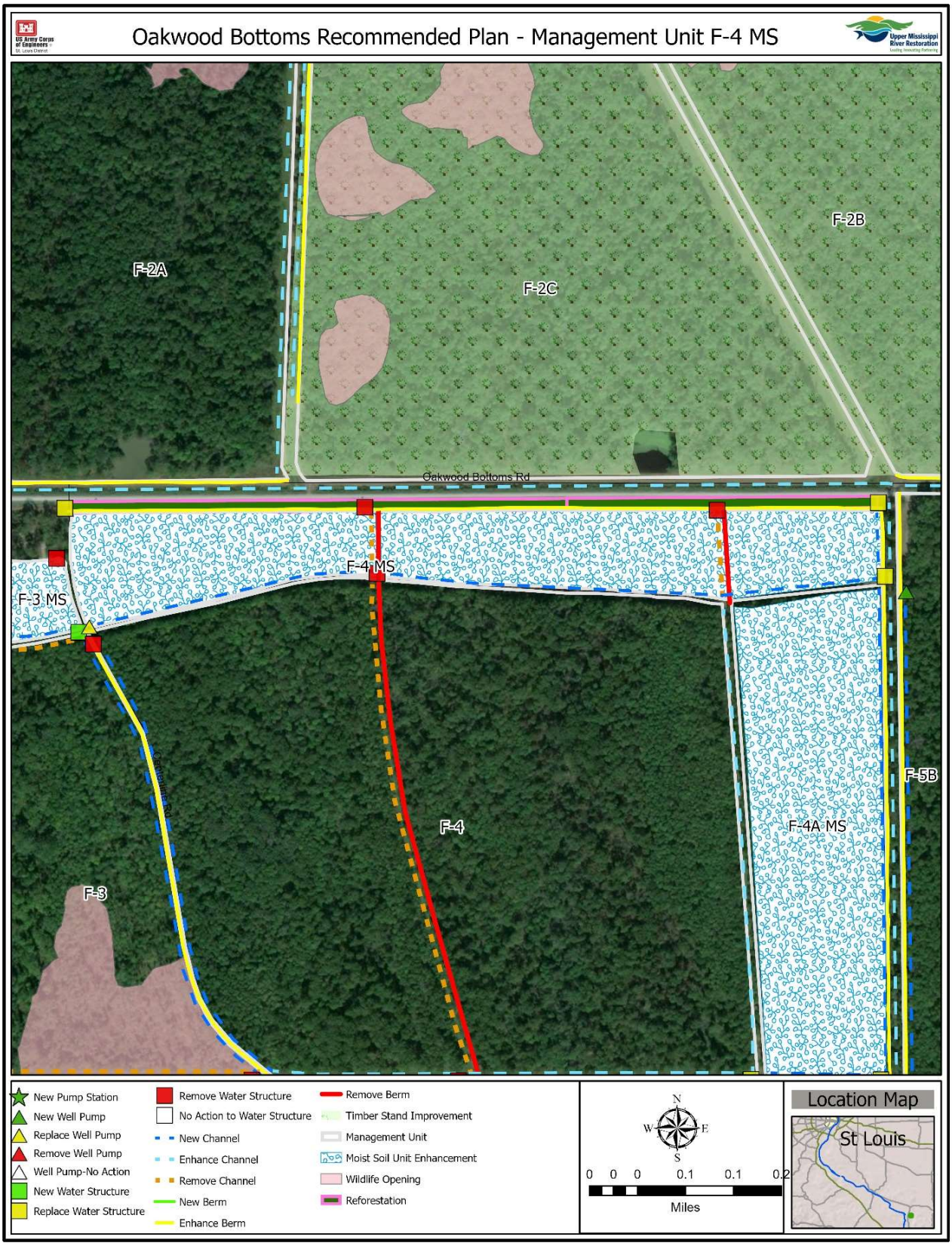

Figure 37. Recommended Plan – Management Unit F4MS

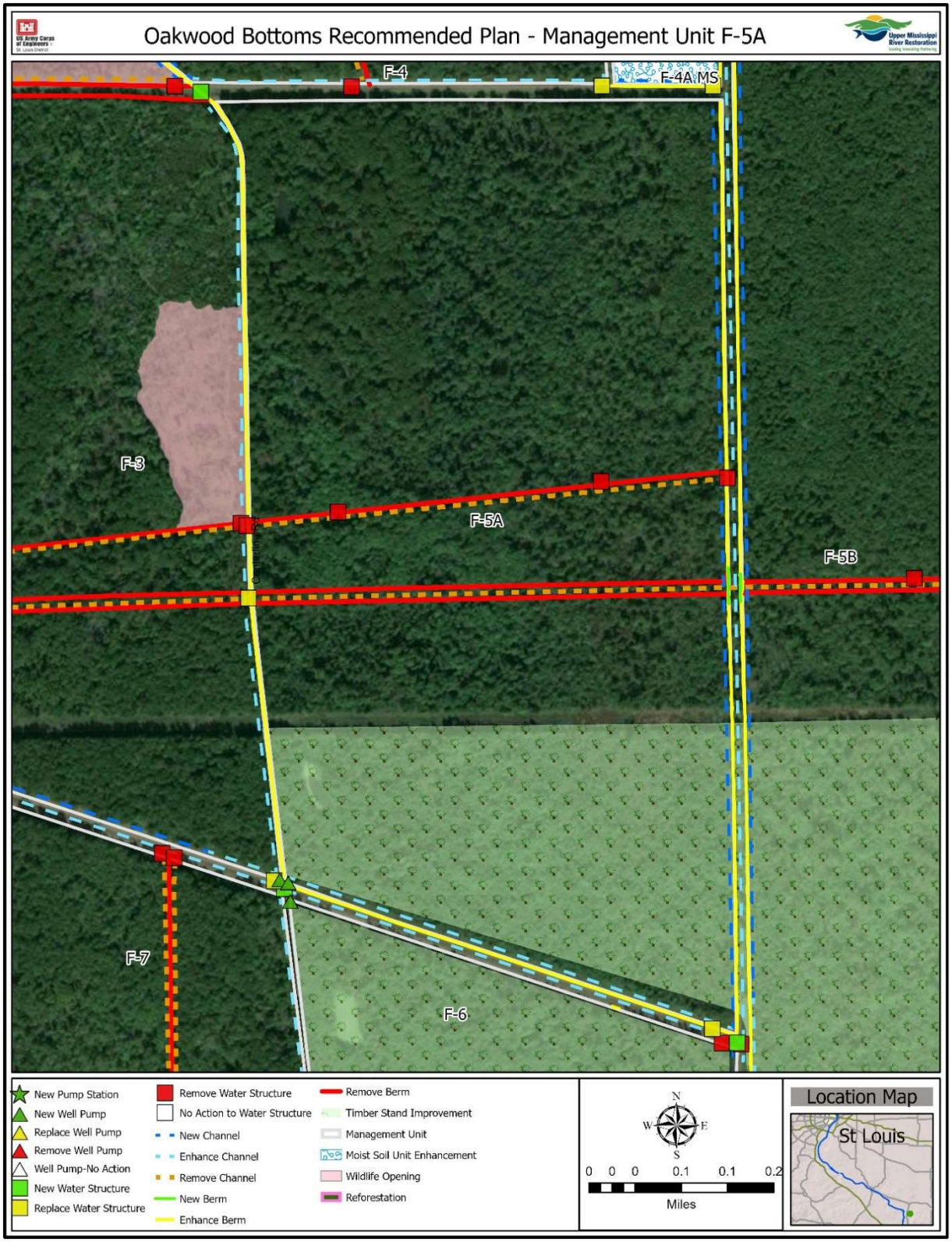

Figure 38. Recommended Plan – Management Unit F5A

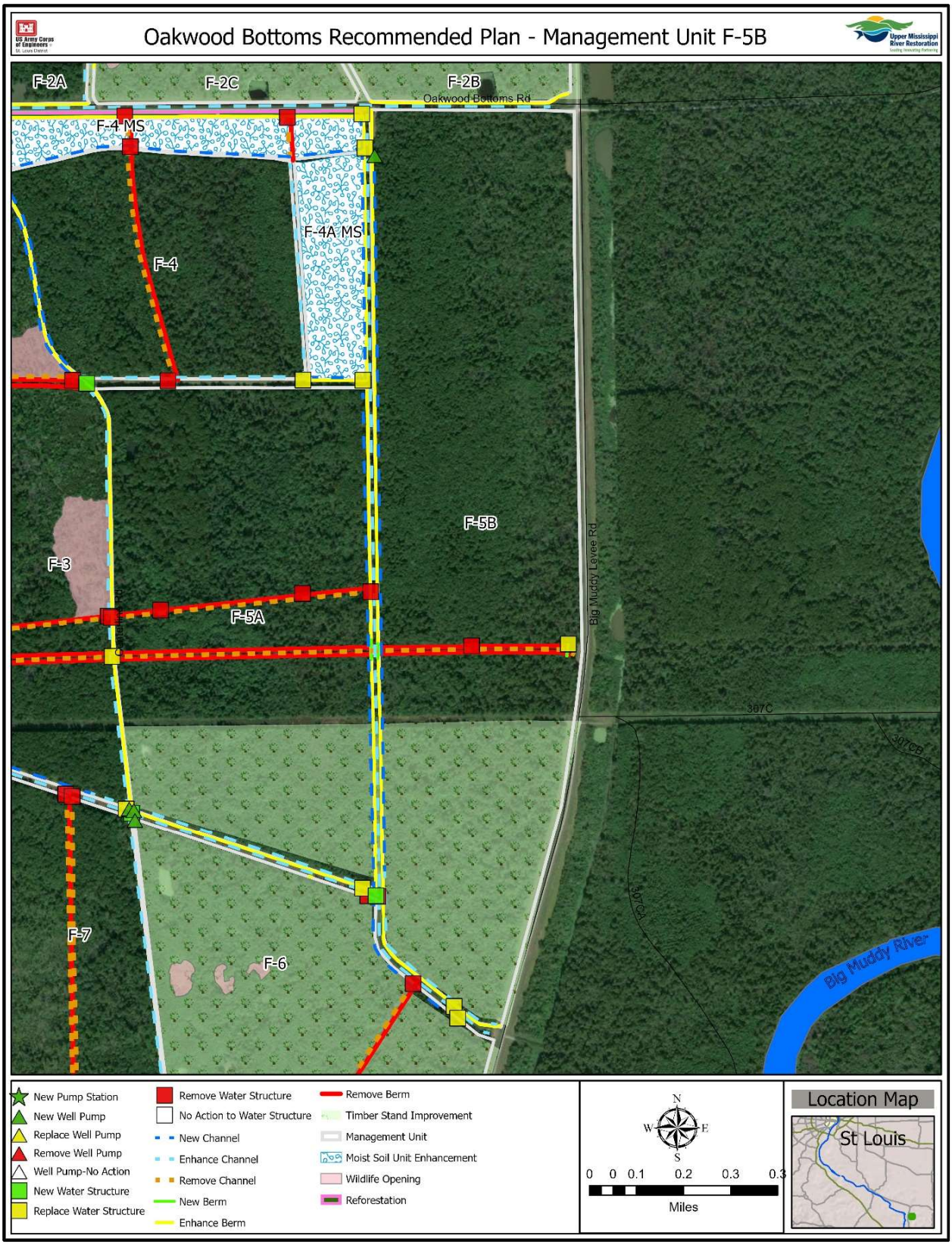

Figure 39. Recommended Plan – Management Unit F5B

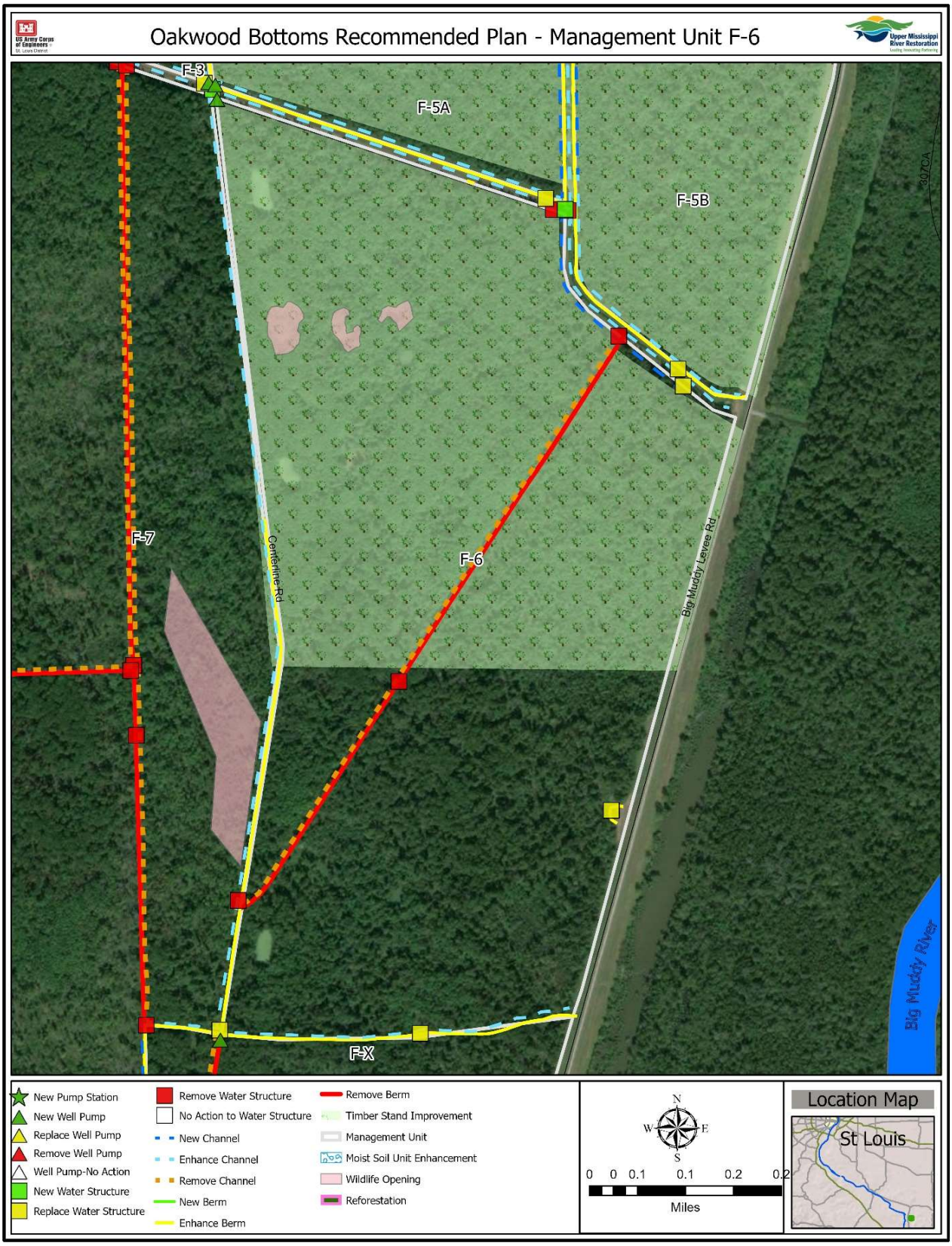

Figure 40. Recommended Plan – Management Unit F6

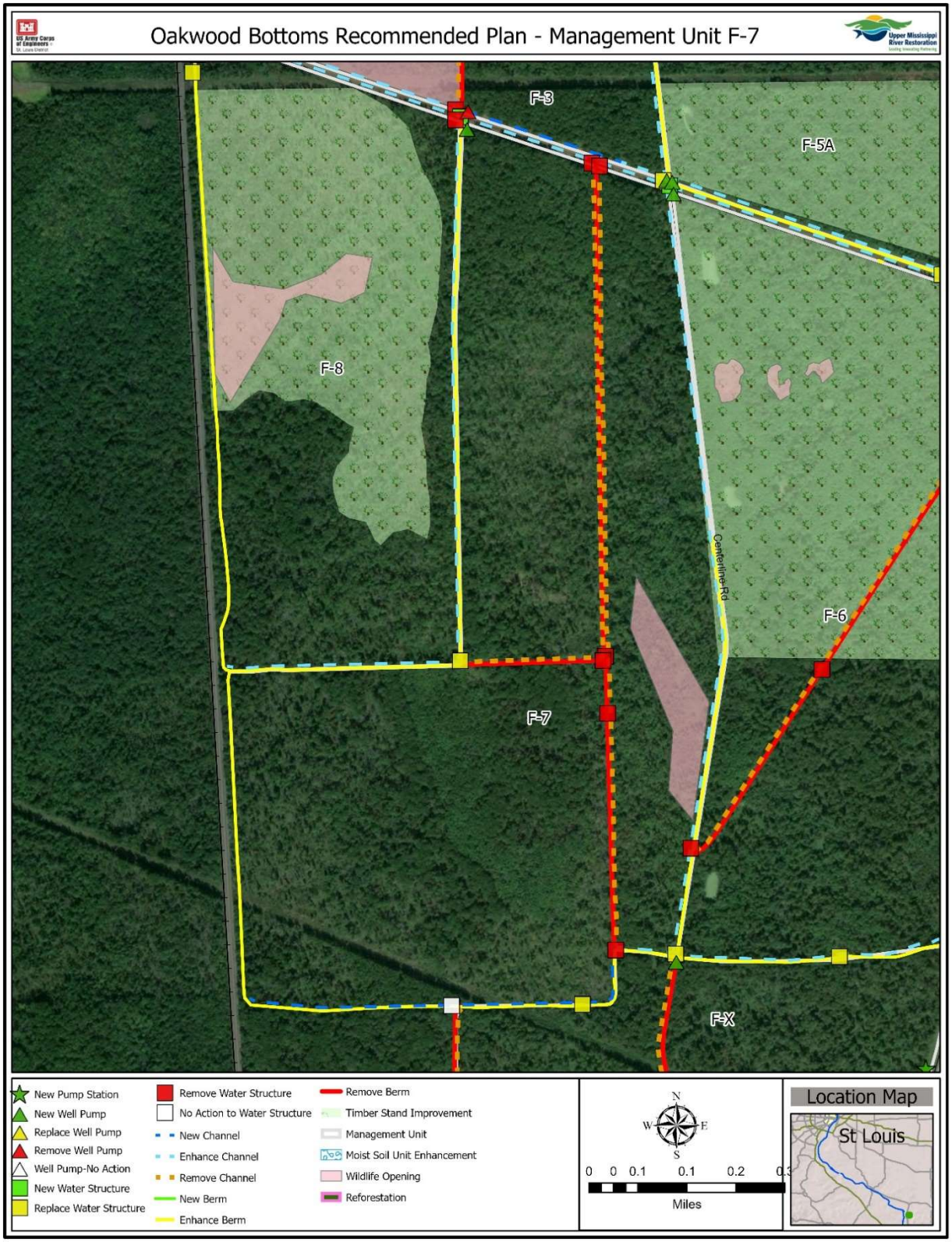

Figure 41. Recommended Plan – Management Unit F7

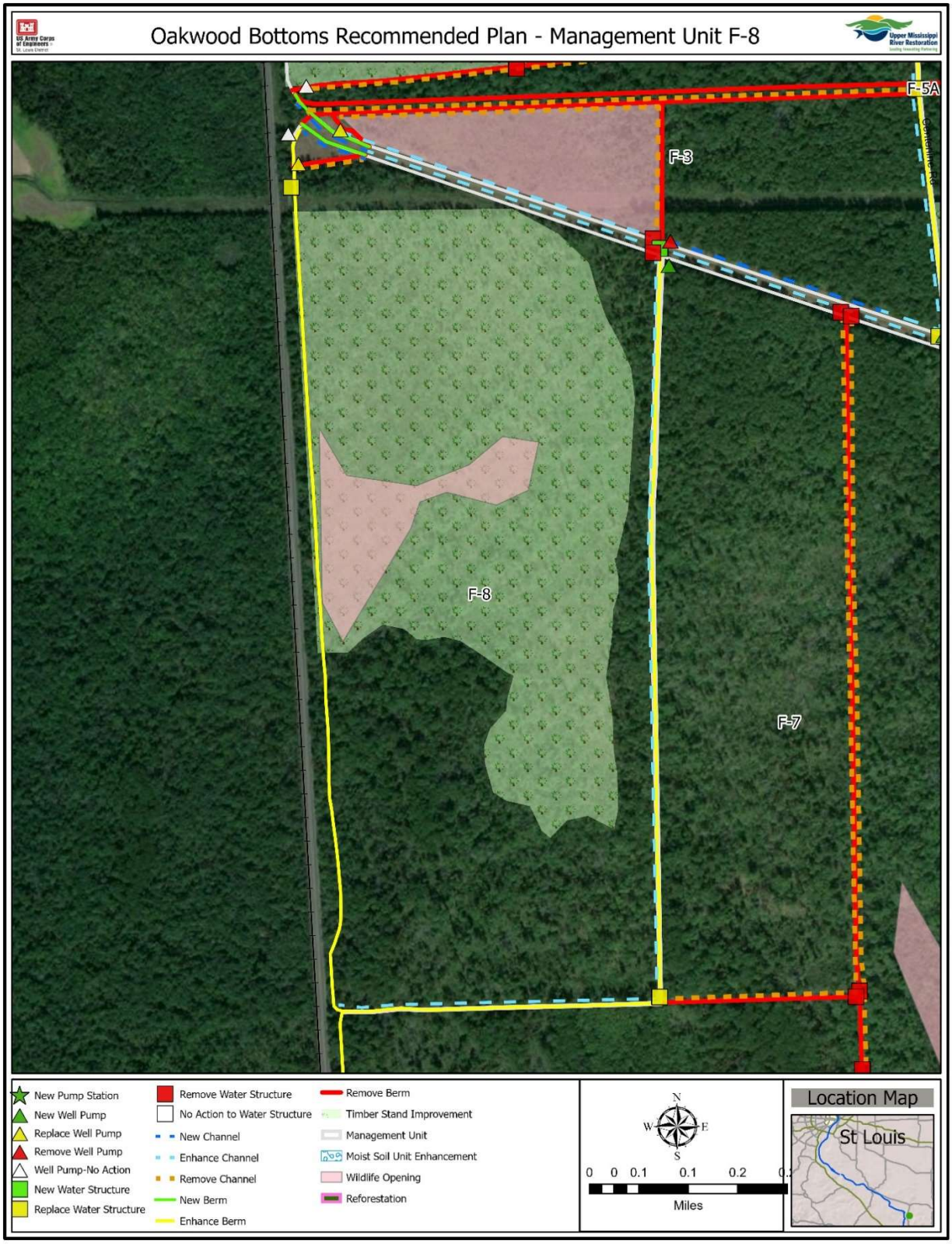

Figure 42. Recommended Plan – Management Unit F8

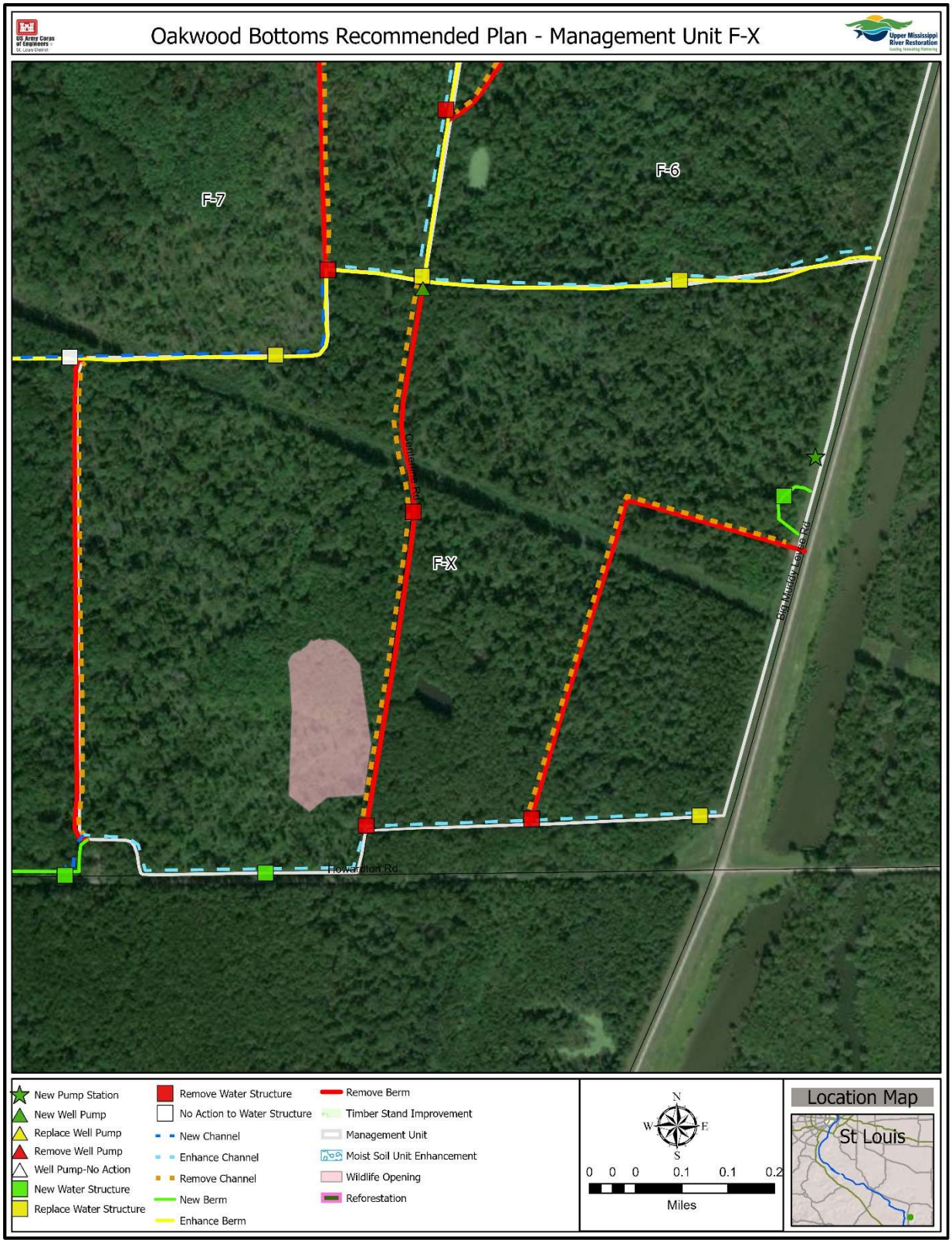

Figure 43. Recommended Plan – Management Unit FX

9.1 Design Considerations

During pre-construction engineering and design (PED), the USACE and the USFS will complete the detailed engineering & 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 alternative will occur during this time.

9.1.1 Public Access and Safety

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

9.1.2 Geotechnical

Additional subsurface exploration will need to be obtained during PED for the design of project features. More information is available in the Appendix O - *Geotechnical*.

9.1.3 Cultural

The layout and design of measures was conducted to avoid impacts to known cultural sites. In an effort to avoid or minimize adverse effects to other cultural resources, final project site selection and design may be altered as a result of consultation with the SHPO and Tribes or as a result of any newly discovered cultural resources located by cultural resource surveys which may take place in the future. Design specifications will include requirements, developed in consultation with the SHPO and affiliated THPOs, to the contractor for what to do in case culturally sensitive sites are encountered during construction.

9.2 Construction Considerations

9.2.1 Protected Species

9.2.1.1 Finger Dogshade (Cynosciadium digitatum)

Known locations of finger dogshade exist within the study area. These areas will be delineated and avoided during construction.

9.2.1.2 Bald Eagles

Consideration (in coordination with the USFWS) will be given during design preparation sequencing construction activities in a manner that minimizes impacts. No clearing of trees where roosting or occupied nests exist shall be allowed when bald eagles are present in the area. If any nesting activity is observed, no construction activities within 660 feet of the nest shall be allowed.

9.2.1.3 Indiana Bat and Northern Long-Eared 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.

9.2.1.4 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. Proposed tree clearing during winter would also avoid nesting migratory wildlife.

9.2.1.5 U. S. Forest Service sensitive species (RFSS, SVC, MIS)

Known locations of U.S. Forest Service designated sensitive species (Regional Foresters Sensitive Species, Species with Viability Concerns, Management Indicator Species) exist within the study area. These areas will be delineated and avoided, when possible, during construction.

9.2.2 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[6] would be followed.

9.2.3 Permits

Laws of the United States and the State of Illinois have assigned the Corps 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.

9.2.3.1 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 I – *Clean Water Act*) for more details. Based on this evaluation, this project would qualify for a Nationwide 27 permit for *Ecosystem Restoration.* Similarly, since this project meets the conditions of Nationwide 27 permit for *Ecosystem Restoration*, the necessary Section 401 water quality certification would be achieved through the associated Nationwide 27 permit general conditions and would be in accordance with IL EPA Section 401 water quality certification requirements through meeting the conditions of Nationwide 27 permit.

9.2.3.2 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.

9.2.4 Construction Schedule Constraints

Scheduling of construction contracts would depend on availability of funds, and based on expected funding, it is likely that the contract would be awarded in at least 2 construction contracts. 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.
- During peak hunting weekends activities may be required to cease for a short period of time.
- Specific reforestation dates would be determined during PED.

9.3 Project Schedule

A Project schedule was developed based upon the assumption that this Report will be approved in the last quarter of FY 2020. The schedule sequences design and construction activities to begin in FY 2021 once the report is approved and appropriations to construct are acquired. The development of this schedule assumes Federal funding is available in the years required.

Milestone/Event	Current Schedule
MSC Decision Milestone	02 JUL 20
Release of Draft Feasibility Report	14 OCT 20
District Engineer's Transmittal of Final Report Package	30 NOV 20
Report Approval	31 DEC 20
Contract Award	31 OCT 21
Construction Complete	31 OCT 23

9.4 Risk and Uncertainty

At the feasibility level of planning, there is always uncertainty about the extent to which the recommended plan will meet the planning objectives. Even when project performance uncertainty is negligible, there is some retained risks. In addition there can be new or transferred risks associated with the recommended plan. It is important to evaluate, communicate, and manage the risks prior to beginning PED.

9.4.1 Cost Risk

A class three cost estimate was created for the recommended plan, meaning there was a minimum level of scope and technical work done to generate a cost estimate. All measures have been recently constructed in the district so minimal uncertainty associated with cost was identified.

Additionally, an abbreviated cost and schedule risk analysis was performed to include risk identification and sensitivity analysis using a Monte Carlo simulation method. The risk analysis documented the conditions, uncertainties, and evaluation methodology used to determine an overall contingency. This contingency will be used to cover unknowns, uncertainties, and/or unanticipated conditions that are not possible to evaluate from the data used in this study but must be accounted for to cover identified risks.

9.4.2 Implementation Risk

Minimal risks associated with implementation were identified. However geotechnical borings were not obtained during feasibility level design. There is a minimal risk that the location of various structures may change based on suboptimal soil conditions.

9.4.3 Performance Risk

While risks were reduced to a tolerable level by managing the uncertainty associated with project benefits, residual risks and the potential for new risks remain. To account for these risks a monitoring and adaptive management plan was created.

9.4.3.1 Monitoring and Adaptive Management

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

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

Berm modification measures may require adjustment to their design to include adjustment of heights and locations. Excavation adaptive management response would involve actions to correct any performance concerns that occur after project construction. Well pumps and water control adaptive management response would involve either location modifications of a structure or an additional structure if water wasn't conveyed as intended. Reforestation and timber stand improvement management response actions would involve additional tree plantings and/or additional management measures.

This monitoring and adaptive management plan has been developed with input from the Federal resource agencies. The monitoring schedule is summarized in Table 28. Details on performance indicators, monitoring targets, time of effect, frequency of monitoring, adaptive management triggers, and responsibilities of monitoring and data collection are detailed in Appendix H-*Monitoring and Adaptive Management Plan.*

9.4.3.2 Monitoring and Adaptive Management Costs

Per Section 1161 guidance, monitoring costs (not to exceed 10 years after project construction) were considered as part of project costs. Any monitoring conducted after 10 years would not be part of the total project cost and will be 100% Federal Sponsor

costs. The estimated adaptive management costs are outlined in Table 28.

Table 28. OBGTR Conceptual Monitoring Schedule and Estimated Monitoring Costs.

Feature	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	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000		45,000
	Topographic Survey	LiDAR	50,000										50,000
	AM feature: Berm modification					167,000					167,000		334,000
Structures	95% of unit area has ideal surface water hydrology by spring/fall by drain/fill management	Monitor water input and drainage:	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500			20,000
	AM feature: Resize structures					177,500					177,500		355,000
Wells	Water supply not sufficient	Observation	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500			20,000
	AM feature: Additional well pumps					108,000					108,000		216,000
Emergent Wetland	Species diversity	Vegetation surveys	10,000								10,000		20,000
	Water management capability	Water drainage/filling	5,000				5,000				5,000		15,000
	AM feature :None identified												0
Reforestation	Forest Community Diversity	Forest monitoring			6,000				6,000				12,000
	AM feature: supplemental planting										81,,000		81,000
Timber Stand Improvement	Regeneration occurring	Regeneration surveys								20,000			20,000
	AM feature: Additional TSI										74,,000		74,000
	Performance Evaluation Report	Inspection and report writing					37,500					37,500	75,000
													TOTAL $1,337,000

* Baseline monitoring costs occurring in PED are not included in adaptive management totals.

9.5 Operation, Maintenance Considerations

Maintenance requirements would be further detailed in the Project's OMRRR Manual after construction completion. The OMRRR life cycle costs include oversight, management, monitoring, debris and sediment removal, mowing, power, earthwork, tree clearing, plantings, periodically replacing fittings and hoses, conducting preventive and periodic maintenance on the pump engine and automation systems, ensuring reception systems are prepared for flood operations, protected from weather, theft, and vandalism. The total annualized cost for OMRRR of the recommended plan is $215,000 using the FY 2020 2.75% discount rate. A breakdown by year for the 50-year period of analysis is shown in Table 29**Error! Reference source not found.** (see Appendix B-*Engineering Design* for additional details). The USFS is 100% responsible for OMRRR costs. These quantities and costs may change during final design.

Table 29. Estimated Annual Operation and Maintenance Costs (October 2019 price levels).

Year		Cost
1	$	187,440
5	$	323,251
10	$	385,301
15	$	307,301
20	$	385,301
25	$	535,301
30	$	385,301
35	$	307,301
40	$	385,301
45	$	307,301
50	$	665,001
Total	**$**	**10,910,060**
Annualized	**$**	**215,000**

10 LANDS, EASEMENTS, RIGHT OF WAYS, RELOCATIONS AND DISPOSAL

The Federal sponsor is required to provide any lands, easements, right of ways, relocations and disposals (LERRD) necessary for project construction and OMRRR. Any LERRDs determined to be integral to the project will be credited to the project.

The lands are presently owned by the United States and are under the control of the USFS. As such, the Project would be a 100% Federal cost. An easement is not needed to access the study area for construction.

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

11 COST ESTIMATES

Table 30 shows the Project First Cost. The detailed cost estimate is provided in Appendix G - *Cost Estimate*; however, due to the sensitivity of providing this detailed cost information, which could bias construction contract bidding, this material has been omitted in the public document. Quantities and costs may vary during final design. All cost estimates are calculated using the FY20 Price Level. The habitat benefits did not change with the updated design but the cost did, therefore the new average annual cost per habitat unit is $973, using the FY20 federal discount rate of 2.75% and 50 year period of analysis.

Table 30. Project First Cost Estimate (October 2019 Price Level).

Account	Feature	Cost
01	Lands and Damages (LEERD)	$0*
06	Fish & Wildlife Facilities	$14,873,000
09	Contingency	$6,520,000

Account	Feature	Cost
30	Planning, Engineering, & Design	$4,141,000
31	Construction Management	$1,557,000
16	Adaptive Management and Monitoring	$1,337,000
	Project First Costs	**$28,428,000**

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

12 IMPLEMENTATION RESPONSIBILITIES

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

Performance evaluation, which includes monitoring of physical/chemical conditions and some biological parameters, is a USACE responsibility.

A *Memorandum of Agreement* is the formal agreement that would be entered into by the Corps of Engineers and the USFS before implementation of the project. The Memorandum of Agreement (MOA), describes obligations for constructing, operation, and maintaining the implemented features of the Oakwood Bottom Greentree Reservoir HREP. This draft MOA is used in lieu of a separate List of Items of Local Cooperation normally used in Specifically Authorized and Cost Shared projects because:

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

12.1 U.S. Army Corps of Engineers

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

12.2 U.S. Forest Service

The USFS is the Federal Sponsor and has provided technical and other advisory assistance during all phases of the study and will continue to provide assistance during Project implementation. The Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRRR) of the Project is the responsibility of the USFS in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. The annual OMRR&R costs are estimated at $215,000. These functions will be further specified in the Project OMRRR Manual to be provided by USACE prior to final acceptance of the Project by the Federal Sponsor. The USFS has agreed to support this HREP's monitoring and data collection needs as outlined earlier in this report.

13 CONSISTENCY WITH USACE CAMPAIGN PLAN

The USACE Campaign Plan provides goals, objectives, and actions for improving the USACE contribution to the nation in the areas of warfighting, civil works processes and delivery systems, risk reduction from natural events, and preparation for the future. The four primary goals are to 1) Support National Security, 2) Deliver Integrated Water Resource Solutions, 3) Reduce Disaster Risks, and 4) Prepare for Tomorrow. The OBGTR HREP supports the Campaign Plan with contributions to Goal 2, "Deliver Integrated Water Resource Solutions." The study does not make significant contributions to the other three goals.

Goal 2 (Deliver Integrated Water Resource Solutions) includes the following objectives: 2a - Deliver quality water resource solutions and services; 2b - Deliver the civil works program and innovative solutions; 2c - Develop the civil works program to meet the future needs of the Nation; and 2d - Manage the life-cycle of water resources infrastructure systems to consistently deliver reliable and sustainable performance. The OBGTR HREP supports Goal 2 by:

- Identification of a plan to restore the function, structure, and process of the OBGTR;
- Coordination with significant stakeholder groups throughout the study process; and
- Recommendation of a sustainable and resilient plan, with appropriate consideration of the long term operation and maintenance of the restoration features.

14 CONSISTENCY WITH USACE ENVIRONMENTAL OPERATING PRINCIPLES

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 EOPs are: foster sustainability as a way of life throughout the organization; proactively consider environmental consequences of all USACE activities and act accordingly; create mutually supporting economic and environmentally sustainable solutions; continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments; consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs; leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner; and employ an open, transparent process that respects views of individuals and groups interested in USACE activities. The EOPs were considered during the plan formulation, and the recommended plan is consistent with the EOPs. The recommended plan promotes sustainability and economically sound measures by incorporating the most natural and least cost methods for restoring bottomland hardwood forest and emergent wetland habitats for migratory waterfowl and other wildlife species.

15 CONCLUSION*

The USACE planning team designed management measures to meet the study's objectives of restoring emergent wetland structure and function as well as restoring bottomland hardwood forest habitat. The management measures identified as the NER plan for the OBGTR HREP (pump station, well pumps, water control structures, and reforestation, excavation, and berm modifications) would allow the study area to realize the highest benefit to migratory birds and wildlife.

The USACE planning team anticipates the implementation of the OBGTR HREP would enhance floodplain forest structure and diversity during the 50-year period of analysis. These restoration efforts would provide long-term benefits to resident and migratory wildlife.

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UPPER MISSISSIPPI RIVER RESTORATION PROGRAM

FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

OAKWOOD BOTTOM GREEN TREE RESERVOIR
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

RECOMMENDATIONS

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

- Berm construction and associated earthwork (approximately 9 acres)
- Berm enhancement and associated earthwork (approximately 55 acres)
- Berm deconstruction and associated earthwork (approximately 94 acres)
- Remove 62 water control structures
- Install 1 pump station
- Install 6 well pumps
- Install 30 water control structures
- Excavate 19 acres of channel
- Excavate/re-grade 87 acres of emergent wetlands
- Reforestation (approximately 94 acres)
- Selective clearing and woody debris removal (approximately 124 acres)
- Additional Timber stand improvements (approximately 1,600 acres)

The total Federal estimated Project cost, including general design and construction management, is $28,428,000.

_____ _____

Date

KEVIN R. GOLINGHORST
COL, EN
Commanding

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DRAFT FINDING OF NO SIGNIFICANT IMPACT

OAKWOOD BOTTOMS GREENTREE RESERVOIR HREP WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

JACKSON COUNTY, ILLINOIS

The U.S. Army Corps of Engineers, St. Louis District (USACE) conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated **DATE OF EA**, for the *Upper Mississippi River Restoration Program Oakwood Bottoms Greentree Reservoir Habitat Rehabilitation and Enhancement Project Feasibility Report* addresses restoring ecosystem structure and function opportunities and feasibility in Jackson County, Illinois.

The Final 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 *Forest Service Preferred Alternative*, which is also National Ecosystem Restoration (NER) Plan and includes:

- Berm construction and associated earthwork (approximately 9 acres)
- Berm enhancement and associated earthwork (approximately 55 acres)
- Berm deconstruction and associated earthwork (approximately 94 acres)
- Remove 62 water control structures
- Install 1 pump station
- Install 6 well pumps
- Install 30 water control structures
- Excavate 19 acres of channel
- Excavate/re-grade 87 acres of emergent wetlands
- Reforestation (approximately 94 acres)
- Selective clearing and woody debris removal (approximately 128 acres)
- Additional Timber stand improvements (approximately 1,600 acres)

Monitoring and Adaptive Management is included in Appendix H. Monitoring will not last longer than 10 years.

In addition to a “No Federal Action” plan, three action alternatives were evaluated. The alternatives included:

- Maximum Alternative
- Minimum Alternative
- Forest Service Preferred Alternative

For all alternatives, the potential effect 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 & Hydraulics	☒	☐	☐
Floodplain Habitat	☒	☐	
Aquatic resources/wetlands	☒	☐	☐
Geology & Soils	☒	☐	☐
Fish and wildlife habitat	☒	☐	☐
Threatened/Endangered species/critical habitat	☒	☐	☐
Illinois Resources of Concern	☒	☐	☐
Bald Eagle	☒	☐	☐
Invasive Species	☒	☐	☐
Water Quality	☒	☐	☐
Air Quality	☐	☐	☒
Greenhouse Gas & Climate Change	☒	☐	☐
Hazardous, Toxic, & Radioactive Waste	☒	☐	☒
Historic, Cultural, & Tribal Resources	☐	☐	☒
Socio-economics	☒	☐	☐
Aesthetics	☒	☐	☐
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 9 of the IFR/EA. No compensatory mitigation is required as part of the recommended plan.

Public review of the draft IFR/EA and FONSI was completed on **DATE DRAFT EA AND FONSI REVIEW PERIOD ENDED**. All comments submitted during the public review period were responded to in the Final IFR/EA and FONSI.

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: Gray Bat, Indiana Bat, Northern Long-Eared Bat. 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 determination of the recommended plan has no effect on historic properties is pending and will be determined prior to final report

approval. This determination may be re-evaluated if warranted by further developments.

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 I -*404(b)1* of the IFR/EA.

A water quality certification pursuant to Section 401 of the Clean Water Act would be obtained through meeting the conditions of a 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 dated **DATE OF LETTER**, the **STATE, TERRITORY, OR TRIBE** stating that the recommended plan appears to meet the requirements 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 and environmental criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

_____
Date

_____
KEVIN R. GOLINGHORST
COL, EN
Commanding