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

CLARENCE CANNON NATIONAL WILDLIFE REFUGE

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

February 2014
Draft for Public Review

US Army Corps of Engineers ®
St. Louis District

POOL 25
MISSISSIPPI RIVER
MILES 261.1 THROUGH 263.8
PIKE COUNTY, MISSOURI

ACKNOWLEDGMENTS

The Clarence Cannon National Wildlife Refuge HREP USACE Project Delivery Team members, with roles and experiences, are listed below:

Name	Role	Education	Years of Experience
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	Mechanical Engineer	BS Mechanical Engineering	32
	Electrical Engineer	BS Electrical Engineering	5
	Structural Engineer	MSCE, BE Civil Engineering	32
	Cultural & Historic Resources	BA Anthropology	26
	Tribal Coordination	MS Anthropology	20
	Economics	BS Economics & Finance MS Economics & Finance	5
	Geotechnical Engineer	BS Civil Engineering MS Geotech Engineering	4
	Cost Estimating	Assoc Degree Civil Engineering	31
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	Real Estate	MBA	16
	HTRW	BS Fish & Wildlife BS Electrical Engineering	32
	Surveying & Mapping	BS Surveying	26

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Executive Summary*

A. Purpose of Report. The purpose of this Draft Definite Project Report with Integrated Environmental Assessment, including the draft Finding of No Significant Impact, is to evaluate and document the decision-making process for the proposed Upper Mississippi River Restoration-Environmental Management Program (UMRR-EMP) Habitat Rehabilitation and Enhancement Project (HREP) at Clarence Cannon National Wildlife Refuge (CCNWR). This report is being developed by the U.S. Army Corps of Engineers with the U.S. Fish and Wildlife Service (USFWS) serving as the Federal project partner. This report provides planning (including National Environmental Policy Act compliance), engineering, and sufficient construction details of the Tentatively Selected Plan (TSP) to allow final design and construction to proceed subsequent to document approval by the Mississippi Valley Division U.S. Army Corps of Engineers.

B. Project Location. The Clarence Cannon National Wildlife Refuge (CCNWR) HREP is located along the right descending bank of the floodplain within the Upper Mississippi River Navigation Pool 25 between river miles (RM) 261.1 and 263.8, adjacent to the town of Annada in Pike County, Missouri. Clarence Cannon National Wildlife Refuge covers 3,750-acres of seasonally flooded wetlands, open marsh, mixed shrub/scrub/emergent wetlands, bottomland hardwood forest, agricultural fields, backwater lakes and sloughs, and floodplain forest. The CCNWR HREP would be constructed on land owned by the Federal Government with management responsibility provided by the USFWS.

C. Problem Identification. In the early 1900s, the area was drained, ditched, leveed, and cleared for agricultural production in fragmented parcels which altered the site hydrology and resulted in large-scale conversion of native plant communities (floodplain forest and emergent wetland) leading to disturbed and degraded ecosystem structure and function. Currently, on the 3,750 acre refuge, approximately 3,200 acres are fragmented into 27 named units capable of limited manual water level alteration, and this fragmentation has eliminated the natural drainage, topography, and habitat connectivity of the project area. In addition, forest resources on the refuge, primarily pin oak and pecan, were impacted by the flood of 1993. Up to 80% of the floodplain forests in the approximate 400 acres of forest died due to the flood. Furthermore, backwater sloughs, lakes, and old meander scars have been cut-off from the river by the exterior berm. Almost all of these aquatic areas are greatly deteriorated due to lack of connectivity with the main stem Mississippi River. This has greatly reduced aquatic habitat diversity and important seasonal habitat for a diverse suite of aquatic organisms. Furthermore, due to the altered hydrology and loss of native wetland vegetation, non-native reed canary grass is spreading across the site resulting in further ecosystem degradation.

D. Project Goal and Objectives. The goal of this HREP is to restore and improve the quality and diversity of wetland ecosystem resources in the project area. The following objectives and structural and non-structural feasible restoration features were considered in detail to achieve the project goal:

Objective 1. *Restore native wetland plant communities (forest and emergent wetland) in areas of suitable elevation, hydrology, and soil* – Decrease habitat fragmentation between the management units to restore historic vegetation patterns. Restore forest and other wetland species at suitable elevations, soils, and hydrology. This would restore wetland habitat to the interior of CCNWR.

- No Action
- Setback berm with water control structure
- Setback berm with exterior berm degrade
- Notch or fully degrade or partially degrade interior berms to establish larger connected management units
- Reforestation

Objective 2. *Improve aquatic ecosystem resources* – Increase aquatic habitat diversity and floodplain topographic diversity. Restore seasonal connectivity between the project area and the Mississippi River.

- No Action
- Excavate existing water bodies and historic meanders
- Setback berm with water control structure
- Setback berm with exterior berm degrade

Objective 3. *Improve water drainage and delivery* – Deliver water to achieve target surface water levels in < 7 days within the management units. This would provide the project partner improved water conveyance management capability on the management unit(s) which will increase wetland plant diversity, increase invasive species management capabilities, and improve overall ecosystem resources. In addition, during large, overtopping flood events, drain the interior project area to target water levels in < 40 days which is needed to prevent ponding of floodwaters which is detrimental to wetland structure and function.

- No Action
- Water control structures associated with larger management units
- Pump station

E. Plan Formulation, Evaluation, and Comparison. Feasible features that met the project goal and objectives, as well as the no action alternative, were evaluated through an environmental benefits analysis to determine the magnitude of ecosystem benefits to be expected if the features were implemented. The benefits of the feasible features were evaluated using the Wildlife Habitat Appraisal Guide (WHAG) and Aquatic Habitat Appraisal Guide (AHAG). The benefits were then combined with cost estimates for each feature. Ecosystem benefits and project costs were then run through Cost Effectiveness and Incremental Cost Analysis using the U.S. Army Corps of Engineers Institute of Water Resources Program (IWR). This incremental analysis identified which combinations of restoration features (a total of 408 alternatives) and their associated environmental outputs (average annual habitat units) would be both cost efficient and cost effective. This analysis also showed the changes in cost for increasing levels of environmental output. This analysis resulted in 38 cost effective alternatives, and a total of 9 that were considered "Best Buy" Alternatives, including the No Action Alternative. These nine alternatives were then compared and assessed on their ability to meet project objectives, NEPA

compliance, and achieving the USACE Planning and Guidance evaluation criteria of acceptability, completeness, effectiveness, and efficiency (ER 1105-2-100).

F. Plan Selection. The tentatively selected plan (Alternative 8) for the CCNWR Project consists of multiple features to restore and improve the wetland ecosystem structure and function by implementation of the following project features:

- Setback berm with exterior berm degrade
- Three larger management units (North Unit, South Unit, and Riverside Unit) and associated water control structures and native wetland vegetation restoration
- Restoration of historic meanders
- Diesel pump station
- Reforestation

The tentatively selected plan (TSP) is a best buy alternative that yields 1,703 net average annual habitat units (AAHUs) at an average cost of $787 per habitat unit (FY2014 price level; FY2014 federal discount rate of 3.5%). It best meets the study objectives and has partner support from USFWS. Implementation of the tentatively selected plan would increase the quality and quantity of ecosystem resources and meet the needs for a large variety of native floodplain species. Degrading interior berms to establish larger management units will reduce habitat fragmentation. Constructing a setback berm will increase floodplain connectivity and provide spawning and rearing opportunities for a wide variety of aquatic life. Improving water level management capability would provide more wetland habitat, greater vegetation diversity, a reliable food supply to resident and migratory wetland species, and better means to manage for invasive plant species. Reforestation would increase wetland habitat diversity. Restoring the historic meanders would increase aquatic habitat and improve floodplain topographic diversity. The project outputs are consistent with the refuge's Habitat Management Plan goals and objectives and support the overall goals and objectives of the Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP).

All proposed project features would be located on Federally-owned lands managed by the USFWS. As a result, first cost funding for restoration features would be 100 percent Federal. The current estimated Federal construction cost (FY2014 price level) of this project (including contingencies) is estimated at $29,897,000 for the CCNWR HREP. The average annual cost of construction is estimated at $1,274,600. Total project monitoring (including contingencies) cost for the first 10 years is estimated at $108,100 (average annual cost of $4,000). USFWS would be responsible for project operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) at an estimated average annual cost of $62,300 (including contingencies). In total, the TSP (including construction, OMRR&R, and monitoring) yields a net average of 1,703 AAHUs for an average annual cost of $1,340,900.

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(* Denotes National Environmental Policy Act required Sections)

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Chapter 1 Introduction*

1.1 Project Area

The Clarence Cannon National Wildlife Refuge (CCNWR) Habitat Rehabilitation and Enhancement Project (HREP) area is located on the right descending bank of the Mississippi River, adjacent to the town of Annada in Pike County, Missouri, approximately 70 miles northwest of St. Louis (Figure 1). The refuge lies in Pool 25 between Upper Mississippi River Miles (RM) 261.1 and 263.8, just upstream of the pool hinge point at Mosier Landing (RM 260.3L). The project area includes the entire 3,750-acre refuge comprised of floodplain forest with bottomland hardwoods, open marsh, mixed shrub/scrub/emergent wetlands, mud flats, backwater lakes and sloughs, and agricultural fields in rotational crop production (used for wildlife food and to set back succession). Water features include Big Pond, Crane Pond, Rabourn Slough, Heron Pond, Buttonbush Pond, and various other smaller water bodies.

The CCNWR HREP would be constructed on land owned by the Federal Government with management responsibility provided by the USFWS. A full description of the project area and real estate information is in Appendix A, *Real Estate Plan*.

1.2 Project Purpose

The purpose of this Draft Definite Project Report with Integrated Environmental Assessment, including the draft Finding of No Significant Impact (FONSI) is to evaluate the proposal for the Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP) Habitat Rehabilitation and Enhancement Project (HREP) at Clarence Cannon National Wildlife Refuge (CCNWR). This report is being developed by the U.S. Army Corps of Engineers (USACE) with the U.S. Fish and Wildlife Services (USFWS) serving as the Federal project partner. This report provides planning, engineering, and sufficient construction details of the Tentatively Selected Plan (TSP) to allow final design and construction to proceed subsequent to document approval.

1.3 Project Selection

The USFWS identified the Clarence Cannon National Wildlife Refuge HREP for inclusion in the St. Louis District's Upper Mississippi River Restoration - Environmental Management Program (UMRR-EMP). The River Resources Action Team (RRAT), an interagency coordination team, then ranked projects based on critical habitat needs along the Mississippi and Illinois Rivers. After considering resource needs and deficiencies pool by pool, the RRAT recommended and supported the Clarence Cannon National Wildlife Refuge HREP because it provides opportunities for significant aquatic and floodplain ecosystem benefits; and the problems identified were considered to be within USACE's Ecosystem Restoration Mission.

1.4 Resource Significance*

The Mississippi River represents the largest riverine ecosystem in North America and the third largest in the world. The Upper Mississippi River is the portion of the Mississippi River upstream of Cairo, Illinois and its watershed encompasses over 2.6 million acres of aquatic, wetland, forest, prairie, and agriculture, supporting over 300 species of birds, 57 species of mammals, 45 species of amphibians and reptiles, 150 species of fish, and nearly 50 species of mussels. More than 40 percent of North America's migratory waterfowl and shorebirds depend on the food resources and other life requisites (shelter, nesting, rearing habitats, etc.) that the watershed provides and is well documented in the literature for its technical significance involving connectivity (*e.g.*, Mississippi River Flyway), biodiversity, and endangered species (*e.g.*, pallid sturgeon). The importance of these resources was recognized by Congress in the Water Resources Development Act of 1986 by their designation of the Upper Mississippi River System (UMRS) as a "nationally significant ecosystem" and a "nationally significant commercial navigation system"(Section 1103(a)(2)). Institutional recognition of this resource's

significance was further recognized by Congress' initial and continued authorization of Upper Mississippi River Restoration - Environmental Management Program (UMRR-EMP) for the planning, construction, and evaluation of features for restoration of fish and wildlife habitat in the UMRS. Public recognition for the value of this ecosystem comes from several partnerships within the basin wanting to address resource needs and restore the Mississippi River (*e.g.*, Middle Mississippi River Partnership; Floodplain Science Network; River Partnership of Community Foundations; Fishers and Farmers Partnership for the Upper Mississippi River Basin, and many more). Additionally, the National Research Council recognized the ecological significance of large floodplain rivers and identified the Mississippi River and Illinois River as examples of two such rivers in the United States that could become healthy again with proper management and restoration. The Clarence Cannon National Wildlife Refuge is part of this nationally significant ecosystem.

1.5 Scope of Study

The scope of this study focuses on proposed project features that would improve aquatic, wetland, and floodplain habitat and improve overall ecosystem resources. The project is consistent with agency management goals and was planned to restore ecosystem structure and function to benefit resident and migratory wetland and aquatic species.

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

1.6 Authority

Congress authorized the Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP) in Section 1103 of the 1986 Water Resources Development Act (WRDA). Over the course of its first 13 years, UMRR-EMP proved to be one of this country's premier ecosystem restoration programs, combining close collaboration between Federal and State partners, an effective planning process, and a built-in monitoring process. This success led Congress to reauthorize UMRR-EMP in WRDA 1999 (Public Law 106-53). Section 509 of the 1999 Act made several adjustments to the program and established the following two elements as continuing authorities:

- Planning, construction, and evaluation of fish and wildlife habitat restoration and enhancement projects (known as Habitat Rehabilitation and Enhancement Projects (HREPs)).
- Long-term resource monitoring, computerized data inventory and analysis, and applied research (known collectively as Long Term Resource Monitoring Program (LTRMP)).

The proposed project would be funded and constructed under this authorization.

1.7 Proposed Federal Action*

This HREP focuses on proposed restoration features that would improve ecosystem resources (aquatic and wetland complexes) within the approximately 3,750-acre Clarence Cannon National Wildlife Refuge.

Because this potential project is funded by the U.S. Army Corps of Engineers, the St. Louis District Engineer will select one of the alternatives for potential implementation. The District Engineer will also determine, based on the facts and recommendations contained herein, whether this EA is adequate to support a Finding of No Significant Impact (FONSI) or whether an Environmental Impact Statement (EIS) will need to be prepared.

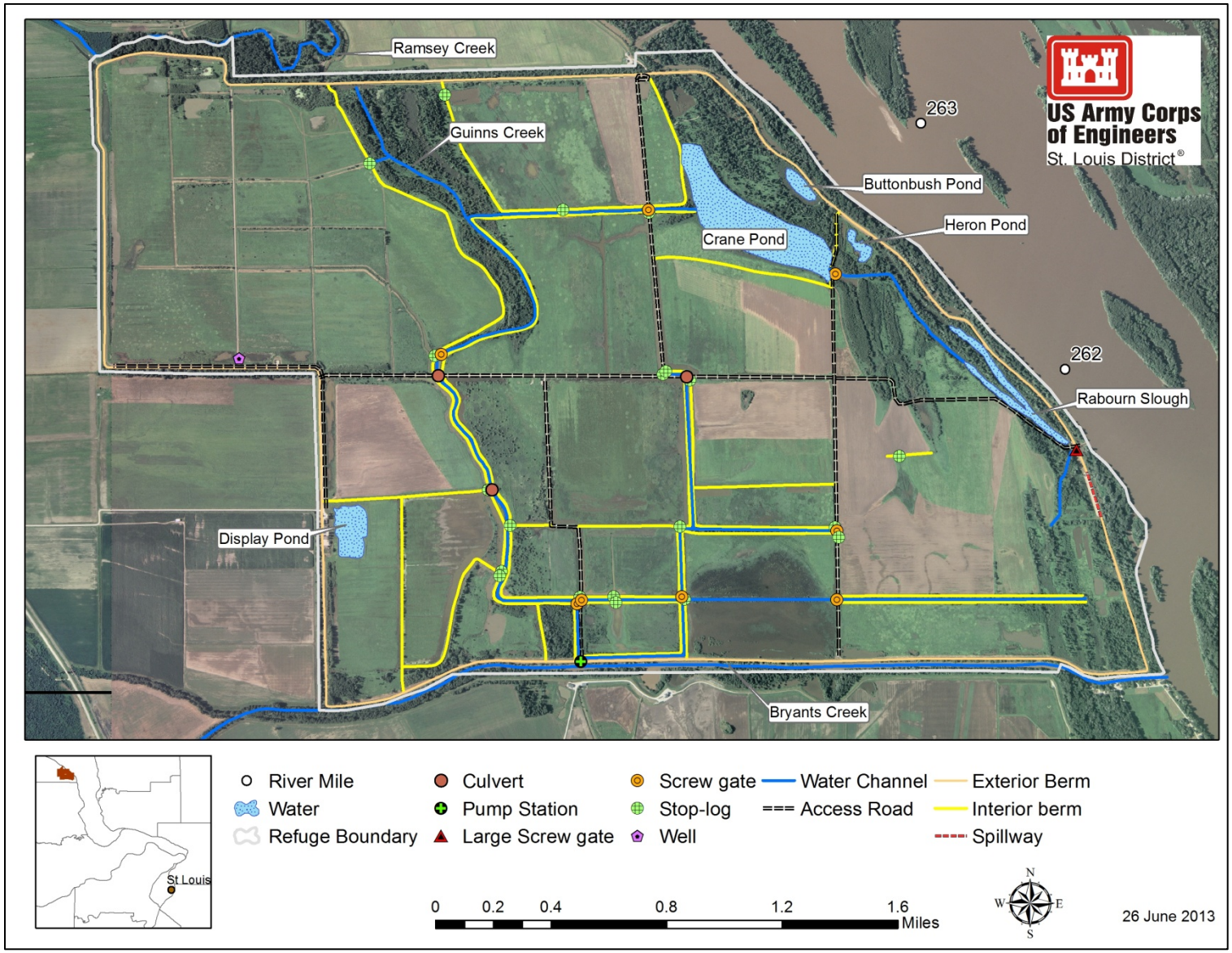

Figure 1. Clarence Cannon National Wildlife Refuge project area boundary with existing infrastructure marked

1.8 Scoping and Coordination*

Scoping is an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. Scoping was conducted during the planning process using a variety of communication methods with the affected public, agencies, and organizations. The input received during scoping was incorporated in the process of making decisions for the CCNWR HREP; however, USACE must ultimately make the decision which direction the HREP will follow.

1.8.1 Coordination Meetings

A Functional Analysis Value Engineering Workshop was held (March 29-31, 2011) prior to the development of this report. Twenty-two technical experts from the Missouri Department of Conservation, USFWS, and USACE attended the workshop to provide input on project objectives, potential project features, future conditions of the site, and to identify resource issues. A copy of the executive summary is provided in Appendix B, *Coordination.* A full copy of the Value Engineering Functional Analysis report is available upon request. In addition, development of this report was actively coordinated throughout the planning process with the project partner, USFWS. Appendix B, *Coordination*, documents the coordination.

1.8.2 Public Scoping

A public meeting will be held to encourage the public to provide comments on the proposed actions.

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. Communication with 20 Federally recognized tribes was initiated with a USACE letter dated 12 October 2012. The Osage Nation responded with a letter dated 30 November 2012 requesting to receive copies of any cultural resource survey reports regarding the project; and anticipates reviewing and commenting on any materials for the proposed project in the future. Copies of all tribal correspondence are provided in Appendix B, *Coordination*.

1.9 Prior Studies and Reports

The following references provide further detail on the UMRS, including Pool 25, in terms of formation over geological time; physical, environmental, and cultural characteristics; social and economic conditions; and multi-purpose management:

Johnson, B.L., and K.H. Hagerty, eds. 2008. Status and Trends of Selected Resources of the Upper Mississippi River System. U.S. Geological Survey, La Cross, WI. Technical Report LTRMP 2008-T002. This report describes the Upper Mississippi River System and includes discussions on the historic and existing conditions, river monitoring and management, and ecosystem goals and indicators. It also discusses the status and trends of biological, physical, and chemical indicators of system health developed through the Long Term Resource Monitoring Program.

*Theiling, C.H., C. Korschgen, H. DeHann, T. Fox, J. Rohweder, and L. Robinson. 2000. Habitat Needs Assessment for the Upper Mississippi River System: Technical Report. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI. Contract report prepared for U.S. Army Corps of Engineers, St. Louis District, St. Louis, MO***.** This report summarizes the first Habitat Needs Assessment of the UMRS and is designed to help guide future ecosystem restoration projects. It describes and

compares historical, existing, forecasted, and desired future conditions to identify habitat needs within the UMRS.

McGuiness, D. 2000. A River that Works and a Working River: A Strategy for the Natural Resources of the Upper Mississippi River System. Upper Mississippi River Conservation Committee (UMRCC), Rock Island, IL. This report describes the critical elements of a strategy for the OMRR&R of the natural resources of the UMRS and its tributaries including the setting of restoration goals and objectives. The report suggests nine objectives for successful resource management of the UMRS: 1) improve water quality, 2) reduce erosion, sediment, and nutrient impacts, 3) return natural floodplain, 4) restore seasonal flood pulse and periodic low flow conditions, 5) restore backwater connectivity, 6) manage sediment transport and deposition in floodplain and side channels, 7) manage dredging and channel maintenance, 8) sever pathways for exotic species, and 9) provide for passage at dams.

*WEST Consultants, Inc. 2000. Upper Mississippi River and Illinois Waterway Navigation Feasibility Study – Cumulative Effects Study, Volumes 1-2. Prepared by WEST Consultants, Inc. for the U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL***.** This report describes the cumulative effects of the Upper Mississippi River and Illinois Waterway Navigation Feasibility Study on channel morphology and ecology and develops predictions of geomorphic and ecological conditions for the year 2050.

Chapter 2 Assessment of Existing Resources*

Chapter 2 assesses the existing conditions of resources within the project area and is organized by resource topic. Resource topics analyzed in detail include natural resources (floodplain, aquatic, geology and soils, wildlife, Missouri Species of Concern, fisheries, water quality, and air quality), hazardous, toxic and radioactive waste, historical and cultural resources, socioeconomic resources, aesthetic resources, noise levels, and threatened and endangered species. This is not a comprehensive discussion of every resource within the study area, but rather focuses on those aspects of the environment that were identified as relevant issues during scoping or may be affected by the alternatives. The environmental consequences on these resources are described in Chapter 6.

2.1 Natural Resources

Natural Resource History. Historically, the Mississippi River created fluctuating habitat through frequent flooding. Flood waters deposited nutrient-rich sediments on floodplain vegetation, developed wetlands, and provided fish spawning habitat. Annually, during summer and during periodic droughts the floodplain dried, consolidated sediment, creating ideal conditions for fire, and allowing less flood tolerant vegetation to thrive in the traditionally wet areas (CCNWR 2010). Prior to human disturbance, lands of Clarence Cannon National Wildlife Refuge consisted of a matrix of seasonally flooded wetlands interspersed with natural sloughs and scours connected to the Mississippi River either directly, through streams, or during seasonal dynamic flood events. The General Land Office surveys from the early 1800s indicate the project area was predominantly herbaceous wetlands with various forest habitats (*i.e.*, oak/pecan forest, open woodland, barren/scrub) along the Mississippi River and Bryants Creek (Fig. 2).

Prior to European settlement (early 1800s), Pool 25, which includes the project area, was comprised of 46% herbaceous wetlands, 35% floodplain forest, 18% open water, and <1% marsh/swamp; while contemporary (1989) land cover composition has changed to 54% agriculture, 19% floodplain forest, 18% open water, 6% herbaceous wetlands, and <1% marsh/swamp (Theiling *et al.* 2000). Historic conversions of floodplain forest and herbaceous wetlands in the UMRS floodplain to agricultural use reduced the quantity and quality of both these wetland habitats. These losses in habitat quality and quantity, coupled with the lack of floodplain connectivity to the river, limit the present and future ability of the project area to sustain a diverse floodplain ecosystem, which provides ecosystem structure and function to a suite of resident and migratory fish and wildlife.

The area began to change with human settlement. By the 1890s, the majority of the project area was already in agricultural production (Fig. 3 – top panel; hatch marks designate agricultural fields) primarily for corn and soybean with small remnants of shrub-scrub/emergent wetland/marsh mix and forest along the river. In the 1920s, the area was leveled in an effort to grow rice, which flattened the topography of the project area (DOI 1978). Additionally, drainage channels were dug, berms were constructed which constricted the floodplain and isolated the area from the natural influences of the river and surrounding streams, and the area was cleared; however, no water control structures had been installed yet (DOI 1965). War Department survey maps generated from 1929/30 aerial photography, indicate the area had been divided into two Levee and Drainage Districts with an agricultural berm surrounding the entire project area and a second running along the west side of Guinn's Creek through the center of the area (Fig. 3 – bottom panel). This further fragmented the native wetland habitat and converted more land to agriculture. In addition, Bryants Creek to the south had been channelized to parallel the south berm, and a ditch was dug to parallel the north berm. Internally, the project area was divided into numerous rectangular agricultural parcels with multiple drainage channels. Project area lands were fragmented and converted from various wetland habitats to

agricultural fields, primarily for corn, soybean, and rice production. The majority of this past habitat fragmentation still persists today. Figure 4 provides a series of aerial photographs illustrating the changes in land use of the site, loss of historic meanders, and extensive cultivation.

In 1958, the entire project area was incorporated into the Mark Twain National Wildlife Refuge for the purpose of providing a feeding and resting area for resident and migratory wildlife. In the 1960s, the agricultural berms were no longer monitored for flood risk management and their operation and maintenance became the responsibility of the USFWS. In 1964, the project area was renamed Clarence Cannon National Wildlife Refuge after the former Missouri Congressman who was instrumental in establishing the refuge. At this time, the primary water conveyance channels were already present at the site, but they dried by the fall along with all other water bodies leaving little or no water resulting in little migratory wildlife use (DOI 1964). Beginning in 1966 and continuing through the 1990s, water control structures were installed and existing water conveyance channels were excavated to establish wetland management units for wildlife use (DOI 1966).

Figure 5 shows more recent land cover types for the refuge with the historic agricultural parcels still being evident throughout the refuge, and the use of agriculture as a management tool for early successional wetland plant management. In 2007, USFWS removed the interior berms within the northwest corner of the refuge to construct one larger, connected management unit (named MSU7). In more recent times, the USFWS has moved away from using agriculture as a management tool and has been able to restore small areas of herbaceous wetland habitat (a total of approximately 20 acres in 8 different locations); however, this floodplain wetland habitat type is still not as dominant as it was historically.

Historically, fall flooding occurred sporadically throughout the Mississippi Valley with different areas flooding each year. Due to floodplain development and wetland habitat loss throughout the Mississippi Valley, CCNWR water levels are managed annually in order to provide the needed habitat required for species using the Mississippi Flyway during fall migration. Ideally in spring and summer, water levels at CCNWR are gradually lowered in the varying wetland management units by using a series of water conveyance channels and water control structures. This exposes mudflats where the soils are stabilized by drying and compaction and are colonized by moist soil plants providing food and habitat for migrating and resident wetland species. In the fall ideally, the wetlands would be slowly re-flooded providing protected resting and feeding areas. As the water level begins to rise, the summer's production of seeds and tubers becomes available to dabbling ducks, which prefer to dabble for food in shallow water. Later migrants benefit from the slow advance of waters as new areas of food become available. If the water rose suddenly, or remained static, the early migrants would quickly exhaust the food supply. However, due to limited ability to move water, the project area struggles to mimic this flooding and drying cycle required to ensure habitat resources are available for a suite of wetland species.

Site records and hydrologic analysis indicate that 14 floods, 1947, 1969, 1973, 1979, 1983, 1986, 1993, 1996, 1998, 2001, 2002, 2008, 2011, and 2013, overtopped the exterior berm and inundated the interior of CCNWR (Photo 1). Once flood waters fill the interior, they must drain through the existing spillway or water control structures. The primary drainage problem is due to the majority of the project area draining through the existing pump station (See Appendix D, *Hydraulics and Hydrology* for depiction of existing drainage flow patterns). This results in the interior of CCNWR being flooded longer than the exterior which is detrimental to wetland resources within the refuge.

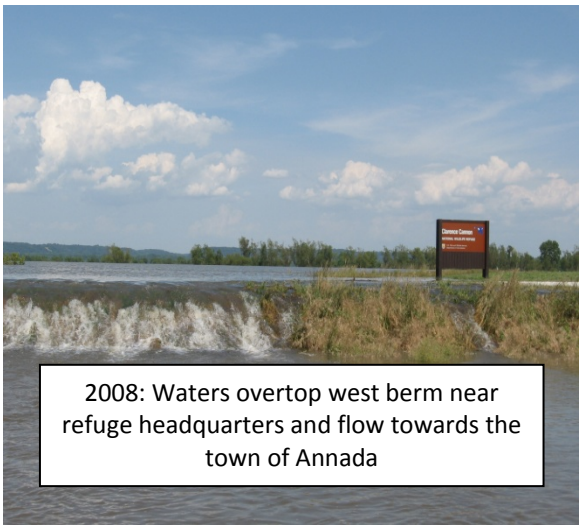

Photo 1. Photos of Clarence Cannon National Wildlife Refuge during the 2008 and 2013 floods.

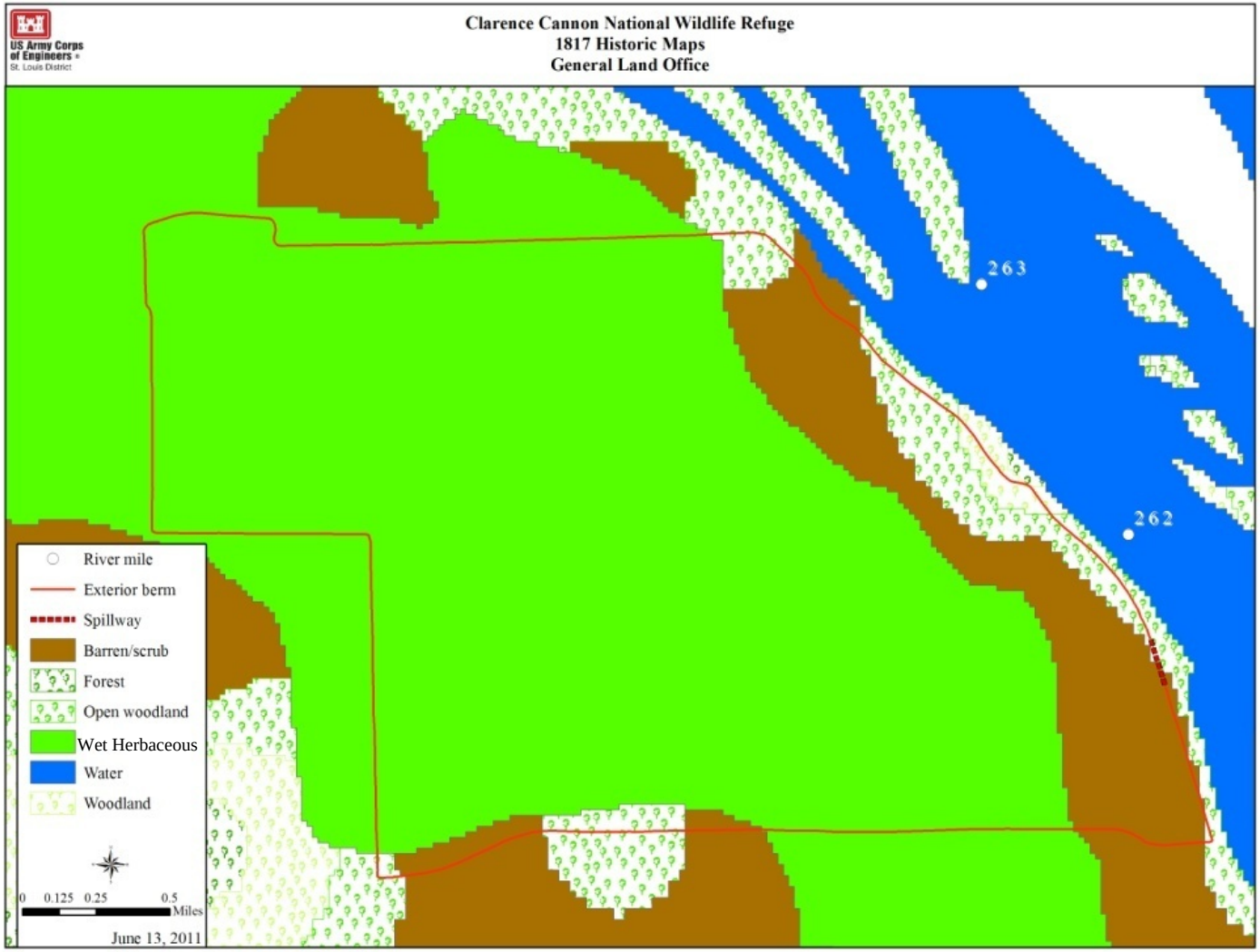

Figure 2. Clarence Cannon National Wildlife Refuge 1817 land cover classification

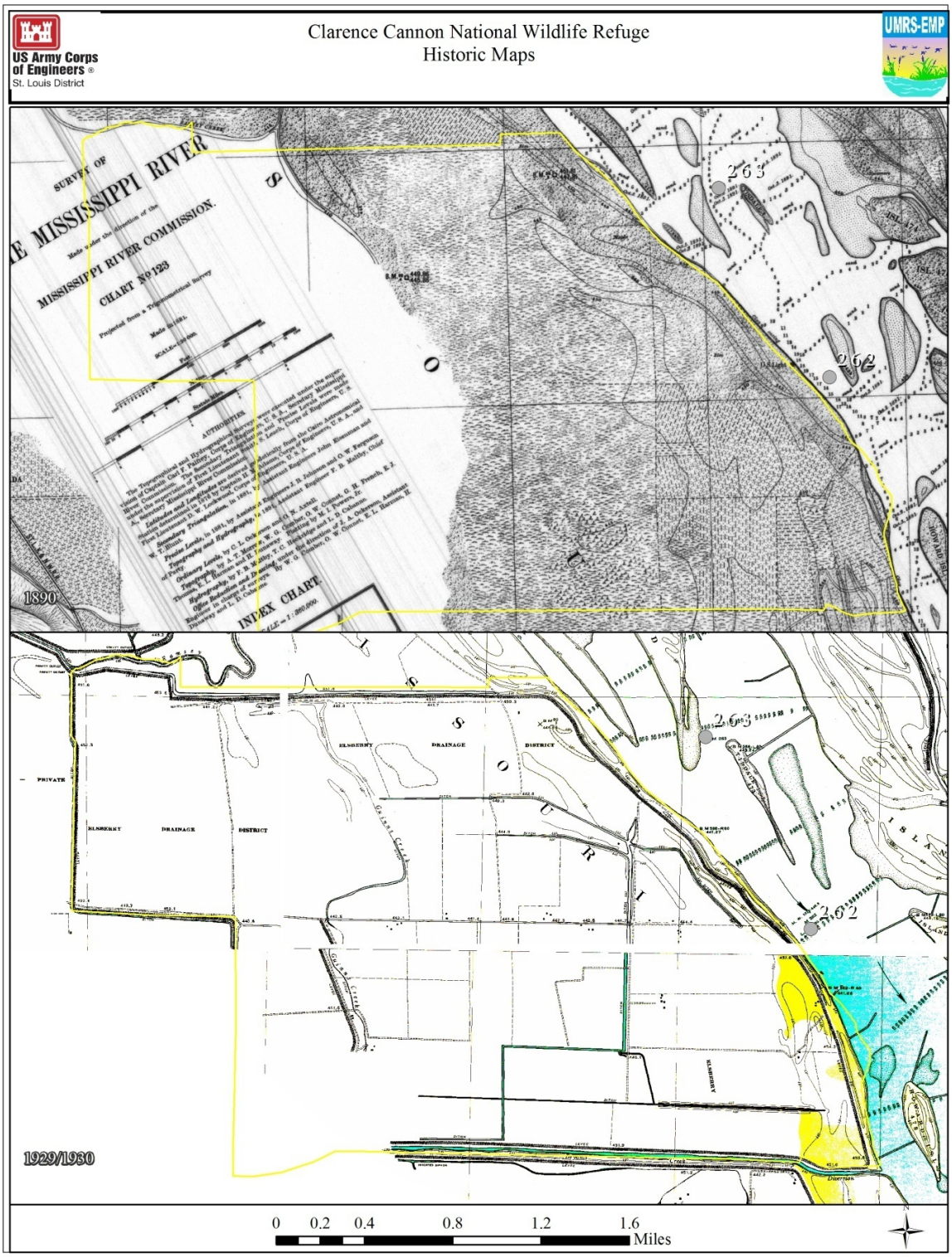

Figure 3. Historic maps of project area. Hatch marks depicted in upper (1890) reference agricultural fields. Lower map (1930) depicts separate parcels.

Figure 4. A series of aerial photographs from 1940, 1956, 1972, 1988, 1996, and 2010 for Clarence Cannon National Wildlife Refuge

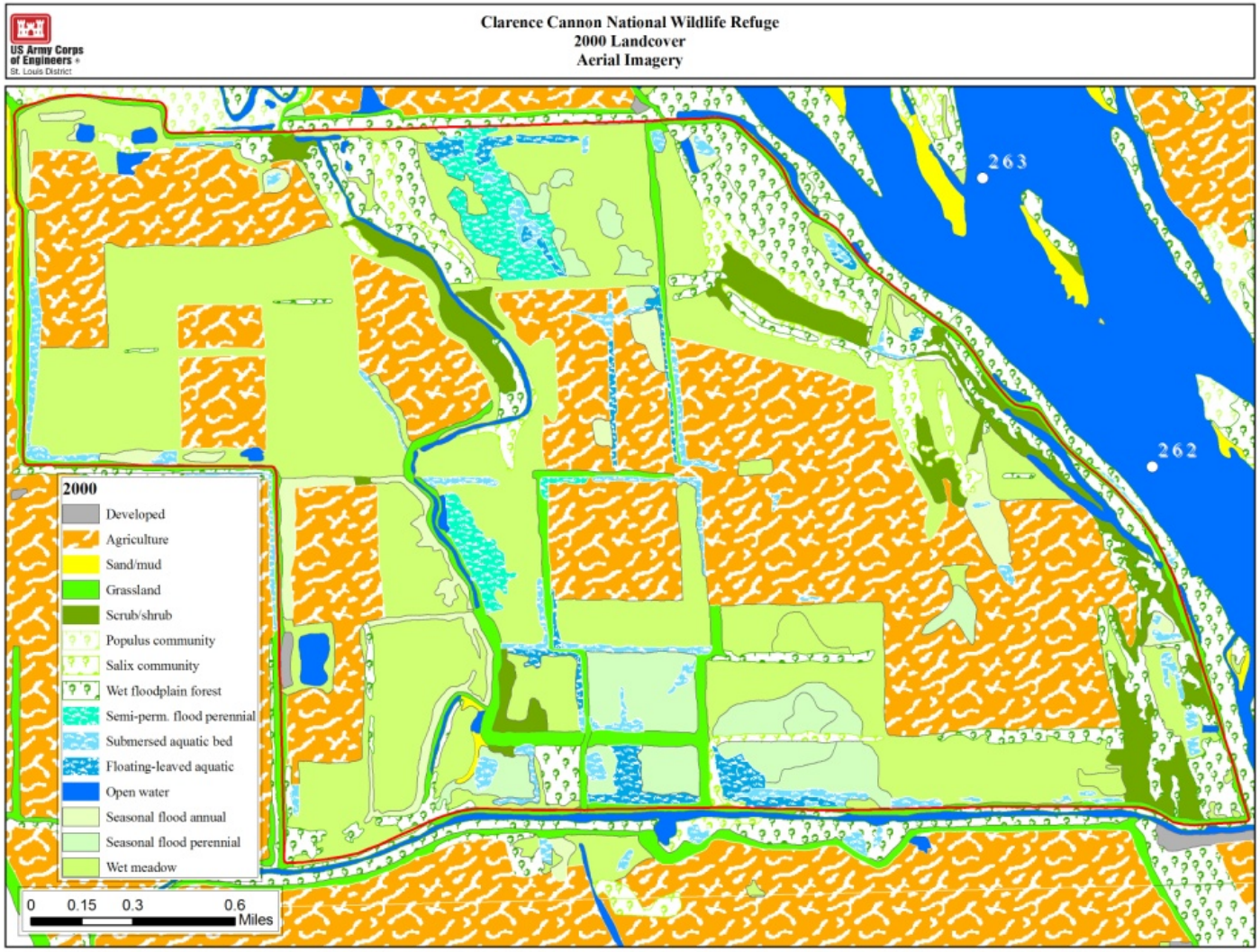

Figure 5. Clarence Cannon National Wildlife Refuge 2000 land cover classification

2.1.1 Floodplain Habitat

Historically, the project area was a complex of seasonally flooded wetlands interspersed with backwater sloughs and forested habitat connected to the river directly or through streams. Today, one-hundred percent of the project area is disconnected from the river by the exterior berm built in the 1920s, except during overtopping flood events which results in the floodwaters ponding in the project area. Within the project area, the floodplain ecosystem is experiencing a loss of hard mast trees (*i.e.*, pin oak) and the forest is shifting to a more willow-cottonwood-maple forest complex. This loss of hard mast trees within the Upper Mississippi River System degrades the floodplain ecosystem and has been related to the impacts of altered river hydrology (*i.e.*, changes in flood duration rate and patterns of sedimentation, and plant community composition) caused by the hydrologic modifications that support navigation and flood risk management (Yin *et al.* 2009; De Jager *et al.* 2012). To confound this problem the flood of 1993 overtopped the exterior berm and inundated the interior of CCNWR for most of the growing season. The area could not be drained until the Mississippi River fell below flood stage. In the following years, approximately 80% of the floodplain forests died in the remaining 400 acres of forest. The adverse impacts of prolonged flooding have been well documented in the literature to cause physiological dysfunctions induced by soil anaerobiosis (*e.g.*, changes in respiration, photosynthesis, protein synthesis) and an increase to phytotoxic compound exposure (Kozlowski 2002; Yin *et al.* 1998; Yin *et al.* 1995). The remaining hard mast trees (approximately 100 acres; primarily pecan with little regeneration occurring) within the project area have persisted through subsequent large flood events since they are located in areas of higher floodplain elevation, which reduces the negative impacts because these areas generally have better soil drainage.

Reed canary grass (*Phalaris arundinacea*), an invasive cool-season, perennial grass that aggressively spreads in disturbed wetland environments, has become problematic at Clarence Cannon National Wildlife Refuge. This species eventually dominates a site by establishing a dense monoculture which adversely effects aquatic ecosystem quality (Kercher and Zedler 2004). Prior to the 1960s, reed canary grass did not occur within the site. It was first introduced at the project site in the 1960s to stabilize the soil and prevent erosion along the interior and exterior berms (DOI 1965). Since then this species has spread throughout the refuge and is beginning to form dense stands in most management units, with the worst stand occurring in the northwest corner of the refuge (approximately 100 acres). The project partner is aggressively combating the invasion through water drawdown coupled with mechanical control. Without seasonal drawdown, water ponds in the management units, assisting establishment and growth of reed canary grass (Pinkerton and Rice 1993; Miller and Zedler 2003; Kercher and Zedler 2004). Once this species forms a dense stand it prevents growth of other species and traps sediment during flood events, decreasing microtopography, and altering microhabitat conditions (*e.g.*, light, soil moisture, and nutrient acquisition). These changes further benefit reed canary grass (Aniteau 1998; Kercher and Zedler 2004). This species is a major threat to ecosystem structure and function at Clarence Cannon National Wildlife Refuge and elsewhere.

2.1.2 Aquatic Resources

The exterior berm surrounding CCNWR separates it from the seasonal fluctuations of the river, and disconnects the refuge from the surrounding watershed and creeks except during overtopping flood events. The only sources of water for the refuge are rainfall, overtopping Mississippi River floods, water intake from the large water control structure on the Mississippi River, and/or pumping from Bryants Creek (Fig. 1). Although the berm isolates the area's water bodies, it also prevents the influx of agricultural run-off from adjacent farms which may contribute nutrients and chemicals into the refuge.

Aquatic features on or adjacent to CCNWR include the main channel of the Mississippi River, Bryants Creek, Guinn's Creek, Rabourn Slough, backwater lakes, sloughs, and wetlands (Fig. 6). The Mississippi River adjacent to CCNWR is controlled by Lock and Dam 25 (RM 241.4) Environmental Pool Management, and minimum flat pool is approximately 434.0 NGVD. All of the project area is above the hinge point located just downstream of the project area at Mosier Landing (RM 260.3) which lessens the impact of the dam (*i.e.*, elevated water table and pooled lake-like conditions), but these impacts still influence the project areaThe conditions of the other named water features within the project area are described below.

Crane Pond: 55-acre semi-permanent water body surrounded by scrub-shrub habitat, primarily buttonbush and persimmon. A water conveyance channel through the area provides a slightly deeper channel. On 31 May 2011, during high water (445.07 ft NGVD 1929 at Mosier Landing RM 260.3; flood stage is 441.0 ft), the depth of Crane Pond was approximately 4-6 feet deep, with high water clarity (34.5 inches Secchi Disk reading), but relatively low dissolved oxygen (5.33 mg L^{-1}) for this time of year and no measurable flow detected. The project partner estimated water was four feet higher than normal suggesting that during certain times of the year Crane Pond has only 2 feet of water or less. The water body did support fish with the prominent species being gizzard shad. Other species sampled with daytime electrofishing included common carp, black crappie, bluegill, largemouth bass, and bigmouth buffalo.

Rabourn Slough: 11-acre backwater slough which holds water year-round surrounded by scrub-shrub habitat, primarily buttonbush. Rabourn Slough is connected to Crane Pond during high water. Rabourn Slough can receive water input through the large Mississippi River water control structure on the exterior berm and when the spillway is overtopped. On 31 May 2011 the depth of Rabourn Slough was approximately 5-6 feet deep, with lower water clarity (9.5 inches Secchi Disk reading), seasonally low dissolved oxygen (5.71 mg L^{-1}), and no measurable flow. The project partner estimated water four feet deeper than normal. The water body did support fish with the prominent species being shortnose gar. When the spillway was overtopped in May 2011 refuge staff observed common carp, but no identifiable silver or bighead carp entering the refuge.

Buttonbush Pond: 3-acre isolated backwater pond surrounded by scrub-shrub habitat. The water quality conditions of this area have not been sampled directly. However, the project partner describes the area as having "harsh" conditions for fish (*e.g.*, low dissolved oxygen, high turbidity, and shallow water).

Heron Pond: 2-acre isolated backwater pond surrounded by scrub-shrub habitat. The water quality conditions of this area have not been sampled directly. However, the project partner describes the area as having "harsh" conditions for fish (*e.g.*, low dissolved oxygen, high turbidity, and shallow water).

Display Pond: 11-acre water body near the refuge headquarters. The pond is approximately 2-3 feet deep and is stocked with fish for educational and outreach purposes. The pond is surrounded by herbaceous vegetation.

2.1.3 Geology and Soils

The geology and soils found at the project site are characteristic of wetland hydric soils which can hold water, but if drained could be farmed. Appendix K, *Geotechnical Considerations,* provides further detail on soil physiography, stratigraphy, and classification.

The project area is located entirely in bottomland composed of alluvium. The soils on the project area are found on 0-2% slope and are occasionally to frequently flooded (Fig. 7). According to NRCS, 87 acres qualify as prime farmland if used for farming based on soil type, moisture and slope; however, these acres are forested and not used for farming.

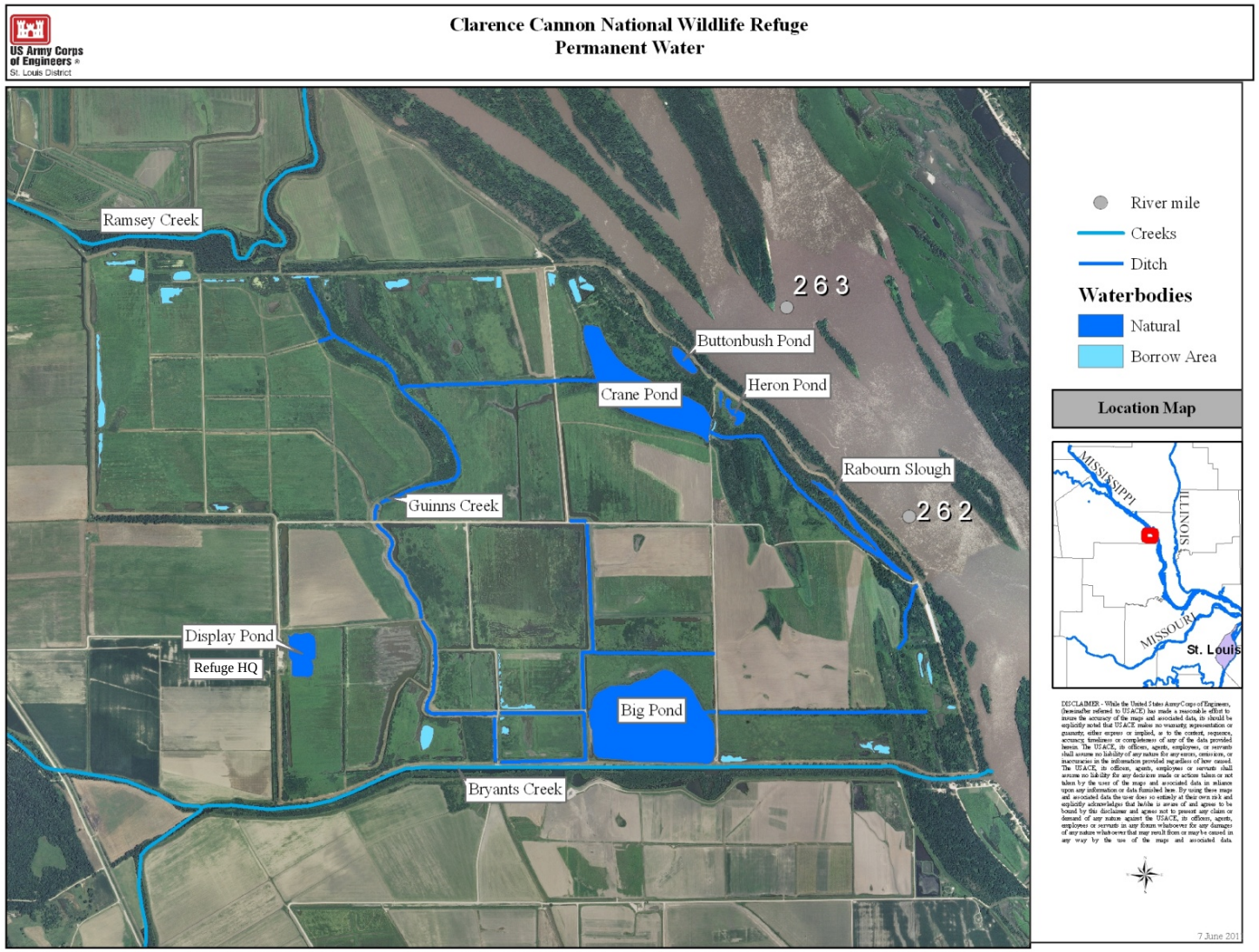

Figure 6. Aquatic features found on Clarence Cannon National Wildlife Refuge

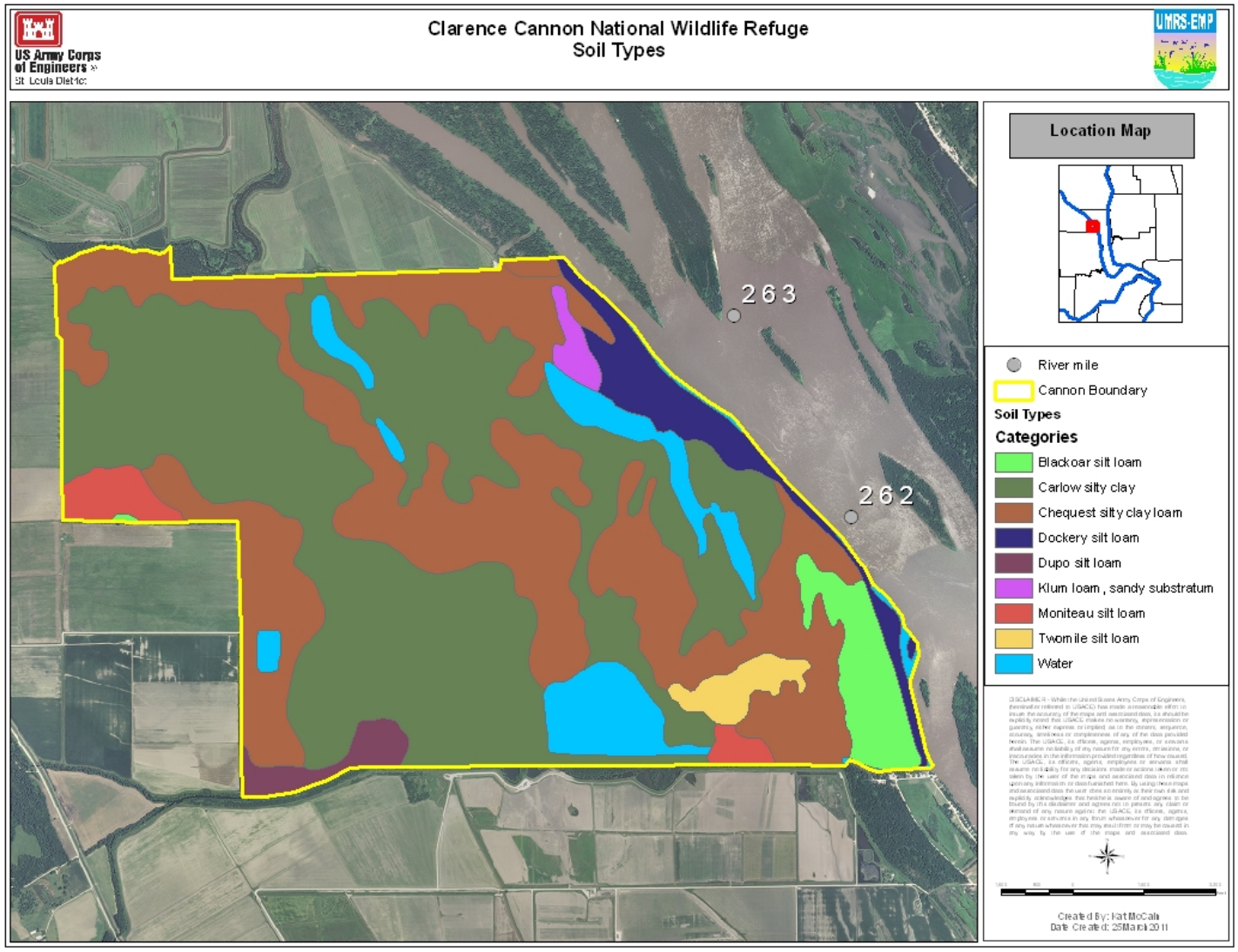

Figure 7. Clarence Cannon National Wildlife Refuge Soil Classification

2.1.4 Wildlife

Clarence Cannon National Wildlife Refuge 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 in the North American Waterfowl Management Plan as a habitat of major concern. About 20 species of ducks and geese stop during fall and spring migrations to rest, feed and seek sanctuary in the wetlands and deepwater habitats of Pools 24, 25, and 26 and adjacent floodplain (Havera 1985). In addition, approximately 285 species of birds including song birds, shorebirds and gulls, waterfowl, herons and egrets, and vultures and hawks are known to use or probably use the floodplain habitats of Pools 25 (Terpening *et al.* 1975).

At CCNWR several bird species including waterfowl, shorebirds, wading, marsh, and song birds use the refuge during migration. The most abundant bird species during the breeding season include: Canada Goose, Wood Duck, Blue-winged Teal, Green-winged Teal, and American Coot. Other common bird species observed at the site during spring/fall include: Snow Goose, Hooded Merganser, Wild Turkey, Northern Bobwhite, Pied-billed Grebe, American White Pelican, Great Blue Heron, Great Egret, Green Heron, Bald Eagle, American Kestrel, Killdeer, sandpipers, Mourning Dove, owls, Belted Kingfisher, woodpeckers, vireos, swallows, wrens, warblers, sparrows, and finches (GRNWR 2006). Numerous wetland obligate reptiles, amphibians and mussels likely inhabit CCNWR. Approximately 50 species of mammals may inhabit the project area (Terpening *et al.* 1975). Common species include opossum, raccoon, muskrat, mink, beaver, and white-tailed deer. River otter are known to utilize the site.

2.1.5 Missouri Species of Concern

The Missouri Natural Heritage Program (MNHP) has identified several species of conservation concern for Pike County, Missouri (Table 1; MDC 2013). Any federally listed species noted in Table 1 are discussed in Section 2.1.6. Species on the MNHP are critically imperiled (S1), imperiled (S2), and vulnerable (S3). The species of conservation concern known to occur on CCNWR (based on field observations; GRNWR 2006) include American Bittern, Bald Eagle, Common Moorhen, King Rail, Least Bittern, Little Blue Heron, Marsh Wren, Mississippi Kite, Sora, and Virginia Rail. The likelihood of observing these species, as defined by the Bird Checklist (GRNWR 2006), is provided for each below. All of these species would benefit from the CCNWR HREP. Federally listed species are discussed in the Biological Assessment, Sections 2.1.6 and 6.1.6.

American Bittern is a critically imperiled species. American Bittern occurs in dense freshwater marshes and extensive emergent wetlands. They prefer wetlands with thick cattail and bulrush, mixed with areas of open water. This is a nesting species, only observed March through August, and is listed as uncommon (defined as present, but not certain to be seen; GRNWR 2006).

Bald Eagle is a vulnerable species and is protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. This species is common (defined as certain to be seen in suitable habitat; GRNWR 2006) at CCNWR most of the year. It prefers to build large nests in the tops of large trees near rivers, lakes, marshes, or other aquatic areas.

Common Moorhen is an imperiled species. This species occurs in marshes with robust emergent vegetation. This is a nesting species and is listed as occasional (defined as seen only a few times during the season; GRNWR 2006) at CCNWR from March through November.

Table 1. Species of Conservation Concern located in Pike County. Species state rank are listed as (S1) critically imperiled, (S2) imperiled, and (S3) vulnerable (MDC 2013).

Common Name	Scientific Name	State Rank
BIRDS		
American Bittern[2,3]	*Botaurus lentiginosus*	S1
Bald Eagle[2,3]	*Haliaeetus leucocephalus*	S3
Common Moorhen[2,3]	*Gallinula chloropus cachinnans*	S2
King Rail[2,3]	*Rallus elegans*	S1
Least Bittern[2,3]	*Ixobrychus exillis*	S3
Little Blue Heron[2,3]	*Egretta caerulea*	S3
Marsh Wren[2,3]	*Cistothorus palustris*	S3
Mississippi Kite[2,3]	*Ictinia mississippiensis*	S3
Sora[2,3]	*Porzana carolina*	S2
Virginia Rail[2,3]	*Rallus limicola*	S2
MUSSELS		
Black Sandshell[4]	*Ligumia recta*	S2
Ebonyshell[4]	*Fusconala ebena*	S1
Fat Pocketbook[1,4]	*Potamilus capax*	S1
Flat Floater	*Anodonta suborbiculata*	S2
Hickorynut[4]	*Obovaria olivaria*	S3
Rock Pocketbook[4]	*Arcidens confragosus*	S3
Sheepnose	*Plethobasus cyphyus*	S2
Wartyback[4]	*Quadrula nodulata*	S3
PLANTS		
Barnyard Grass	*Echinochloa walteria*	S1
Coontail	*Ceratophyllum echinatum*	S1
Decurrent False Aster[1]	*Boltonia decurrens*	S1
Large Seeded Mercury	*Acalypha deamil*	S1
Rose Turtlehead	*Chelone obliqua*	S2
Wild Sarsaparilla	*Aralia nudicaulis*	S2
REPTILES		
Western foxsnake	*Pantherophis vulpinus*	S1
FISH		
Ghost Shiner[4]	*Notropis buchanani*	S2
Lake Sturgeon[4]	*Acipenser fulvescens*	S1
River Darter[4]	*Percina shumardi*	S3
Western Sand Darter[4]	*Ammocrypta clara*	S2S3
MAMMALS		
Gray Bat[1]	*Myotis grisescens*	S3
Indiana Bat[1,2]	*Myotis sodalis*	S1

[1] Species are also Federally listed
[2] Species that occur or may occur in the project area
[3] Species that may be affected by the project
[4] Species found adjacent to the project area

King Rail is a critically imperiled species. King Rail prefers expansive stands of permanent freshwater herbaceous marshes (*e.g.*, sedges, rushes, and cattail), but it will also occupy marsh habitats interspersed with willow, buttonbush, and dogwood. This species would benefit with reduced habitat fragmentation. At CCNWR, this is an uncommon species observed from March through November (GRNWR 2006). Darrah and Krementz (2009) noted a high concentration of King Rails present at Clarence Cannon National Wildlife during their habitat use study.

Least Bittern is a vulnerable species. Least Bittern occurs in emergent vegetation in freshwater marshes. At CCNWR, this is a nesting species and is uncommon March through August, but is listed as occasional from September to November (GRNWR 2006).

Little Blue Heron is a vulnerable species. Little Blue Heron prefers inland wetlands including ponds, freshwater marshes, and non-forested wetlands. At CCNWR, this species is uncommon March through May, and is listed as common during June through November (GRNWR 2006).

Marsh Wren is a vulnerable species. Marsh Wren prefers large freshwater marshes having tall vegetation (*e.g.*, cattails, bulrushes, or sedges, reeds, cordgrass, or needlegrass), and usually avoids nesting in shrubby or forested wetlands. This is a nesting species and is listed as uncommon March through November at CCNWR (GRNWR 2006).

Mississippi Kite is a vulnerable species. Mississippi Kite roosts and nest in riparian forests. Foraging occurs in woodland edges, grasslands, savannas, and human-altered areas. At CCNWR, this species is listed as occasional during March through August, but has not been observed at the site the rest of the year (GRNWR 2006).

Sora is an imperiled species. Sora occurs in wetland marshes and non-forested wetlands dominated by cattail, sedges, bulrushes, smartweeds, rushes, rice cutgrass, and barnyard grasses. This species is listed as common during the spring, but uncommon during June through September at CCNWR (GRNWR 2006).

Virginia Rail is an imperiled species. Virginia Rail prefer seasonal and semi-permanent freshwater marshes with emergent vegetation interspersed with open water, mudflats, and to a lesser extent, floating residual vegetation. The species has also been observed breeding in non-forested wetlands, restored wetlands, permanent wetlands and in emergent vegetation along river and stream banks. This is a nesting species, and is listed as uncommon during spring, occasional during summer, and rare (as defined as seen only at intervals of 2 to 4 years) during fall at CCNWR (GRNWR 2006).

2.1.6 Federally Threatened and Endangered Species

In compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, the USFWS provided a listing of Federally threatened, endangered or candidate species or designated critical habitat that may occur in the vicinity of CCNWR. Via an email communication on 29 April 2013, the USFWS provided a list of species that could potentially occur in the project vicinity (Pike County, Missouri). On December 16, 2013 USFWS advised adding Northern long-eared bat based on its recent listing (https//ecos.fws.gov/ipac). Table 2 lists the species that may occur in Pike County, Missouri. Additional up to date information is provided in the USFWS draft Fish and Wildlife Coordination Act Report received from USFWS on 2 August 2013 (Appendix B, *Coordination*). The Sheepnose mussel is listed for Pike County; however, this mussel is only found in the Bourbeuse River, which is not located in Pike County or near the project area, and therefore is not discussed further. This section and Chapter 6 of this report are being used to satisfy the requirement of completing a Biological Assessment.

Table 2. Federally endangered and threatened species potentially occurring in Pike County, Missouri (accessed online 16 Dec 2013 http://www.fws.gov/midwest/endangered/lists/missouri-cty.html)

Common Name	Scientific Name	Status	Habitat
Gray Bat	*Myotis grisescens*	Endangered	Caves; feeding – rivers/reservoirs adjacent to forest
Northern long-eared Bat	*Myotis septentrionalis*	Proposed Endangered	Hibernates in caves and mines – swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests during spring and summer.
Indiana Bat*	*Myotis sodalis*	Endangered	Hibernacula = caves & mines; Maternity & foraging habitat = small stream corridors with riparian woods; upland forests
Decurrent False Aster	*Boltonia decurrens*	Threatened	Disturbed alluvial soils
Fat Pocketbook	*Potamilus capax*	Endangered	Rivers

*May occur within the project area

Gray Bat. The Gray bat is a federally listed, endangered mammal species (USFWS 2013). Gray bats utilize caves for both winter hibernation and summer roosting locations. Foraging occurs in riparian forest canopy and over water along river and lake edges. CCNWR does not have suitable hibernation or summer roosting habitat.

Northern long-eared Bat. The Northern long-eared Bat has been proposed to be federally listed as an endangered species (USFWS 2013). Northern long-eared bats spend winter hibernating in large caves and mines. During summer, this species roosts singly or in colonies underneath bark, in cavities, in crevices of both live and dead trees. Foraging occurs in upland forests. CCNWR does not have suitable hibernation habitat. Northern long-eared bats have not been documented at CCNWR by the project partner, however the refuge does have suitable summer habitat.

Indiana Bat. The Indiana bat is a Federally listed, endangered mammal species (USFWS 2013) that has been found over most of the eastern half of the United States. The 2009 population estimate was approximately 387,000 bats, less than half as many as when the species was listed as endangered in 1967. Indiana bats winter in caves or mines, and then migrate north in summer and use dead or living large trees, mainly along streams, with exfoliating bark as roost/maternity trees. Indiana bats eat a variety of flying insects found along streams, rivers, lakes, and in upland areas. Loss of forested habitat, particularly stands of large, mature trees, can affect bat populations. Indiana bats have not been documented at CCNWR by the project partner; however, the refuge does have suitable summer habitat and this species has been collected from nearby areas within Pool 25 (*i.e.,* Dog Island – RM 262, Calhoun County, Illinois).

Decurrent False Aster. Decurrent false aster is a Federally listed, threatened floodplain plant species that is considered to potentially occur in Cape Girardeau, Dunklin, Franklin, Howell, Lincoln, Mississippi, Pike, St. Charles, and St. Louis counties of Missouri bordering the Mississippi River (USFWS 2013). It is a perennial, early successional plant found on moist, sandy floodplains and non-forested wetlands. It requires either natural or human disturbance to create and maintain suitable habitat and remove other plants competing for the same habitat. Without disturbance, other plant species can out-compete decurrent false aster and eliminate it in 3 to 5 years from any given area. Species decline is due to several factors including excessive silting of habitat due to topsoil run-off, conversion of natural habitat

to agriculture, drainage/development of wetlands, altered flooding patterns, and herbicide use. No critical habitat rules have been published for the decurrent false aster. Federal regulations prohibit any commercial activity involving this species or the destruction, malicious damage or removal of this species from Federal land or any other lands in knowing violation of State law or regulation, including State criminal trespass law. The only recent distribution of this species in Missouri is in St. Charles County (MDC 2011). Decurrent false aster has not been found in or adjacent to the project area.

Fat Pocketbook. Fat pocketbook is a Federally listed, endangered mussel species (USFWS 2013). This mussel has been found occasionally within the Mississippi River; currently there are no known viable populations (USFWS 1989). Collection records suggest that this mussel prefers habitat with flowing water and firm substrate (USFWS 1989).

2.1.7 Fisheries

All of the water bodies may hold fish. The water bodies in the project interior are isolated from the river, except when the exterior berm is overtopped, during active pumping, or when the large water control structure along the Mississippi River is open. While no formal sampling or monitoring has been conducted on the site, a preliminary fishery sample (daytime electrofishing) was conducted on 31 May 2011. Sampling was conducted by USACE during high water (445.07 ft NGVD 1929 at Mosier Landing RM 260.3; flood stage is 441.0 ft), when the large Mississippi River water control structure was closed, and the spillway had been overtopped six days prior. Samples were taken near the large water control structure along the Mississippi River and in Crane Pond. The species collected near the large water control structure included 11 shortnose gar, 17 gizzard shad, one black buffalo, two black crappie, one freshwater drum, and one golden shiner. In Crane Pond, fish species collected included 36 gizzard shad, one black crappie, four bluegill, one bigmouth buffalo, and five common carp.

2.1.8 Water Quality

The refuge is completely disconnected from the Mississippi River except during overtopping flood events. Due to lack of connectivity, interior water bodies have lost depth and have reduced water quality (primarily low dissolved oxygen). Low dissolved oxygen and the shallow water have degraded the aquatic ecosystem and have made conditions unfavorable for fish and other aquatic species during most of the year and amphibians during times of severely low dissolved oxygen.

Missouri previously listed the Mississippi River as impaired by lead and zinc (MDNR 2008). On December 9, 2010, the Environmental Protection Agency (EPA) approved a Missouri Total Maximum Daily Load (TMDL) for lead and zinc. As such, the Mississippi River was removed from the Missouri 303(d) list (http://www.epa.gov/region07/newsevents/legal/pdf/missouri_impaired_waters_letter_4_29_2011.pdf). Bryants Creek, Guinn's Creek and Ramsey Creek are not listed.

2.1.9 Air Quality

The Environmental Protection Agency (EPA) has identified standards for seven pollutants: lead, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter less than 10 microns in diameter, and particulate matter less than 2.5 microns. Pike County, Missouri, currently meets all EPA air quality standards (accessed online 03 May 2013; http://epa.gov/airquality/greenbk/ancl3.html).

2.2 Hazardous, Toxic and Radioactive Waste

A Contaminant Assessment Process (CAP) for the Great River National Wildlife Refuge, which includes CCNWR, was conducted in 2010 to evaluate existing information from regulatory agency databases to identify documented and potential contaminant issues which may affect refuge property and resources (USFWS 2010). From this report, CCNWR is susceptible to Mississippi River flood borne contaminants

such as agricultural chemicals, manufacturing by-products or waste, urban run-off, sewage, heavy metals and polychlorinated biphenyls, and waste debris (*e.g.*, tires, batteries, barrels/drums, etc.). The spillway increases flood frequency and thus the risk of flood borne contaminants entering the refuge. The pump house located on Bryants Creek does allow for potential contamination of the water conveyance system and/or management units.

Tissue samples from common carp, yellow bullhead, longnose gar, bowfin, channel catfish, red eared slider, common snapping turtle, and stout floater mussel were collected from Clarence Cannon National Wildlife Refuge in 1988 by USFWS to determine if metal or organic contaminants were elevated in the biota located on the refuge (Charbonneau and Nash 1998). The metal residue concentrations of copper, iron, manganese, and zinc found in tissue samples were above the detection limit; however, the study emphasized that the limited number of samples collected at the refuge and differing tissue types may demonstrate the reason for apparent concentrations of concern and did not provide recommendations for remediation activities (Charbonneau and Nash 1998). In 1989 and 1992, staff from the USFWS Rock Island Ecological Services Office conducted a contaminant study to determine if pollutants were present in CCNWR aquatic sediments along the Mississippi River within the refuge boundary (USFWS 1995). No organic pollution from chemicals (*i.e.*, DDT, chlordane, or PCB) was detected in the refuge. Heavy metal concentrations were within or slightly elevated above background limits (USFWS 1995).

A Phase I Environmental Site Assessment was completed in August 2013, and a copy of the report is provided in Appendix G, *HTRW*. This assessment concluded that in general the project area contains no sites of interest, which pose significant environmental concerns. The unknown sites of the landfills (1 or 2 potential dump sites) are considered a potential recognized environmental condition (REC) and data gap. It was unclear whether the landfill at the entrance of the refuge that was closed in 1968 represents a dump that replaced the 1967 dump, or represents a separate second dump site. The locations of the dump(s) could not be identified through historical records, aerials, and interviews, and no evidence of historical dumping was identified during site reconnaissance visits. If any landfill material is encountered during excavation of this project the USACE should be contacted to coordinate the handling and disposal of the material; however, no project features are located near the entrance of the refuge.

2.3 Historical and Cultural Resources

The land adjacent to the Mississippi River is rich in prehistoric archaeological sites representing many cultural traditions and stages. Prior to European settlement, the area that became Pike County, which includes CCNWR, was inhabited by several Native American tribes.

Archaeological sites may be abundant on the broad floodplain as well as on the tributary floodplains and surrounding uplands. Potentially the entire prehistoric cultural sequence may be present: Paleo-Indian (10,000–8,000B.C.), Dalton (8,000–7,000 B.C.), Early Archaic (7,000–5,000 B.C.), Middle Archaic (5,000–3,000 B.C.), Late Archaic (3,000–1,000 B.C.), Early Woodland (1,000–200 B.C.), Middle Woodland (200B.C. –A.D. 400), Late Woodland (A.D. 400–900), Mississippian (A.D. 900–1350). The most numerous archaeological sites were occupied during the Hopewell-influenced Middle Woodland, Late Woodland, and Mississippian period (Rusch *et al.* 1999:234).

Under the provisions of the Native American Graves Protection and Repatriation Act, an inventory of archaeological sites and collections at Mark Twain National Wildlife Refuge, which included Clarence Cannon National Wildlife Refuge, was completed in 1992 (Illinois State Museum Society 1992). The inventory included identifying, on Mark Twain NWR managed lands the following: American Indian Tribes known to have inhabited land in and around the refuge; archaeological projects, and artifact

collections and documents; human remains and associated objects; and known graves and their probable and unlikely locations.

The refuge was surveyed in 1977 by McNerney (1978a; 1978b), who found five prehistoric sites. A determination was made in 1987 that the sites were eligible for nomination to the National Register of Historic Places. In 1992 an archaeological inventory survey was conducted and identified several artifacts at each site. The artifacts include lithics and ceramic shards from the Late Woodland-Mississippian, Middle Woodland, and a possible Middle Archaic. Site locations were taken into account during project planning. The location of the archaeological sites and artifacts in this public document are not specified. As part of the 1992 archaeology study, a literature search was conducted at the Illinois State Museum and the Illinois State Library to ascertain information about the history of tribal lands in and around Mark Twain NWR. Native American Tribes known to have inhabited land in and around CCNWR include the Iowa, Kickapoo, Peoria, Potawatomi, and Sauk and Fox (Illinois State Museum Society 1992).

Shipping (and shipwrecks) dates from the 1830s in the area within the Mississippi River. Mosier Landing (RM 260.3L) on the Illinois side of the river was established to service this traffic. The single documented shipwreck in the vicinity of the project area is a "coal boat" lost in 1859 around Mozier Island, which is downstream of the project area. In terms of potential shipwreck within the project area, a review of historic maps indicates that the Mississippi River channel has experienced no appreciable change at least since 1880. Because of the accretion of land on the Missouri side of the river, any shipwreck on the Missouri bank prior to 1880 could conceivably be buried under or near the existing exterior berm.

In accordance with Section 106 and Section 101 of the National Historic Preservation Act, and 36 CFR 800.4, the district's tribal coordination efforts were initiated in a letter sent to 20 tribes dated 12 October 2012 (Appendix B, *Coordination*).

2.4 Socioeconomic Resources

Pike County had a population of 18,516 based on the 2010 U.S. Census Bureau estimate, which is a slight increase from the 2000 census estimate of 18,351 individuals (http://factfinder.census.gov; Accessed online July 15, 2011). Based on the 2010 population estimate, 55 percent were male, 90 percent were Caucasian, and 16.6 percent of individuals live below the poverty level. In 2000, the median household income was $32,373 with an average household size of 2.50, while by 2010 the median household income had increased to $42,082 with an average household size of 2.41. The main industries providing employment include manufacturing (19.1% of the workforce), education, health, and social services (17.5% of the workforce), and retail trade (12.9% of the workforce). The unemployment rate is 6.4 percent as of July 2013 (http://www.pikecountymo.org/).

2.5 Aesthetic Resources

Aesthetic resources of the site consist primarily of natural habitat with roads, berms, and water control structures interspersed. Forested and emergent wetlands and the river provide scenery for visitors. The site has high aesthetic value for viewing wildlife.

2.6 Noise Levels

Noise levels surrounding the project area are varied depending on the time of day, staff activities, and climatic conditions. The current human activities causing elevated noise levels include the diesel powered pump station, trucks, and farming equipment. The sound of firearms during hunting seasons is also prevalent in the surrounding area and within the refuge. The cabins located on the adjacent

property to the south of the refuge as well as traffic on the Mississippi River may also contribute to noise levels.

2.7 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." The standard unit of analysis for environmental justice is the census-designated Block. The project area is contained within twenty-four Census Blocks. Due to the rural nature of the area, the Census Block analysis was extended beyond refuge boundaries to include the town of Annada, Missouri, approximately a total of 4,177 acres. The population within this area was approximately 97% white. According to the 2010 Census, the village of Annada is 97% white, 15.4% of the population lives below the poverty line, and from 2000 to 2010 the population decreased by 39.6%. For Pike County, Missouri 90% is white, and 16.6% of the population lives below the poverty line.

Chapter 3 Project Objectives *

3.1 Problem Identification

Historically, CCNWR consisted of a matrix of seasonally flooded wetlands interspersed with natural sloughs and scours connected to the river through seasonal dynamic flood events that included a spring flood, summer low water, and a minor fall flood similar to what is depicted in Figure 8. In the 1800s, people settled in the area and began converting and altering the habitat by cutting trees, building berms, digging drainage channels, and leveling the area for agriculture. The construction of the locks and dams, other river training structures, and other human-induced changes on the Mississippi River have continued to dramatically alter this ecosystem by eliminating the historic cycle of floodplain scour and deposition. These changes have led to wetland loss due fragmentation and sedimentation, which ultimately degrade ecosystem structure and function in the project area (CCNWR 2010).

The project area itself is completely surrounded by an exterior berm which disconnects the refuge from the Mississippi River and surrounding watershed, except during overtopping flood events. During overtopping flood events, the exterior berm, coupled with limited drainage capacity and controlled water movement, allows floodwaters to pond, which induces anaerobic conditions in the soils that negatively affect wetland resources and also prevents the project area from mimicking the summer low water needed to promote vegetation necessary for wetland species. Inability to mimic the summer low water also promotes the spread of reed canary grass, which forms a thick mat of vegetation impeding growth of trees and other native plant species resulting in a loss of diversity. In non-flooding years, the the project partner attempts to mimic (the historic pre-impoundment seasonal flooding/drying cycle through controlled water movement; however, this is highly limited due to the inefficient and undersized water conveyance system on site due to numerous, small and highly fragmented management units with individual water control structures, and the inability to reach target water levels in a timely manner in order to meet habitat and ecosystem restoration objectives. Currently, this is done by active pumping and/or gravity draining to either pump water on or off the site as needed throughout the year. However, this requires a much longer period of time which decreases the site's ability to meet habitat restoration objectives dependent on the timing of the water with plant establishment and ultimately migratory wildlife. Having dependable controlled water movement throughout the site is critical in meeting management and ecosystem restoration objectives.

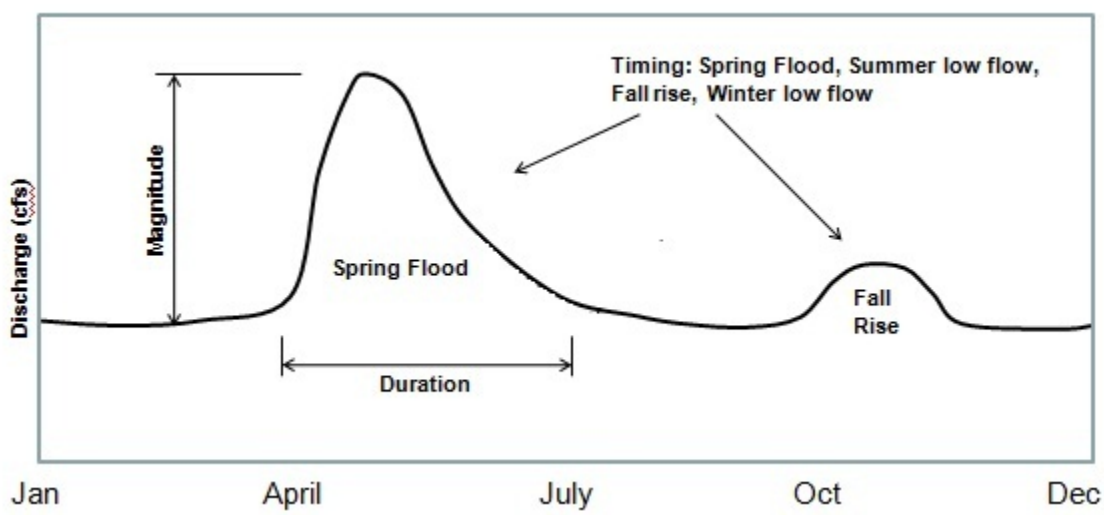

Figure 8. Depiction of annual flood pulse typical of the Mississippi River.

Currently, on the 3,750 acre refuge, approximately 3,261 acres are fragmented into 27 named units capable of limited manual alteration of water levels through a water conveyance system, portable Crissafulli pump, pump station with two stationary diesel pumps, spillway, and numerous water control structures (Figure 9; for description see Appendix C, *Existing Infrastructure*). This fragmentation has eliminated the natural drainage, topography, and habitat connectivity of the area. CCNWR management differs among the targeted habitats of seasonally flooded wetlands, rotational agricultural fields (*i.e.*, agriculture is used as a management tool to set back succession and reduce woody encroachment into emergent wetlands), semi-permanent wetlands, and forest units (Figure 9). Most of the seasonally flooded wetlands (named with "MSU") are managed for annual plant production (*e.g.*, millet, desirable smartweeds, bidens, etc.) through the manipulation of vegetation and/or soils to set back succession (*e.g.*, buttonbush, willows) and/or nuisance species (*e.g.*, reed canary grass, swamp smartweed, spike rush). Current management of these areas includes prescribed fire, water level manipulation, chemical treatment, and mechanical methods (*e.g.*, mowing, disking, rolling, and brushing). The forested area and the rotational agricultural fields along the eastern portion of the refuge make up the Riverside Unit, which has little or no ability for active water level management and are subject to the river levels via seepage, overtopping of the spillway, or through the large screw gate on the exterior berm (Figure 9). The conditions of each area are described in Table 3.

Historic floodplain habitat conversion to agricultural use reduced the quantity and quality of both floodplain forest and emergent wetland habitats. In addition, pin oak and pecan, critical components of the historic riparian forest ecosystem along the Mississippi River, have been damaged by severe flooding during the past two decades. The prolonged flood of 1993 caused floodplain forest mortality from Pool 17 to Pool 26 of the UMRS (Yin 1998). Throughout the entire UMRS, floodplain forests have become less diverse due to flood-tolerant species such as silver maple becoming more dominant; forest structure shifts due to disease and pests (*i.e.,* loss of green ash and American elm); invasive species (*i.e.,* reed canary grass) interfering with regeneration of floodplain forest (Romano 2010); and an altered hydrology associated with river modification for navigation, flood risk management, and water supply. Within the project area, up to 80% of the trees in the 400 acres of floodplain forest have been lost due to many of these factors.

Backwater sloughs and old meander scars have been cut-off from the river by the exterior berm. Almost all of these aquatic areas have greatly deteriorated due to shallow depth and poor aquatic habitat quality (*i.e.*, low dissolved oxygen). The disturbed conditions at the refuge have led to loss of native plant communities and have allowed invasive plant species to spread. These factors have degraded ecosystem structure and function at CCNWR.

Specifically at CCNWR the major resource problems include:

- lack of floodplain connectivity
- habitat fragmentation
- loss of floodplain topographic diversity and aquatic habitat
- site water regime struggles to mimic historic water regime (*i.e.*, summer low water with fall flood)
- loss of native wetland habitat (forested and emergent wetlands) and subsequent spread of invasive species

Table 3. Description, acres, and condition of the wetland management units at Clarence Cannon National Wildlife Refuge

Management Unit Name	Acres	Habitat Type	Description
Big Pond	150	Seasonally flooded	Seasonally flooded emergent vegetation, wet herbaceous wetland, and scrub-shrub habitat; with some permanent water
F2	19	Forest	Forested area dominated by silver maple
F3	21	Forest	Forested area dominated by silver maple
F4	31	Forest	Mesic bottomland forest
F5	17	Forest	Mesic bottomland forest
Fields 14A, 14B, 14C, 15, 16, & 25	375	Agriculture	In rotational agricultural crops. Unable to manipulate water levels
Goose Pasture & 6A	177	Wetland	Semi-permanent flooded emergent vegetation; dominated by perennials (*e.g.*, common burred, cattail, soft-stem bulrush, river bulrush)
GTR 7	134	Forest	Mesic bottomland forest, seasonally flooded
GTR 9	15	Forest	Mesic bottomland forest, seasonally flooded
Little Rabbit Ears	7	Wetland	Seasonal wetland with emergent vegetation. Unable to manipulate water levels
MSU1	52	Seasonally flooded	Seasonally flooded wetland with emergent vegetation
MSU2	156	Seasonally flooded	Semi-permanent flooded and seasonally flooded emergent vegetation
MSU3 E & W & WM1	176	Seasonally flooded	Seasonally flooded emergent vegetation and wet herbaceous wetland; semi-permanent flooded emergent vegetation
MSU4	77	Seasonally flooded	Semi-permanent and seasonally flooded emergent vegetation
MSU5	128	Seasonally flooded	Seasonally flooded emergent vegetation and wet herbaceous wetland
MSU6	39	Seasonally flooded	Seasonally flooded emergent vegetation and scrub-shrub habitat
MSU7	720	Seasonally flooded	Seasonally flooded emergent vegetation
MSU8	168	Seasonally flooded	Seasonally flooded emergent vegetation and wet herbaceous wetland
MSU9	59	Seasonally flooded	Semi-permanent flooded emergent vegetation, floodplain forest, and seasonally flooded emergent vegetation
MSU10 & MSU 10 N	172	Seasonally flooded	Seasonally flooded emergent vegetation, wet herbaceous wetland, and agriculture (used as a management tool on a rotational basis)
MSU11	118	Seasonally flooded	Seasonally flooded emergent vegetation
MSU12	43	Seasonally flooded	Semi-permanent flooded emergent vegetation dominated by perennials (*e.g.*, common burred, cattail, soft-stem bulrush, river bulrush), and seasonally flooded emergent vegetation
Rabbit Ears N, E, & W	85	Wetland	Semi-permanent flooded emergent vegetation, mesic bottomland forest, and scrub-shrub habitat. Unable to manipulate water levels
Supply Pond	40	Wetland	Permanent and semi-permanent flooded emergent vegetation
Riverside Mid	60	Forest	Floodplain forest intermixed with hard mast tree species (*i.e.* Pecan and Pin Oak). Unable to manipulate water levels
Riverside N	91	Forest	Floodplain forest intermixed with hard mast tree species (*i.e.* Pecan and Pin Oak). Unable to manipulate water levels
Riverside S	131	Forest	Primarily floodplain forest intermixed with hard mast tree species (*i.e.*, Pecan) in areas of higher elevation. Unable to manipulate water levels
TOTAL WETLAND ACRES	3,261		

F = Forest; MSU = Moist Soil Unit; GTR = Green Tree Reservoir

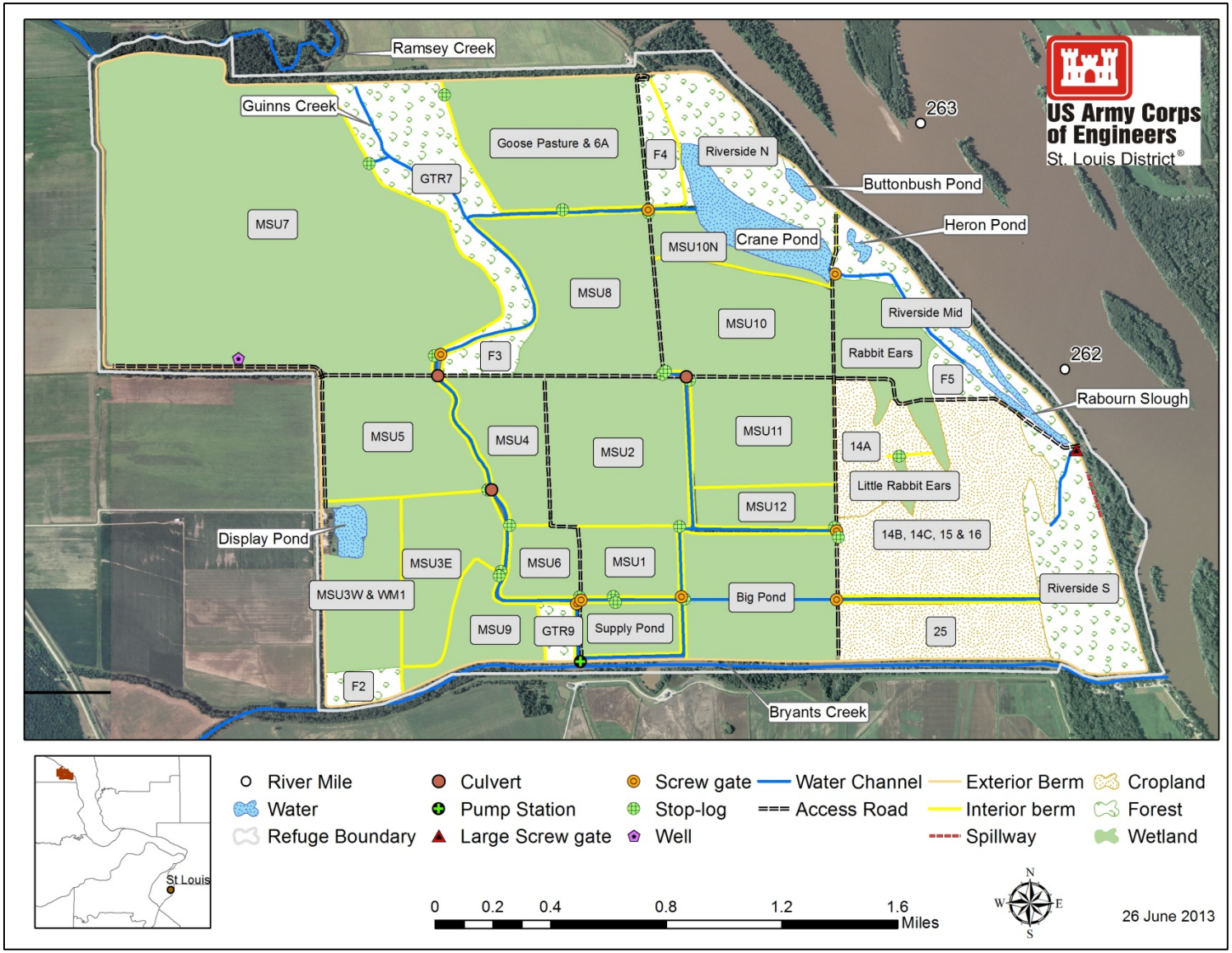

Figure 9. Depiction of current management units and infrastructure at Clarence Cannon National Wildlife Refuge.

3.2 Opportunities

Opportunities exist to restore, improve, and increase ecosystem resources before they are lost within the project area. Improving the hydrology (e.g., dependable controlled water movement) of the site will increase the reliability of seasonal food and cover for resident and migratory wetland wildlife. Restoring floodplain connectivity will improve ecosystem structure (*e.g.*, fish access to backwater habitat) and function (*e.g.*, nutrient cycling) within the project area. Increasing aquatic habitat complexity and diversity will provide seasonal refugia for fish and other aquatic species as well as increase topographic diversity on the floodplain. Restoring native vegetation and floodplain forests, which are "an important contributor to the functional ecology of the Upper Mississippi River System" (Romano 2010), provide additional opportunities to restore the mosaic of wetland habitat types that once occurred at CCNWR. Lastly, an opportunity exists to reduce habitat fragmentation and increase acreage and diversity of native wetland vegetation (*i.e.*, forested and emergent wetlands) by improving habitat connectivity and restoring site hydrology.

3.3 Goals and Objectives

Based on the USFWS Habitat Management Plan, the overarching refuge goal is identified as:

To the best of our abilities, restore function of refuge lands to conditions that existed prior to human influence.

In consideration of the identified problems (Section 3.1 above) and the refuge habitat management goal, the interagency planning team led by USACE developed goals and objectives, and potential restoration features (Table 4). The overarching goal of the CCNWR HREP is identified as:

To restore and improve the quality and diversity of wetland ecosystem resources in the project area

This goal would be achieved by the following objectives:

1) *Restore native wetland plant communities (forest and emergent wetlands) in areas of suitable elevation, hydrology, and soil* – Decrease habitat fragmentation between the management units to restore historic vegetation patterns. Restore forest and other wetland species at suitable elevations, soils, and hydrology. This would restore wetland habitat to the interior of CCNWR.
2) *Improve aquatic ecosystem resources* - Increase aquatic habitat diversity and floodplain topographic diversity. Restore seasonal connectivity between the project area and the Mississippi River.
3) *Improve water drainage and delivery* – Deliver water to achieve target surface water levels in < 7 days within the management units. This would provide the project partner improved water conveyance management capability on the management unit(s) which will increase wetland plant diversity, increase invasive species management capabilities, and improve overall ecosystem resources. In addition, during large, overtopping flood events, drain the interior project area to target water levels in < 40 days which is needed to prevent ponding of floodwaters which is detrimental to wetland structure and function.

Table 4. Problem, opportunities, goal, objectives, and all potential features considered for the CCNWR HREP.

PROBLEMS	OPPORTUNITIES	GOAL	OBJECTIVES	POTENTIAL FEATURES
Loss of native plant communities Invasive plant species colonization & domination Habitat fragmentation	Increase acreage of and connectivity between native plant communities while reducing acreage of invasive plant species	Restore & improve wetland ecosystem resources	Restore native wetland plant communities in areas of suitable elevation, hydrology, and soil	- Reforestation - Degrade berms to establish larger & fewer management units - Plant native herbaceous vegetation
Lack of floodplain connectivity Shallow water in backwaters and loss of historic meanders	Restore floodplain connectivity between the Mississippi River and the project area		Improve aquatic ecosystem resources	- Setback - Partially degrade exterior berm - Degrade berms between management units - Deepen/reconnect existing water bodies - Deepen/reconnect historic meanders
Site water regime no longer follows historic water regime which native flora and fauna are adapted to	Improve water delivery and drainage to the refuge to simulate pre-impoundment hydrograph preferred by native vegetation and to control for invasive species		Improve water delivery and drainage	-Larger water control structures and pump station - Raise berms of existing delivery channels - Excavate new water delivery channels

3.4 Future Without Project Condition (No Action Alternative)

Without the project, USFWS would continue to manage the site under their current plan. Without the project, it is assumed that USFWS would not have adequate water management capabilities and the project area would remain fragmented and disconnected from the River. Without improved floodplain connectivity, decreased habitat fragmentation, and improved water level management capabilities, the ecosystem at Clarence Cannon National Wildlife Refuge would heavily degrade into the future (See Appendix E, *Habitat Evaluation and Quantification*). Additionally, inability to manage water levels across the site may favor establishment and spread of invasive reed canary grass resulting in a monoculture that has little benefit to wildlife and prevents trees from naturally establishing. Without the project, the project area would continue to be disconnected from the river preventing the access of spawning, rearing, and foraging habitats of riverine species that require backwaters to complete major life stage as assessed by the Aquatic Habitat Appraisal Guide (FWOP AAHUs = 0.00 as compared to With Project AAHUs= 395.26; Appendix E, *Habitat Evaluation and Quantification*). Without the project, the emergent wetland areas would continue to be highly fragmented and not be able to reach target water levels reducing the site's ability in providing resources required by resident and migratory wetland

species as assessed by the Wildlife Habitat Appraisal Guide (FWOP AAHUs = 894.55 as compared to With Project AAHUs = 1,935.03; Appendix E, *Habitat Evaluation and Quantification*). Overall, without the project, it is assumed that Clarence Cannon National Wildlife Refuge would continue to have reduced ecosystem structure and function caused by degraded and disturbed ecosystem resources (*e.g.,* decreased habitat quality, quantity and diversity; increased invasive species; lack of connectivity).

Several assumptions have been made to determine the future without project conditions:

1) Past land use of the site has detrimentally impacted the native plant communities and these communities will not naturally recover.
2) Current Environmental Pool Management of the Mississippi River which has led to an elevated water table at the site is assumed to be sustained during the 50-year period of analysis.
3) USFWS will continue to maintain existing infrastructure (including water control structures, pump station, water channels, and spillway) and habitats.
4) No substantial increases to current operation and maintenance budget for the site will occur while efforts to maintain infrastructure will increase along with increases in projected prices of consumables (*i.e.,* diesel fuel) which will take away from habitat management.
5) Without habitat management (*e.g.*, water level manipulation, prescribed fire, etc.) that mimics historic disturbances, the ecosystem will continue to degrade and reed canary grass and other invasive and detrimental species may expand and invade.
6) Reed canary grass spread throughout the refuge will inhibit growth of forest and emergent wetland species reducing ecosystem structure and function.
7) Existing exterior berm will not be removed. This berm would continue to provide protection from the agricultural run-off from the surrounding watershed. However, it is assumed that the long-term impacts of the disconnection from the river will lead to continued shallow water and eventual loss of the sloughs, backwaters, and old meander scars along with continued degradation of aquatic ecosystem resources. If no action is taken to restore these water bodies and improve connectivity, it is assumed that approximately 70-acres of seasonal fisheries habitat will be reduced over the 50-year period of analysis.

Prior to refuge establishment, the site had little habitat use by wetland species, specifically migratory birds. Currently the site is home to a suite of wildlife during migration. However, if the site continues to lose native vegetation to invasive species, water bodies continue to have shallow depth and poor aquatic conditions, and the site water regime fails to follow the historic hydrograph then the ecosystem would continue to degrade leading to reduced fish and wildlife use. Without approved Corps action, the potential for having a long-term, self-sustaining, functioning ecosystem at CCNWR would be lost and rare wetland habitat along the Mississippi River would be reduced.

The No Action Alternative would not include any USACE project features and no additional costs to the USACE would be generated. The U.S. Fish and Wildlife Services would continue to manage the area. No habitat units would be gained or lost from USACE activities. However, USFWS continued site management would likely have a positive effect while the continued degradation of ecosystem structure and function would likely have a negative effect on the habitat and thus habitat units over time (See Appendix E, *Habitat Evaluation and Quantification*).

Chapter 4 Potential Project Features*

The National Environmental Policy Act (NEPA) requires Federal agencies to evaluate a range of reasonable alternatives to a proposed Federal action. For this environmental assessment, the proposed Federal action is to improve or restore ecosystem structure and function at Clarence Cannon National Wildlife Refuge. The following features and combination of features into alternatives were formulated during scoping and discussion with stakeholders.

This chapter presents the potential features that were considered for implementation of the Clarence Cannon National Wildlife Refuge Habitat Rehabilitation and Enhancement Project. The No Action Alternative, as required by NEPA, is also analyzed.

4.1 Project Features Eliminated from Further Consideration

Several features were discussed during the Functional Analysis Value Engineering Workshop, with the project partner, and the USACE Project Delivery Team (PDT). Not all features were moved forward and some were eliminated from further consideration based on the screening criteria developed by the PDT. The screening criteria included:

1) *Features must meet project goals and objectives:* A feature was eliminated from further consideration if it did not meet the project goal and at least one project objective. This included features with the sole purpose to improve maintenance (*i.e.* build a service access road along an existing water conveyance channel). The purpose of an HREP is to improve the ecosystem; therefore, features without ecosystem benefits were eliminated from further consideration.

2) *Costs must be reasonable relative to the extent of ecosystem benefits provided:* A feature was eliminated from further consideration if the cost of a feature was great relative to the ecosystem benefits it provided. This included an idea of a half setback (versus the full setback which was moved forward). The half setback consisted of constructing a new berm approximately 13,600 feet long on the interior of the existing system, in the northern portion of the Riverside Unit only. Connectivity between the northern Riverside Unit and the river would be restored through a water control structure on the exterior berm. In the southern portion of the Riverside Unit the existing exterior berm would be maintained with no connection to the river. The half setback was eliminated from further consideration because it would place half as much acreage connected to the river as compared to the full setback but only reduces the length of the setback by approximately 1%. Therefore, the half setback would generate approximately 50% of the benefits at 99% of the costs, making it inefficient in production.

3) *Risk and Uncertainty too high:* A feature was eliminated from further consideration if the risk and uncertainty of successful performance was high. This included an idea of using a buried perforated pipe in the main channel of the Mississippi River as a water intake source along the exterior berm and setback berm. The desired function would be to provide an unobstructed, continuous water supply into the southern section of the Riverside Unit. However, the PDT's hydraulic engineer believed that the pipe would fill in due to the sediment characteristics of the Mississippi River. Additional uncertainty included how would the project partner operate and maintain the pipe if it got damaged? Would the pipe impact the navigation channel? Since this feature posed high uncertainty of successful performance, it was omitted from further consideration.

4) *New data or information becomes available during planning:* If during the planning process, new data and information becomes available that can significantly change the PDT's understanding of site conditions, then project features can be eliminated from further consideration based on this new knowledge. During planning, land survey data were collected and historical images were studied to determine how water flowed through the site. With this new information, other locations of a proposed pump station were eliminated from further consideration, which included:

    a. Greentree Reservoir Pump Station. This feature consisted of constructing a new pump station along the northern border of GTR-7. However, through further examination of the elevation data and conditions of the existing water conveyance channel along the northern refuge boundary, this supply channel does not provide a reliable water flow throughout the year.

    b. Heron Pond Pump Station and Channels. This feature consisted of construction of a new pump station just south of Heron Pond along the existing exterior berm coupled with excavating two new pump station delivery channels. However, through further examination of the data this location was deemed infeasible. Issues with this location included: 1) the delivery channel would dissect the Riverside Unit in half leading to less aquatic ecosystem benefits from the proposed setback and continued habitat fragmentation in the Riverside Unit; 2) the North Unit would be dissected into 3 management units versus 2 management units with the South Pump Station location; 3) need for additional water control structures; 4) use of Crane Pond as a delivery channel may require a double berm which would lead to loss of aquatic habitat; and 5) location of the Mississippi River thalweg may cause erosional problems to the pump station infrastructure and intake pipe. With the added expected costs of more infrastructure, but less ecosystem benefits the PDT eliminated this location from further consideration.

4.2 Potential Feasible Project Features

The potential feasible non-structural and structural features moved forward and evaluated are listed in Table 5 and locations are depicted in Figure 10. Similar features are listed together as "functional groups", and included the following: (1) New management units through interior berm modification; (2) exterior berm setback; (3) pump station; (4) excavation; and (5) floodplain reforestation.

Table 5. Brief description of feasible project features

Code	Brief Description	Purpose
REFORESTATION		
T1	Plant water tolerant trees in old agricultural field	Restore forest to suitable elevations
RIVERSIDE UNIT		
RV1	Riverside Unit berm removal (6,500 CY)	Reduce habitat fragmentation
NORTH UNIT		
N1	Northern Subunit berm removal(49,000 CY)	Reduce habitat fragmentation
NW2	Water control structure (3 – 4.5 x 4.5 ft opening)	Improve water conveyance
NE2	Water control structure (3 – 4.5 x 4.5 ft opening)	Improve water conveyance
N3	Plant native herbaceous vegetation	Restore herbaceous wetland habitat
MSU7	Water control structure (6 – 4.5 x 4.5 ft opening)	Improve water conveyance

SOUTH UNIT		
SW1	Southwest Subunit berm degrade (34,000 CY)	Reduce habitat fragmentation
SW2	Water control structure (3 – 4.5 x 4.5 ft opening)	Improve water conveyance
SW3	Plant native herbaceous vegetation	Restore herbaceous wetland habitat
C1	Central Subunit berm removal (20,000 CY)	Reduce habitat fragmentation
C2	Water control structure (3 – 4.5 x 4.5 ft opening)	Improve water conveyance
C3	Plant native herbaceous vegetation	Restore herbaceous wetland habitat
E1	Eastern Subunit berm removal (17,000 CY)	Reduce habitat fragmentation
E2	Water control structure (3 – 4.5 x 4.5 ft opening)	Improve water conveyance
E3	Plant native herbaceous vegetation	Restore herbaceous wetland habitat
BP1	Big Pond Subunit berm removal (10,000 CY)	Reduce habitat fragmentation
BP2	Water control structure (3 – 4.5 x 4.5 ft opening)	Improve water conveyance
BP3	Plant native herbaceous vegetation	Restore herbaceous wetland habitat
RD	Relocate service access road to pump station (7,340 linear ft)	Access to pump station
PUMP STATION		
PS-D	Diesel pump station	Improve water conveyance and allow site to reach target water levels in <30 days
PS-E*	Electric pump station	
PS1	Guinns Creek water control structure (3 – 4.5 x 4.5 ft opening)	Move water into and out of North Unit via pump station delivery channel
PS2	Remove berm/culvert in pump station delivery channel	Improve water conveyance within pump station delivery channel
PS3	Central gated water control structure (3 – 4.5 x 4.5 ft opening)	Move water into and out of pump station delivery channel to east-west channel
PS4	South gated water control structure (3 – 4.5 x 4.5 ft opening)	Move water into and out between east-west channel and north-south channel
EXTERIOR BERM SETBACK		
SET	Setback	Floodplain connectivity
SET-D	Exterior berm degrade	Passive floodplain connectivity
SET-S*	Setback with fish-friendly water control structure (2 – 8.0 x 6.0 ft opening)	Floodplain connectivity through active management
SET-RD	Relocate service access road to northern side of refuge (8,415 linear ft)	Access to northern side of refuge
SPILL	Spillway along Bryants Creek	Provides protection to exterior berm
EXCAVATION		
D1*	Excavate Crane Pond, Heron Pond, Buttonbush Pond, and Rabourn Slough	Provide seasonal refugia for aquatic species
HM1	Remove sediment that blocks historic channels	Restore natural water pathways to promote drainage and fish access
HM2*	Water control structure (each consists single 4.0 x 4.0 ft opening) (not needed if setback with degrade selected)	Provide connection to Bryants Creek through exterior berm
HM3*		

*After Incremental Cost Analysis, feature not retained for further evaluation

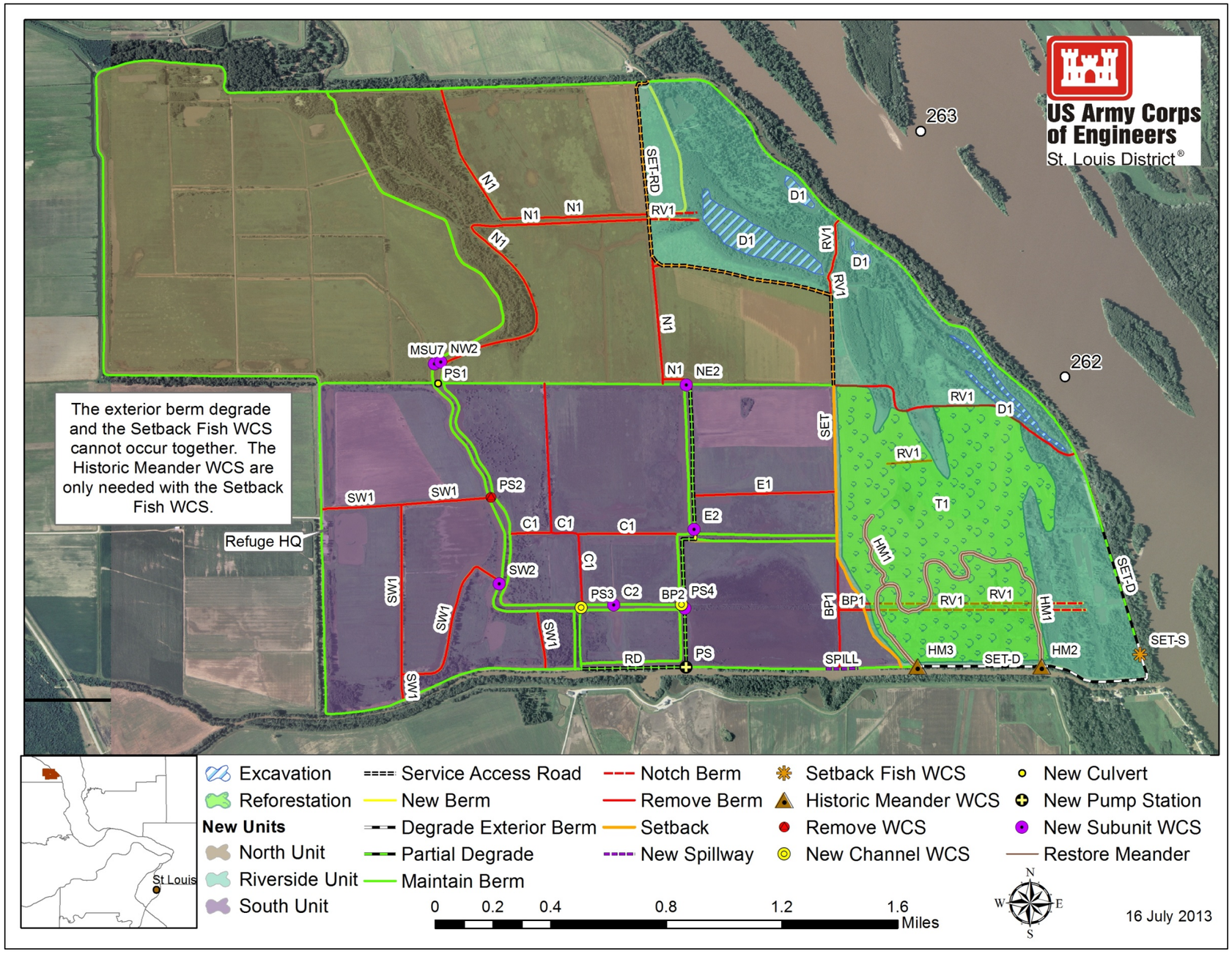

Figure 10. Location of proposed feasible features with identification codes. See Table 5 for feature code descriptions. (Note the location of the native vegetation plantings are in the same location of the interior berm degrades).

4.2.1 New Management Units through Interior Berm Modifications

The purpose of these features is to reduce habitat fragmentation within the refuge by modifying (removing or notching) existing interior berms and connecting areas of common elevation, habitat, and hydrology (Figure 11), while still maintaining access to infrastructure, public use areas, and the ability to manage reed canary grass, an invasive plant species (see Section 2.1.1 above for further discussion on reed canary grass).

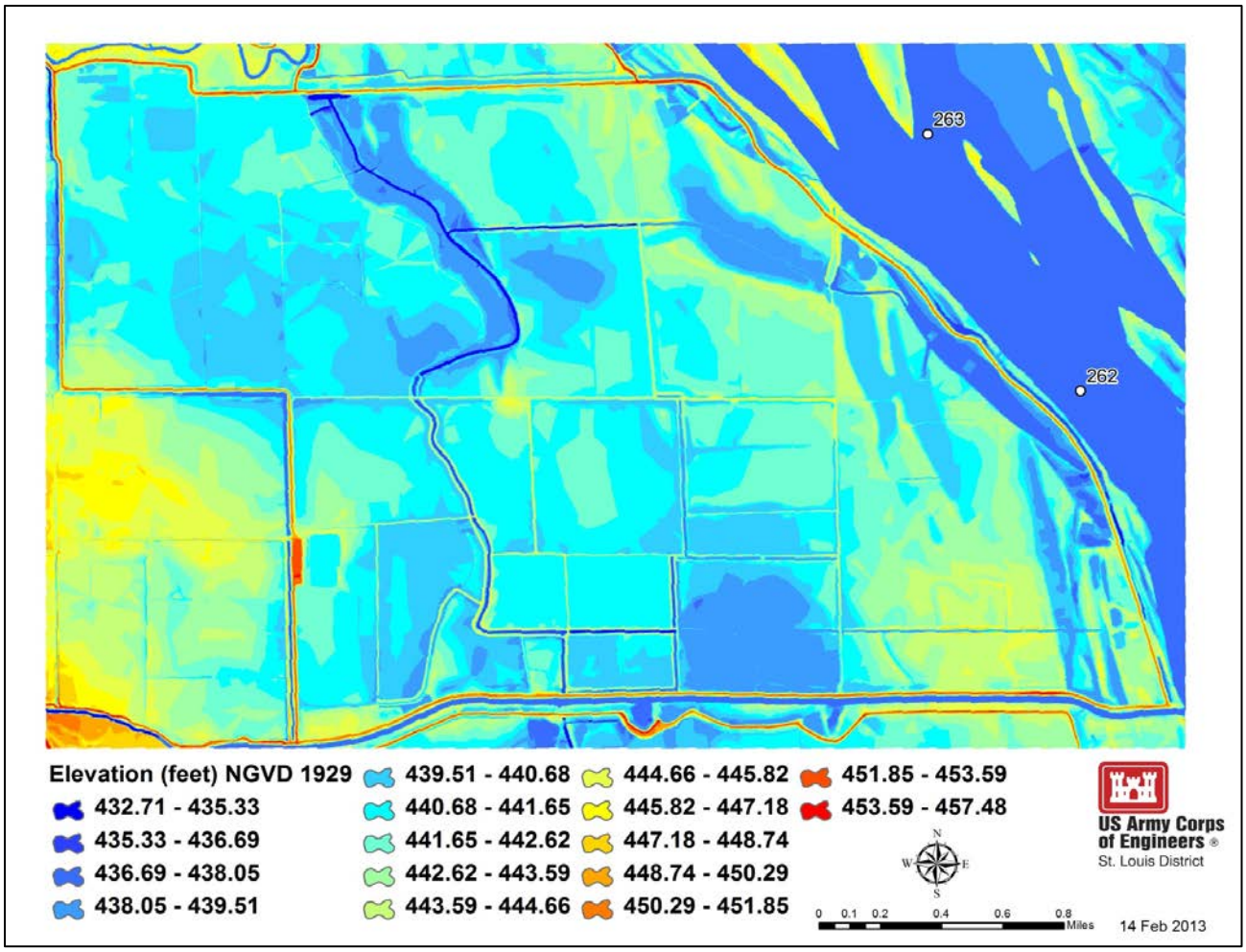

Figure 11. Depiction of surface elevations using SAST data (1995) within CCNWR

Habitat fragmentation is the division of large areas of like habitat into smaller isolated patches. The fragmented patches may be too small and too influenced by edge effects to maintain viable populations of wetland bird species (Johnson 2001). Additionally, berms may act as mammalian predator habitat corridors, therefore reducing the number of these corridors that run through the refuge should benefit ground nesting wetland species such as the King Rail and Least Bittern (Darrah and Krementz 2009), which are Missouri Species of Concern (see section 2.5 above). The existing 27 management units would be reduced to three larger management units (North Unit, South Unit, and Riverside Unit) with subsequent subunits; if all proposed berm modifications are selected. Coupled with the berm removals, existing undersized water control structures would be removed and replaced with new structures to improve water conveyance. For each subunit, the new water control structure would consist of a triple

box culvert having 4.5 x 4.5 ft high barrels. The total number of such water control structures at a particular location varies. The culvert would terminate in a concrete gatewell structure with side walls parallel to flow and four openings on the discharge side of the riser; three controlled by 4.5 x 4.5 ft sluice gates and one controlled by a downward-operating weir gate for adjusting water levels inside the unit (concept on Plate S-2; dimensions on Plate S-6). Figure 12 illustrates the status of the existing water control structures in terms of being maintained, removed, or replaced with the project. Appendix C, *Existing Infrastructure*, provides further detail on the existing water control structures.

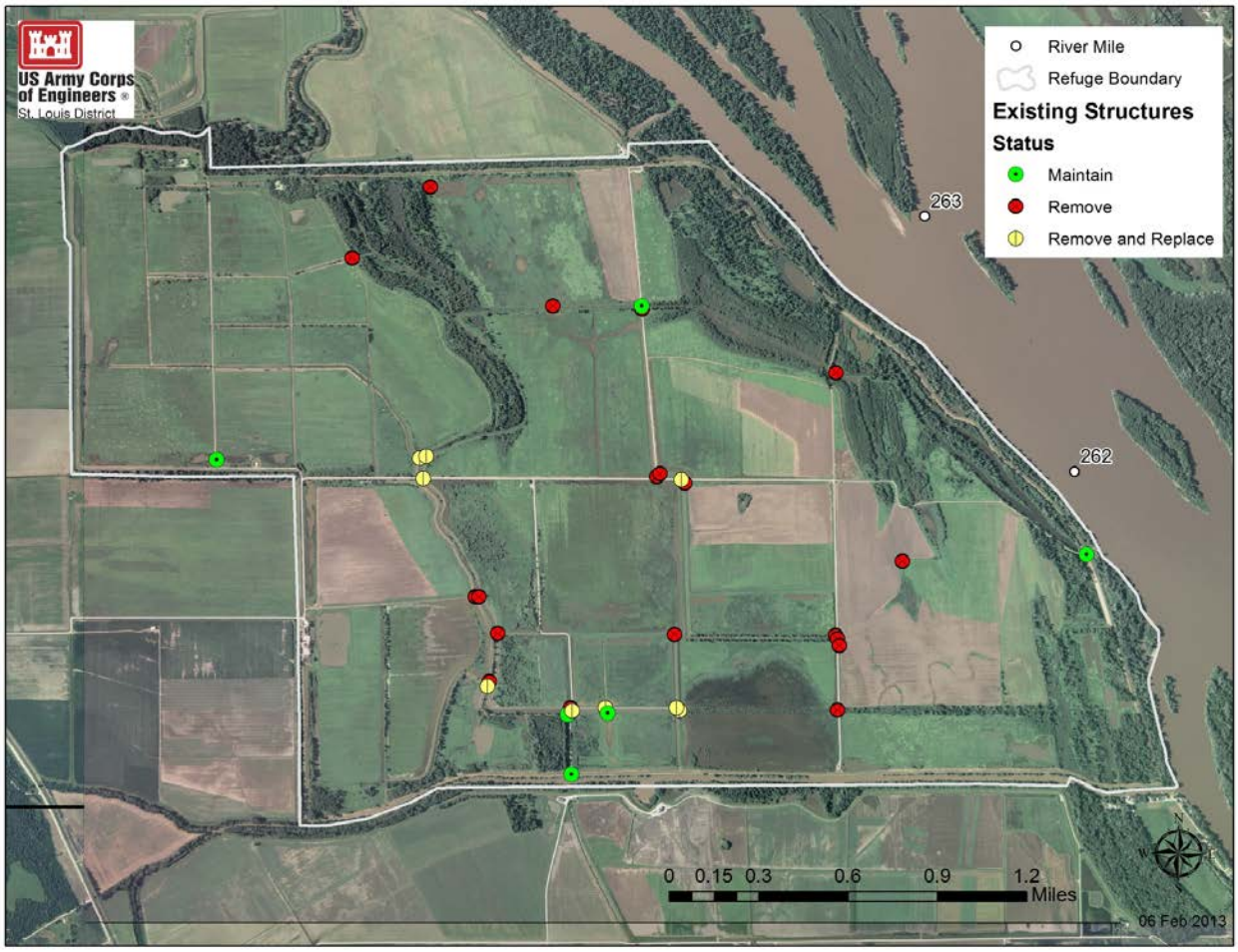

Figure 12. Status of existing infrastructure within the project area

In general, for each of the proposed new management units construction equipment would be used to degrade the existing berms. The material would be side-cast and leveled to prevailing ground elevations or be used to fill in an adjacent water conveyance channel that is no longer needed. The area would then be seed drill planted with a mixture of native wetland sedge species (*Carex* spp.). Degradation and side-casted material placement will avoid already forested areas.

The proposed management units (Figure 13), which can be constructed independently or in combination, include:

South Unit (Plates C-1, C-3). The South Unit includes five subunits (Southwest, Central, Supply Pond, Eastern, and Big Pond), and a service access road to pump station.

- The Southwest Subunit would be established by degrading approximately 34,000 cubic yards of existing berms between the existing management units: MSU5, MSU3, WM1, F2, MSU9 and GTR9. The material would be side cast and leveled, and approximately 6 acres would be seeded with native vegetation.
- The Central Subunit would be established by degrading existing berms between the existing management units: MSU4, MSU2, MSU6, and MSU1. The material would be side cast and leveled, and approximately 5 acres would be seeded with native vegetation.
- No berm removals or new water control structure are proposed within Supply Pond.
- The Eastern Subunit would be established by degrading approximately 17,000 cubic yards of existing berms between the existing management units: MSU11 and MSU12. The material would be side cast and leveled, and approximately 12 acres would be seeded with native vegetation.
- If the proposed setback is selected, the Big Pond Unit would be established by degrading approximately 10,000 cubic yards of existing berms along the eastern border of this unit. The material would be side cast, and leveled, and approximately 5 acres would be seeded with native vegetation. If the setback is not selected, then no berm removals or plantings would occur.
- Within the Southwest, Central, Eastern, and Big Pond subunits, the existing undersized water control structures will be removed and replaced with new structures to improve water conveyance (concept on Plate S-2; dimensions on Plate S-6).
- Relocation of Pump Station Service Access Road. The existing gravel service access road to the existing pump station will be relocated atop an existing berm to provide access from the main east-west road to the new and existing pump station road (approximately 7,338 feet in length). The existing pump station road will be removed to reduce habitat fragmentation within the Central Subunit.
- New Berm. A small section of berm approximately 90 feet in length will be constructed severing the water channel between Big Pond and MSU12 and the north-south water channel since this east-west channel will no longer be needed. This berm will be constructed using fill from the berm removal between MSU11 and MSU 12. The Pump Station Service Access Road would travel across this new section of berm.

North Unit (Plates C-1, C-2) The North Unit includes two subunits (MSU 7 and Northern).

- Within MSU 7 no berm removals are proposed; however two new larger water control structures (concept on Plate S-2; dimensions on Plate S-6) would be constructed in the southeast corner of MSU7 replacing the existing undersized structure.
- The Northern Subunit would be established by degrading approximately 49,000 cubic yards of existing berms between the existing management units: GTR7, Goose Pasture, F3, MSU 8, and MSU 10. The material would be used to fill the existing water channel between Goose Pasture and MSU 8. Approximately 20 acres of native vegetation would be established. Two new larger water control structures will be constructed, one located in the eastern side of the subunit and one located in the west-central side of the subunit (concept on Plate S-2; dimensions on Plate S-6). These two structures would replace existing undersized infrastructure.

Riverside Unit (Plates C-1, C-4). The Riverside Unit includes the area located on the river side of the proposed setback. The management unit would be established by degrading approximately 6,500 cubic yards of existing berms. The material would be side cast and leveled, and approximately 18 acres would be seeded with native vegetation.

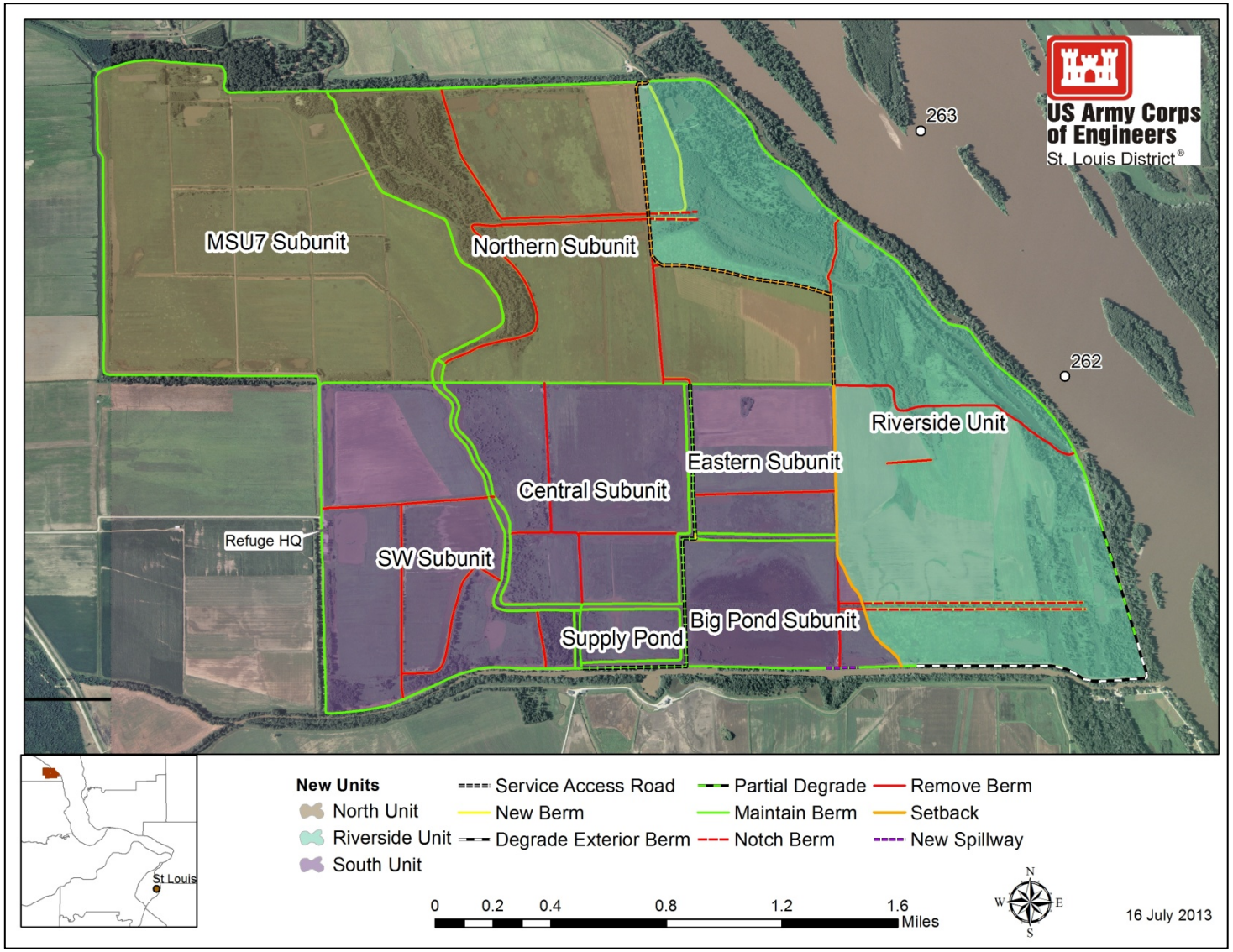

Figure 13. Feasible feature map depicting the subunit names within each of the proposed new management units (North, Riverside, and South). All other feasible features are provided in Figure 10.

4.2.2 Pump Station

The purpose of this feature is to improve the ability to mimic the pre-impoundment water regime (*i.e.*, spring flood, summer drawdown, fall flood) which native flora and fauna adapted to. The existing pump station and water conveyance system are undersized and have limited capability of mimicking pre-impoundment conditions and meeting the ecosystem goal of reaching target water levels during flood-up within 7 days for desirable plant establishment and wildlife use during non-flood years, and to drain the project area within 40 days after large flood events (*i.e.*, 5% chance of exceedance event). This drawdown rate allows for soil saturation, provides conditions favorable for native plant germination and establishment, and provides optimum foraging conditions for wildlife (Fredrickson 1991). This rate would allow the project partner to place water on the management unit(s) later (to coincide with fall migrants) and remove water faster (promoting wetland plant diversity, increasing invasive species management capabilities, allowing floodwaters to be removed faster reducing negative impacts to native vegetation, and improving overall ecosystem resources). The pump station capacity was determined by the need to drain the project area after large flood events within 40 days (*Hydraulics and Hydrology*, Appendix D). This feature consists of building a new pump station and gravity drain along Bryants Creek (Figure 10) as well increasing capacity of the water control structures within the water conveyance channels. This location has a reliable water source from Bryants Creek, and can be tied into the existing water conveyance system on site. This pump station will be able to provide pump-in and pump-out capability in low and high water, as well as a gravity drain. The gravity drain consists of two structures, a triple box culvert and a double box culvert, each having 6.0 x 6.0 ft barrels. Each culvert terminates in a concrete gatewell structure with side walls parallel to flow and two or three openings on the discharge side of the riser, each controlled by a 6.0 x 6.0 ft sluice gate (concept on Plate S-2; dimensions on Plate S-6). The PDT evaluated two different types of pump stations to improve water conveyance:

1) **Diesel Pump Station (Plates M-3 and M-4).** The diesel operated pump station has two 30,000 gpm, axial flow, and vertical line-shaft pumps. Each pump is driven by a diesel engine through a right angle gear reducer. The diesel engines would be permanently mounted and protected by engine enclosures. The pump station design is similar to the electric pump station described below except for the following: Gates on the diesel operated pump station would be operated manually or with a portable electric drill-type wrench powered by a small portable generator. The riser of the diesel station extends from elevation 424.0 ft to elevation 454.0 ft. Adjacent to the top of the riser are concrete pads for diesel engines and containment slabs for the fuel tanks. The pump station and the pads for the engines and fuel tanks would occupy an approximately 59 ft × 29 ft area on the exterior berm. The berm would be widened in the vicinity to accommodate the pump station.
2) **Electric Pump Station.** The electrically powered pump station has two 30,000 gpm electric submersible pumps. The two exterior bays provide sumps for the pumps, and the one interior bay is the discharge chamber. Channel flow through each bay is controlled by 6 sluice gates, one on the Bryants Creek side and one on the managed side of each bay. Water can be moved into or out of the interior management area by changing the arrangements of open and closed gates. Gates would have electric motor operators. The pump sump bays are served by culverts. Bar-screen trash racks will be provided at the intake end of each culvert to prevent debris from entering the pump station. The station will be founded on steel H-piles. The pump station walls extend from elevation 424 to elevation 454 in order to set the control equipment and sluice gate motors above a 2% chance of exceedance flood event. Pedestrian and vehicular access to the operating area is via a localized widening of the berm embankment. The station and appurtenances would occupy an approximately 41 ft × 19 ft area on the exterior berm.

Currently, single-phase electric power lines terminate at the project office in the western part of CCNWR. Due to the size of electric pumps required to meet the 40 day water management goal, three-phase, 480 volt AC electric service is required. Through consultation with Ameren UE, possible locations to access three-phase power were determined. The closest 3-phase power is located approximately 2 miles west of the proposed pump station location along Hwy 79.Three-phase electric service would be routed from Hwy 79 where primary metering would be utilized. Ameren UE would not be responsible for maintaining the power transformers and primary feeders on the load side of the meter. From the load side of the meter at Hwy 79, three-phase power would be routed aerial approximately 0.7 miles to the refuge border, and then underground along the existing roads and exterior berm approximately 1.7 miles to the proposed pump station. Power would be routed underground within the refuge because aerial electric lines would pose a hazard to the thousands of migratory birds that utilize the refuge. Power transformers would be installed at the proposed pump station to step-down the primary voltage to the appropriate operating voltage of the station. Upon completion of the Incremental Cost Analysis (Chapter 5) this feature was not retained for further consideration.

Pump Station Delivery Channel Water Channel Structures (Plates C-1, C-3, S-3, S-6). Within the pump station delivery channel, one culvert (PS2) will be removed completely and a second culvert located within Guinns Creek (going under main east-west road) will be replaced with a larger structure (PS1; triple box culvert with 4.5 x 4.5 ft barrels; concept on Plate S-3; dimensions on Plate S-6) to improve water conveyance within the pump station delivery channel. Two other existing gated structures (PS3 and PS4) located within the water channels will be replaced with larger structures. Each structure consists of a triple box culvert having 4.5 x 4.5 ft high barrels. The culvert terminates in a concrete gatewell with side walls parallel to flow and three openings on the discharge side of the riser, each controlled by a 4.5 x 4.5 ft sluice gate. Upgrading these structures is needed to ensure no “bottlenecks” occur within the water conveyance system.

4.2.3 Exterior Berm Setback

A setback is defined as “an earthen embankment placed some distance landward of the bank of a river, stream, or creek. It develops bypasses for the mainstream, flooding a land area usually dry but subject to flooding at high mainstem stages” (USACE 1999). Due to the exterior berm surrounding Clarence Cannon National Wildlife Refuge, the site is disconnected from the river except during overtopping flood events. The purpose of a setback feature is to increase floodplain connectivity and storage without increasing sedimentation of existing water bodies. A setback provides floodplain storage benefits and sustains dynamics of the river system, which depends on recurring flood events. The passage of water and sediment in the main channel, and their exchange between the channel and floodplain, characterizes the physical environment and effects of habitat, biodiversity, and sustainability of the river (Poff *et al.* 1997). The setback location proposed utilizes existing high ground, and places remaining forest in the Riverside Unit outside the setback which will reduce ponding to these trees during large flood events. The existing exterior berm would remain along the Mississippi River to act as a sediment deflection structure reducing sedimentation of existing water bodies and allows for back flooding into the Riverside Unit. The setback feature also includes construction of a spillway. Connection between the setback area and the river could be achieved through one of two ways, but not both:

Setback Berm with Mississippi River Water Control Structure. This feature consists of constructing a new reach of berm approximately 13,700 feet long requiring 225,000 cubic yards (CY) of embankment with a crest elevation estimated at 452.0 feet NGVD (1929). This new section of berm would be located on the interior of the existing system along the natural high ridge and existing roadways. This would be

coupled with construction of a new fish passage water control structure in the southeast corner along the Mississippi River. The purpose of the water control structure and setback berm would be to allow the Riverside Unit connectivity with the river to provide fish access to spawning and rearing habitat, although slightly restricted due to fish having to pass through the structure. In addition, the water control structure could be used to disconnect the project area from the river during undesirable events (*e.g.,* unusual flood pulses, contamination accidents) and for vegetation management. The structure has two 8.0 x 6.0 ft high openings in a concrete barrier wall crossing between concrete abutments. The openings are controlled by sluice gates. Vehicular access across the structure is via a precast concrete bridge spanning between abutments. There will be a 4-ft clear zone between the bridge deck and barrier wall to admit sunlight to the area behind the gates to promote fish passage. The openings are controlled by sluice gates. Features dependent on the setback berm include: deepening of the existing water bodies, restoring historic meanders, and reforestation. Upon completion of the Incremental Cost Analysis (Chapter 5) this feature was not retained for further consideration.

Setback Berm with Partial Exterior Berm Degrade (Plates C-1, C-5). This feature only differs from the above in the means of how connectivity is achieved. Instead of a water control structure providing connectivity to the river, the non-structural feature of partially degrading (approximately 5,000 feet) the southeastern section of the exterior berm along Bryants Creek to prevailing ground elevation and partially degrading approximately 2,300 feet of the exterior berm along the Mississippi River to the existing spillway height would provide unobstructed connectivity to the Mississippi River. Degrading the exterior berm would allow the Riverside Unit connectivity to the river through back flooding. This connectivity would allow a portion of the refuge to be exposed to the annual flood pulse and provide unrestricted access to fish spawning and rearing habitat which is currently lacking at the refuge. The degraded material would be mechanically excavated and transported via construction equipment and used beneficially to construct the setback itself. The proposed exterior berm is primarily covered with grass. Some trees may need to be cleared which could then be used for shoreline protection in the degrade area along the Mississippi River or be used for habitat to increase cover and foraging habitat for fish and wildlife. Any trees not used for habitat will be disposed of on-site. Features dependent on the setback berm include: deepening of the existing water bodies, restoring historic meanders, and reforestation.

Spillway (Plates C-1, C-3, C-5). With a setback, a new spillway will be constructed (850 feet in length) along Bryants Creek by decreasing the exterior berm to an elevation of approximately 450.0 feet NGVD (1929) and armoring a portion of it with articulated concrete block. The spillway would reduce ponding impacts during larger, less frequent flood events that overtop the exterior berm and flood the interior refuge. The spillway would allow for back flooding into the interior of the refuge which reduces head cutting of the exterior berm.

4.2.4 Excavation

The purpose of this feature is to restore aquatic depth diversity to the Riverside Unit to improve aquatic habitat (*e.g.,* overwintering fish habitat) and connectivity at the refuge. Any excavation poses the risk of crossing a sand lens which would cause seepage problems at the site; therefore this functional group is dependent on a setback feature. In addition, the excavated material will be used beneficially on site (*e.g.,* used in setback construction or during reforestation).

Increasing Depth. This feature consists of hydraulically excavating material within existing water bodies located in the Riverside Unit (*i.e.*, Crane Pond, Heron Pond, Buttonbush Pond, and Rabourn Slough) in order to restore aquatic depth diversity and restore overwintering fish habitat. For Crane Pond, three

deep holes (approximately 3 surface acres in size by 4 feet deep) would be excavated (approximately 23,000 CY of material per hole). For Heron Pond and Buttonbush Pond, 1 deep hole (approximately 23,000 CY of material removed) would be excavated from each water body. For Rabourn Slough, a linear dredge cut of approximately 4,440 feet in length by 7 feet in total depth would be constructed to improve connectivity and seasonal habitat for aquatic habitat. During plans and specifications, a survey would be conducted to determine target water elevations. The material would be disposed of on-site, allowed to dewater, and could then be beneficially used to construct other project features (*e.g.*, increase topographic diversity in the former agriculture field prior to reforestation efforts). Silt fences would be incorporated in order to block fine sediments from flowing away with the excess water. Upon completion of the Incremental Cost Analysis (Chapter 5) this feature was not retained for further consideration.

Restoring historic meanders (Plates C-1, C-4, C-5). This feature consists of mechanically excavating material to restore the historic meanders within the Riverside Unit. Historically, these meanders were connected to Bryants Creek, but due to construction of the exterior berm and the leveling of the interior these meanders are now disconnected and topographic diversity has been degraded. In aerial imagery these historic low areas can still be observed. This feature seeks to restore these historic meanders to improve floodplain topographic diversity and aquatic connectivity. Approximately 115,000 CY of material would be excavated and be beneficially used to construct other project features (*i.e.*, setback or side-cast to enhance topographic diversity for reforestation efforts). The meanders would be approximately 5 feet deep, have a bottom width of approximately 35 feet wide and have 1V:6H side slopes. During plans and specifications, a survey would be conducted to determine target elevations. Additionally, these meanders would require connectivity with Bryants Creek for fish passage; therefore, this feature is dependent on a setback feature. If the setback with water control structure is selected then this feature would require two additional water control structures (HM2 and HM3; Figure 10) to provide connectivity to Bryants Creek; however, upon completion of the Incremental Cost Analysis (Chapter 5) the setback with water control structure was not retained therefore the additional water control structures (HM2 and HM3) were also not retained for further consideration.

4.2.5 Reforestation

The purpose of this non-structural feature is to promote geomorphic stability within this area by modifying the hydrology by increasing flow resistance, reducing flow velocity, increasing strength of bank material via root reinforcement, and by promoting entrapment and deposition of suspended sediment (Knox 2006; Darby 1999; Hamilton and King 1983); and to improve diversity within approximately 300 acres (Plates C-1 and C-4) of floodplain forest within the Riverside Unit (Figure 10). Approximately 300 acres of 2-gallon containerized grown trees on the higher portions of the former agricultural field will be planted 30 feet apart with adjacent rows staggered (approximately 48 trees per acre). Primary species may include pin oak (8 per acre), Swamp White Oak (8 per acre), Overcup Oak (8 per acre), and pecan (12 per acre). Additional species (6 per acre) based on site conditions may include Persimmon, Sycamore, or Hackberry. Since attempts to increase floodplain forest diversity by reintroducing mast-producing tree species, such as pin oak, often fail due to ponding of floodwaters (Romano 2010) this proposed feature is dependent on the setback feature. Without the setback any trees planted would be subject to ponding after an overtopping flood event leading to low survivability; therefore, this feature is dependent on a setback to ensure proper drainage which reduces the risk of tree mortality associated with flooding. During plans and specifications, elevation and soil type surveys would be conducted to finalize species selection and placement.

Chapter 5 Feasible Feature Evaluation & Alternative Plan Formulation*

Chapter 5 describes the feasible features that met the goals and objectives of this project. Each feature or combinations of dependent features (*i.e.*, setback and restoration of meanders) were evaluated through an environmental benefits analysis to determine the magnitude of ecosystem benefits to be expected if the features were implemented. The benefits were then combined with cost estimates for each feature and then Incremental Cost Analysis (ICA) was conducted to determine cost effectiveness. Alternatives were generated by creating all possible combinations of the features. A full description of the environmental benefit analysis can be found in Appendix E, *Habitat Evaluation and Quantification.*

5.1 Planning Constraints

In addition to the criteria used to screen project features (Section 4.1), the following constraints were considered in plan formulation:

1. *Laws and Regulations* **–** Features would be designed and constructed to be consistent with Federal, state, and local laws.
2. *Impacts to Cultural Resources* - Features would not detrimentally affect historical and archaeological sites located within the project area.
3. *Elevation Data* – Preliminary design of features used the best topographic data available during planning which were SAST[1] data collected in 1995 in response to the flood of 1993 in the Upper Mississippi River Basin. These are multi-resolution data that cover the geographic extent of the Upper Mississippi River Basin. The vertical positional accuracy of the data meets the U.S. Army Corps of Engineers Standards for Class I mapping and is sufficiently accurate to support generation of four foot contours. The PDT was advised that these data are suitable for use during planning purposes. During planning, ground surveys were conducted in existing and proposed locations of water control structures, pump stations, and points along the interior and exterior berms. These data were used with the SAST data to develop the hydraulic modeling and the preliminary design of features. During plans and specifications, topographic data of the existing conditions of the refuge may be collected as needed.
4. *Impacts to navigation or flood heights* – Restoration features would not detrimentally increase flood heights or adversely affect private property, infrastructure, or navigation.

5.2 Environmental Benefit Analysis

A habitat analysis was performed for the CCNWR HREP, with the goal to restore and improve wetland habitat quality and diversity. This analysis employed a multi-agency team approach with representatives from USACE, USFWS, and Missouri Department of Conservation (MDC). Analysis of existing study area conditions, future conditions without the project, and impacts of several proposed features and alternatives was completed using the Wildlife Habitat Appraisal Guide (WHAG) procedures developed by MDC and the USDA Natural Resources Conservation Service (MDC and USDA 1991). The WHAG is a numerical habitat appraisal methodology based on USFWS Habitat Evaluation Procedures (HEP) (1980). WHAG procedures evaluate the quality and quantity of particular habitats for wetland species selected for evaluation by the WHAG team members. The qualitative component of the analysis is known as the Habitat Suitability Index (HSI) and is rated on a 0.1 to 1.0 scale. The quantitative component of the analysis is the measure of acres of habitat that are available for the selected evaluation species. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula HSI x Acres = HUs. Changes in the quality and/or quantity of HUs would

[1] SAST stands for Scientific Assessment Strategy Team (http://egsc.usgs.gov/isb/pubs/factsheets/fs10399.html)

occur as a habitat matures naturally or is influenced by development. Cumulative HUs are annualized and averaged. To facilitate comparison, target years were established at 0 (baseline or existing conditions), 1, 5, 25, and 50 years. HSIs and average annual habitat units (AAHUs), for each evaluation species, were calculated to reflect expected habitat conditions over the life of the project. Aquatic habitats were evaluated in a similar manner, by using the Aquatic Habitat Appraisal Guide (AHAG) developed by the Corps of Engineers, Waterways Experiment Station (Kilgore and Hardy 1992; Mathias *et al.* 1996). Calculations of habitat units and annualized average habitat units were completed in the same manner as those for the WHAG. Table 6 provides a summary of net AAHUs generated for each of the feasible project features. For a more detailed description of the habitat analysis as well as the detailed net AAHUs generated for feasible feature combinations (which may vary from summing the values of individual features listed in Table 6), refer to the Appendix E, *Habitat Evaluation & Quantification*.

Table 6. Summary of Net Average Annualized Habitat Units (AAHUs) summed across all AHAG and WHAG analyses generated for each of the feasible project features along with feasible combinations.

ICA Code	Feature	Total Net AAHUs
NEW SUBUNITS ONLY (cannot be combined with anything else)		
A1	South Unit (SU)	315.41
A2	North Unit (NU)	335.73
A3	Riverside Unit (RU)	47.66
A4	SU+NU	651.14
A5	SU+RU	363.07
A6	NU+RU	383.39
A7	SU+NU+RU	698.80
DIESEL PUMP STATION OPTIONS (cannot be combined with A or C-H)		
B1	Diesel Pump Station Only	474.89
B2	Diesel Pump Station + SU	621.34
B3	Diesel Pump Station + NU	603.85
B4	Diesel Pump Station + RU	503.27
B5	Diesel Pump Station + SU+NU	750.30
B6	Diesel Pump Station + SU+RU	649.72
B7	Diesel Pump Station + NU+RU	632.23
B8	Diesel Pump Station + SU+NU+RU	778.68
ELECTRIC PUMP STATION OPTIONS (cannot be combined with A-B, or D-H)		
C1	Electric Pump Station Only	474.89
C2	Electric Pump Station + SU	621.34
C3	Electric Pump Station + NU	603.85
C4	Electric Pump Station + RU	503.27
C5	Electric Pump Station + SU+NU	750.30
C6	Electric Pump Station + SU+RU	649.72
C7	Electric Pump Station + NU+RU	632.23
C8	Electric Pump Station + SU+NU+RU	778.68
SETBACK WITH WATER CONTROL STRUCTURE OPTIONS (cannot be combined with A-C; E)		
D1	Setback with WCS only	1065.57
D2	Setback + plantings	1110.37
D3	Setback + excavating	1115.85
D4	Setback + meanders	1082.68
D5	Setback + plantings + excavating	1160.65
D6	Setback + plantings + meanders	1127.48
D7	Setback + excavating + meanders	1132.97
D8	Setback + plantings + excavating + meanders	1177.77

SETBACK + NEW SUBUNITS (Depends on D or E; cannot be combined with A-C; G-H)		
E1	Setback with EBD only	1065.57
E2	Setback + plantings	1110.37
E3	Setback + excavating	1115.85
E4	Setback + meanders	1082.68
E5	Setback + plantings + excavating	1160.65
E6	Setback + plantings + meanders	1127.48
E7	Setback + excavating + meanders	1132.97
E8	Setback + plantings + excavating + meanders	1177.77
SETBACK + NEW SUBUNITS (Depends on D or E; cannot be combined with A-C; G-H)		
F1	+SU	146.05
F2	+NU	126.20
F3	+RU	27.99
F4	+SU+NU	272.25
F5	+SU+RU	174.04
F6	+NU+RU	154.19
F7	+SU+NU+RU	300.24
SETBACK + DIESEL PUMP STATION and/or NEW SUBUNIT OPTIONS NET BENEFIT (Depends on D or E; cannot be combined with A-C; F; H)		
G1	+ Diesel Pump Station	162.50
G2	+Diesel Pump Station + SU	357.58
G3	+Diesel Pump Station + NU	345.18
G4	+Diesel Pump Station + RU	198.15
G5	+Diesel Pump Station + SU+NU	540.26
G6	+Diesel Pump Station + SU+RU	393.23
G7	+Diesel Pump Station + NU+RU	380.83
G8	+Diesel Pump Station + SU+NU+RU	575.91
SETBACK + ELECTRIC PUMP STATION and/or NEW SUBUNIT OPTIONS NET BENEFIT(Depends on D or E; cannot be combined A-C, F-G)		
H1	+ Electric Pump Station	162.50
H2	+Electric Pump Station + SU	357.58
H3	+Electric Pump Station + NU	345.18
H4	+Electric Pump Station + RU	198.15
H5	+Electric Pump Station + SU+NU	540.26
H6	+Electric Pump Station + SU+RU	393.23
H7	+Electric Pump Station + NU+RU	380.83
H8	+Electric Pump Station + SU+NU+RU	575.91

Model Certification Status: Per EC 1105-2-412: Assuring Quality of Planning Models (dated 31 March 2011), planning models such as the AHAG and WHAG are required to be certified. Under the UMRR-EMP, the model certification process for both of these models has begun with reviewer comments received and are currently being addressed. Consistent with guidance from the National Ecosystem Restoration Planning Center of Expertise (ECO-PCX), the Agency Technical Review (ATR) Team for the CCNWR HREP conducted an assessment of the models used for this project. This process evaluated the technical quality and appropriateness of the models utilized. A member of the ATR team evaluated the models during the 2013 ATR. The models were found to be correctly applied and appropriately used for this study. In addition, the ECO-PCX recommended single-use approval of AHAG and WHAG models for use at CCNWR. This recommendation was logged with the Office of Water Project Review for consideration by the Model Certification Team with a memorandum dated 11 October 2013. As of 5 November 2013, the Headquarters Model Certification Team approved the use of AHAG and WHAG for Clarence Cannon National Wildlife Refuge HREP.

5.3 Cost Effective and Incremental Cost Analysis of Alternatives

Corps of Engineers guidance requires a cost effectiveness analysis and an incremental cost analysis (CE/ICA) for determining what project features and design alternatives should be built based on comparison of quantified habitat benefits (outputs) and estimated costs of alternative feature designs. This process identifies alternative features or combinations of features that partially or fully meet the goals and objectives of the project and at the same time are the most cost effective. A cost effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of output. After the cost effectiveness of the alternatives has been established, subsequent incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

CE/ICA is basically a three-step procedure: (1) calculate the environmental outputs of each feature; (2) determine a cost estimate for each feature; and (3) combine the features to evaluate the best overall project alternative based on habitat benefits and cost. A description of habitat evaluation and benefit quantification is provided in Appendix E, *Habitat Evaluation and Quantification*. Costs were annualized by applying a 3.75 % interest rate to the construction cost over the period of analysis of 50 years for planning purposes. The incremental analysis of alternatives was accomplished following guidance by the Corps' Institute of Water Resources and using the methodology described in Robinson *et al.* (1995). Refer to Appendix F, *Incremental Cost Analysis*, for the detailed results of the analysis.

Construction cost and relevant Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) costs for features and subsequently for project alternatives were computed (Tables 7 and 8; Section 10.1), assuming a 50-year project period of analysis and a FY2013 project discount rate of 3.75%.

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

1) AAHUs for all analyzed fish and wildlife species were assumed to have equal value in comparing alternative plans.
2) Alternatives analysis was limited to combinations that at least partially met all three project objectives listed in Table 4.
3) Reforestation, historic meander restoration, and excavation of existing water bodies were assumed to be dependent on the setback feature.

From the process, a total of 408 Plans were generated. The CE/ICA process resulted in 41 cost effective alternatives and 9 "Best Buy" plans (including the No Action Plan) combining the features discussed above. These "Best Buy" plans (alternatives) are displayed in Figure 14 and listed in Table 9.

The Best Buy Alternatives presented provide the information necessary to make well-informed decisions regarding desired project scale (Figure 14; Table 9). Progressing through the increasing levels of output for the alternatives in Table 9 helps determine whether the increase in output is worth the additional cost. As long as decision makers consider a level of output to be "worth it", subsequent levels of output are considered. When a level of output is determined to be "not worth it", then subsequent levels of output will also likely be "not worth it", and the final decision regarding desired project scale for environmental restoration planning will have been reached.

Typically in the evaluation of Best Buy Alternatives, 'break points' are identified in either the last column in Table 9, or in the stair-step progression from left to right in Figure 14. Break points are defined as significant increases or jumps in incremental cost per output, such that subsequent levels of output may not be considered "worth it". Identification of such break points can be subjective. For the Clarence Cannon NWR HREP, the break points were identified as occurring between Alternatives 3 and 4;

between Alternatives 4 and 5; and between Alternatives 8 and 9 (Table 9). Even though Alternative 4 generates only 17 incremental AAHUS, deciding to continue pass this breakpoint allows for a substantial increase in incremental AAHUS in the subsequent alternatives which have relatively similar incremental costs per output (Table 9). Alternatives 5 and 6 generate substantially higher levels of output, 126 incremental AAHUs and 146 incremental AAHUs, respectively, making the decision to continue evaluating and considering Best Buy alternatives beyond these first two breakpoints logical.

Alternative 8 generates a total of 1,703 AAHUs at an average cost of $725 per output. Alternative 9 only generates an additional 50 AAHUs at an incremental cost of $3,449 per output. This considerably higher incremental cost per output was deemed "not worth it". Therefore Alternative 8 is identified as the desired project scale, and includes the following features:

- Setback berm with exterior berm degrade
- Restoration of historic meanders
- Riverside, North and South new interior management units
- Reforestation
- Diesel pump station

Table 7. The estimated construction costs, average annual costs, and operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) cost for each feature (as of May 2013). Costs include contingencies.

	Feature Description	Construction Cost	Average Annual Construction Cost	Average Annual OMRR&R Cost	Total Average Annual Cost
NO ACTION		$0	$0	-	$0
New Units					
	South Unit*	$4,258,000	$189,800	$4,400	$194,200
	North Unit*	$3,145,000	$140,200	$4,200	$144,400
	Riverside Unit*	$182,000	$8,100	$500	$8,600
Pump Station					
	Diesel Pump Station*	$8,515,000	$379,500	$42,000	$421,500
	Electric Pump Station	$10,302,000	$459,200	$47,500	$506,700
Setback					
	Setback with Mississippi River Water Control Structure (WCS)	$11,552000	$514,900	$4,800	$519,700
	Setback with Mississippi River WCS + Historic Meanders[1]	$12,125,000	$540,500	$7,900	$548,400
	Setback with degrade	$8,639,000	$385,100	$3,300	$388,400
	Setback with degrade + Historic Meanders*[2]	$8,855,000	$394,700	$6,500	$401,200
Excavation of Existing Water Bodies[3]		$3,475,000	$154,900	$18,500	$173,400
Reforestation*[3]		$1,407,000	$62,700	$3,900	$66,600

* Denotes features in the tentatively selected plan. Detailed OMRR&R costs for the TSP are discussed in Section 10.1
[1] Includes cost of historic meander excavation and 2 water control structures to connect meanders to Bryants Creek.
[2] Includes cost of historic meander excavation, no water control structures needed

Table 8. Detailed OMRR&R cost estimates for features not retained for further evaluation. Details on features in the Tentatively Selected Plan are included in Section 10.1. Prices as of May 2013.

Component	Qty	Unit	Unit Cost	Cost[1]	Frequency
OPERATIONS					
Electric Pump Station Electricity	1	Lump sum	$25,000	$28,750	Annual
Inspection	16	Hr	$50	$1000	Annual
Setback with WCS Inspection	8	Hr	$50	$500	Annual
Setback with WCS + meanders Inspection	8	Hr	$50	$500	Annual
Setback with degrade Inspection	8	Hr	$50	$500	Annual
Excavation of existing water bodies	8	Hr	$50	$500	Annual
MAINTENANCE					
Electric Pump Station (electrical equipment)	1	Lump Sum	$5,000	$5,800	Annual
Setback with WCS Mowing (25 acres 2x per yr)	50	Acres	$50	$2,900	Annual
Setback with WCS + meanders Mowing (25 acres twice/yr)	50	Acres	$50	$2,900	Annual
Setback with exterior berm degrade Mowing (25 acres twice/yr)	50	Acres	$50	$2,900	Annual
REPAIR					
Electric Pump Station	1	Lump Sum	$1,000	$1,200	Annual
Setback WCS	1	Lump Sum	$1,000	$1,200	Annual
Setback -meander WCS	1	Lump Sum	$1,000	$1,200	Annual
REPLACEMENT					
Electric Pump Station					
Electric pump and tube	2	Each	$190,000	$437,000	Every 50 yrs
Pump Control Panel	2	Each	$30,000	$69,000	Every 25 yrs
Power Transformer	1	Each	$40,000	$46,000	Every 35 yrs
Power Distribution Panel	1	Each	$25,000	$28,800	Every 35 yrs
72 x 72 sluice gates w/ hoists	2	Each	$37,000	$85,100	Every 60 yrs
108 x 84 sluice gates w/ hoists	4	Each	$62,000	$285,200	Every 60 yrs
channel WCS 54 x 54	6	Each	$27,400	$189,100	Every 60 yrs
Gravity Drain	5	Each	$31,100	$178,800	
Setback WCS sluice gate	2	Each	$31,100	$71,500	Every 60 yrs
Setback -meander WCS Sluice Gate 48x48	2	Each	$26,100	$60,000	Every 60 yrs
Excavation (57,500 CY – ½ original)	1	Lump sum	$345,000	$396,800	Every 50 yrs
Sluice Gate 72 x 72	2	Each	$31,100	$71,500	Every 60 yrs
Excavation of existing water bodies	1	Lump Sum	$2,224,000	$2,557,600	Every 50 yrs
REHABILITATION					
Electric Pump Station gate & electric sponsor	6	Each	$30,000	$207,000	Every 25 yrs
30,000 gpm pump	2	Each	$40,000	$92,000	Every 25 yrs
Gravity drain sluice gate operator	5	Each	$3,000	$17,250	Every 25 yrs
Stainless steel sluice gate	5	Each	$3,000	$13,800	Every 25 yrs
Setback WCS Sluice gate	2	Each	$6,000	$13,800	Every 25 yrs
Setback - meander WCS Sluice gate	4	Each	$6,000	$27,600	Every 25 yrs

[1]Cost estimates include a 15% contingency

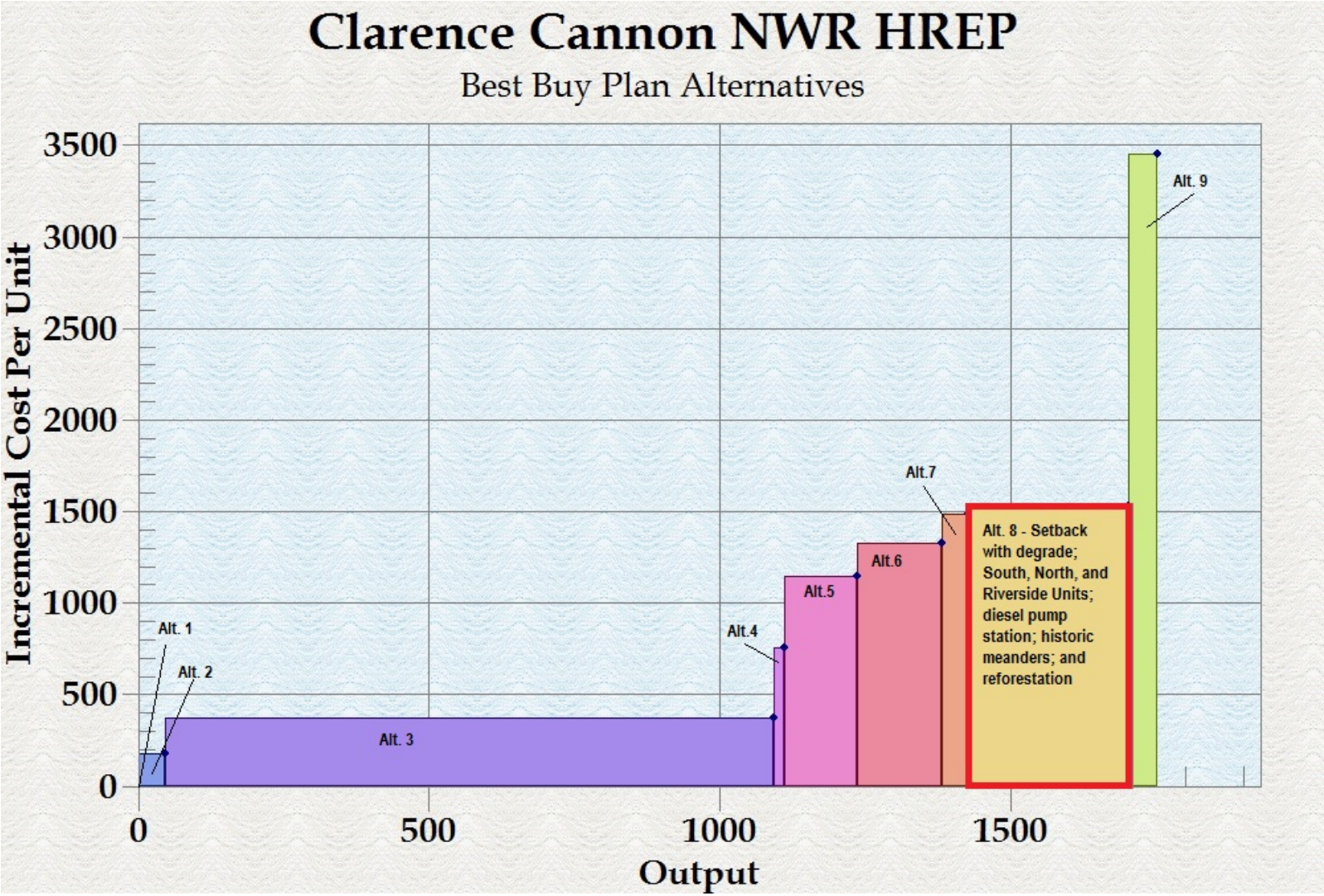

Figure 14. Incremental cost per output (net AAHUs) for the Clarence Cannon National Wildlife Refuge "Best Buy" Plans. Alternative 8 (tentatively selected plan) is highlighted.

Table 9. The project features that are incorporated into the 9 best buy alternatives and the average annualized total cost and output (net average annualized habitat units (AAHUs)) of each of these alternatives. The tentatively selected plan is bolded and shaded in gray; and includes the features from the alternatives listed above it.

Best Buy Alt. #	ICA Plan Code	Alternative Description - Additional feature added	Output (AAHU)	Annualized Cost[1]	Average Cost ($/AAHU)	Incremental Cost	Incremental Output	Incremental Cost/Output ($/Output)
1	A0B0C0D0E0F0G0H0	No Action	0.00	$0				
2	A3B0C0D0E0F0G0H0	+ Riverside Unit	47.66	$8,600	$180.44	$8,600	47.66	$180.44
3	A0B0C0D0E1F3G0H0	+ Setback with exterior berm degrade	1,093.56	$397,000	$363.03	$388,400	1,045.9	$371.35
4	A0B0C0D0E4F3G0H0	+ Restoration of historic meanders	1,110.67	$409,900	$369.06	$12,900	17.11	$753.95
5	A0B0C0D0E4F6G0H0	+ North Unit	1,236.87	$554,200	$448.07	$144,300	126.20	$1,143.42
6	A0B0C0D0E4F7G0H0	+ South Unit	1,382.92	$748,400	$541.17	$194,200	146.05	$1,329.68
7	A0B0C0D0E6F7G0H0	+ Reforestation	1,427.72	$815,000	$570.84	$66,600	44.80	$1,486.94
8	**A0B0C0D0E6F0G8H0**	**+ Diesel Pump Station**	**1,703.39**	**$1,236,500**	**$725.91**	**$421,500**	**275.67**	**$1,529.00**
9	A0B0C0D0E8F0G8H0	+ Excavation of existing water bodies	1,753.68	$1,410,000	$804.02	$173,500	50.29	$3,449.99

[1]Annualized cost (using May 2013 price estimates) includes initial construction and OMRR&R costs (including contingencies) based on a 50-year period of analysis, 3.75% interest rate (analysis conducted in FY 13 using FY 13 interest rate levels)

5.4 Plan Selection

The ICA Best Buy Alternatives (Table 10) were assessed by the PDT and USFWS on their ability to meet project objectives and achieve the four Planning and Guidance evaluation criteria identified in ER 1105-2-100. The four evaluation criteria are acceptability, completeness, effectiveness, and efficiency. The full definitions were provided to the team prior to evaluation; and the condensed definitions are provided below. For full definitions see ER 1105-2-100.

Acceptability is the workability and viability of the alternative with respect to acceptance by Federal and non-Federal entities and the public and compatibility with existing laws, regulations, and public policies. Two primary dimensions to acceptability are implementability and satisfaction.

Completeness is the extent to which an alternative provides and accounts for all necessary investments or other actions that ensure the realization of the planning objectives. *Effectiveness* is the extent an alternative alleviates the specified problems and achieves the specified objectives.

Efficiency is the extent to which an alternative is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment (P&G Section VI.1.6.2(c) (3)).

To allow for easier comparison, a matrix (Table 10) was prepared to rank each "best buy" alternative according to how well the alternatives met the evaluation criteria while considering the project objectives. The following is a discussion of the factors considered when ranking the alternatives.

Alternatives 1-2: These alternatives were not chosen because they do not improve aquatic ecosystem resources or improve water conveyance of the site (See flow diagram of existing conditions in Appendix D, *Hydraulics & Hydrology*). Alternative 2 would only reduce habitat fragmentation on a portion of the project area. These alternatives do a poor job at meeting project objectives; therefore were not selected.

Alternative 3: This alternative improves aquatic ecosystem resources through increased aquatic diversity and floodplain connectivity and improves external drainage through the construction of the setback berm with exterior berm degrade. This alternative however does not address the problems of habitat fragmentation or the inability to move water to mimic the seasonal cycle of spring flood, summer drawdown, and fall flood within the interior areas of the refuge, which is critical in restoring ecosystem resources by providing reliable food and habitat resources required for resident and migratory wetland species. In addition, the interior of the refuge would still be highly fragmented into individual parcels limiting wetland connectivity and ultimately ecosystem resources. The project partner felt that reducing habitat fragmentation and improving water conveyance throughout the entire project area is critical for refuge management. Furthermore, this alternative only improves ecosystem resources within the Riverside Unit (approximately 1/3rd of the entire project area); therefore fails to address the problems associated with the remaining project area and does not ensure success of the entire project area. Therefore, this alternative does not fully meet the project needs and objectives, and was not selected.

Alternatives 4: This alternative adds in the historic meanders which meet the objective of increasing floodplain topography; however, this alternative does not address the problems of the interior areas of the refuge; therefore was not selected.

Alternatives 5-6: These alternatives provide for new water control structures and berm degrades in the North and South Units, as well as restore emergent wetlands to areas of the berm degrades. These alternatives meet the objectives of improving water drainage, but fail to improve water delivery to the units. These alternatives meet the objectives of restoring emergent wetlands, but fail to restore floodplain forest; therefore were not selected.

Alternative 7: This alternative reduces habitat fragmentation and improves acreage of native wetland plant communities, both forested and emergent wetlands. This alternative also improves the aquatic ecosystem resources by improving aquatic diversity, floodplain topography, and floodplain connectivity. This alternative improves water drainage and water level management; however, fails to improve water delivery; therefore was not selected.

Alternative 8: With the addition of the diesel engine driven pump station, this is the first alternative that meets the project goal of improving water drainage and *delivery* internally and externally of the site which is key to ensure success of ecosystem restoration of the entire project area. The improved water conveyance system of a pump and water control structures deliver water required to reach target water levels within each management unit (see Appendix D, *Hydraulics and Hydrology*), remove floodwater to reduce negative effects associated with floodwaters ponding within the site, as well as meets all other project objectives. The PDT feels that the alternative meets the objectives at a reasonable cost (See last column in Table 9) as well as achieves all P&G evaluation criteria (See Table 10). The subsequent alternative also meets the objectives, but additional benefits are limited and not cost effective.

Alternative 9: This alternative adds in the feature of excavation of existing water bodies (*i.e.*, Crane Pond, Heron Pond, Buttonbush Pond, and Rabourn Slough). This feature would provide additional aquatic habitat diversity within the Riverside Unit and restore deep water areas within these water bodies; however, the construction of these areas is very expensive making this alternative less efficient.

5.4.1 Tentatively Selected Plan

The results of the NEPA analysis, incremental cost analysis, P&G criteria evaluation, and habitat evaluation in this chapter were considered with other factors, including physical features on the site, management objectives of the resource agency, critical needs of the region, and ecosystem needs of the UMRS were used in the decision making process. The Clarence Cannon NWR HREP team concluded that the alternative plan that best meets the goals and objectives of each agency and the UMRR-EMP program is alternative 8. This alternative is cost-effective and justified as a “Best Buy” plan.

Alternative 8 was selected by the PDT as the tentatively selected plan (Figure 15), and has the approval of the project partner, USFWS (letter of support provided in Appendix B, *Coordination*). This alternative best meets the study’s goal and objectives. The plan improves internal and external water drainage, management, and delivery. It reduces habitat fragmentation, increases floodplain connectivity and topography, and restores the wetland ecosystem on the site.

Table 10. Best buy alternatives evaluated on their ability to achieve the four Planning and Guidance Evaluation criteria and project objectives. The tentatively selected plan is bolded and shaded in gray.

Best Buy Alt.	Additional Feature Added	P&G Evaluation Criteria				Restore native wetland plant communities[1]	Improve aquatic ecosystem resources[2]	Improve water drainage and delivery[3]
		Acceptability	Completeness	Effectiveness	Efficiency			
1	No Action	Low	Low	Low	Low	No	No	No
2	+Riverside Unit	Low	Med	Low	Low	Low (H)	No	No
3	+Setback with exterior berm degrade	High	Med	Med	High	Low (H)	Med (A, FP)	Low (E)
4	+Restoration of historic meanders	High	Med	Med	Low	Low (H)	High (A, T, FP)	Low (E)
5	+North Unit	High	Med	Med	Med	Med (H, W)	High (A, T, FP)	Med (E, I)
6	+South Unit	High	High	Med	Med	Med (H, W)	High (A, T, FP)	Med (E, I)
7	+Reforestation	High	High	High	Med	High (H, F, W)	High (A, T, FP)	Med (E, I)
8	**+Diesel Pump Station**	**High**	**High**	**High**	**High**	**High (H, F, W)**	**High (A, T, FP)**	**High (E, I, D)**
9	+Excavation of existing water bodies	High	High	Med	Low	High (H, F, W)	High (A, T, FP)	High (E, I, D)

[1] Abbreviations: H = reduces habitat fragmentation; F = improves acreage of floodplain forest; W = improves acreage of non-forested wetland

[2]Abbreviations: A = improves aquatic diversity; T = improves floodplain topography; FP = improves floodplain aquatic connectivity

[3]Abbreviations: E = improves external drainage; I = improves internal drainage of management units; D = improves water delivery and water level management

5.4.2 National Ecosystem Restoration (NER) Plan

Engineering Regulation 1105-2-100 directs that Corps of Engineers ecosystem restoration projects should contribute to national ecosystem restoration. The NER Plan reasonably maximizes the cost of implementing other restoration options. In addition to considering the system benefits and costs, it also considers information that cannot be quantified such as environmental significance and scarcity, socioeconomic impacts, and historic properties information. Alternative 8 has an overall output of 1,703 Net AAHUs, and was identified as the Tentatively Selected Plan (Figure 15). While the other "Best Buy" alternatives evaluated for this project would partially address the goals and objectives of the project, the consensus of the interagency team was that Alternative 8 would reasonably maximize ecosystem restoration benefits for the greatest diversity of resident and migratory wetland and aquatic species, and that other considered alternatives would be less effective in meeting project objectives.

In addition, this alternative would maximize the rare opportunity to increase floodplain connectivity and restore a critical functional component of the floodplain ecosystem (*i.e.*, floodplain forest) on public lands by re-establishing a large (300 acres), self -sustaining contiguous tract of this cover type within CCNWR. Implementation of the proposed project features would improve the overall quality of the ecosystem within CCNWR, as well as surrounding areas, by improving ecosystem structure and function which are expected to provide benefits extending beyond the 50-year period of analysis. For these reasons, Alternative 8 is identified as both the NER Plan as well as the project partner's preferred plan.

5.4.3 Consistency with USACE Campaign Plan

The U.S. Army Corps of Engineers (USACE) has developed a Campaign Plan with a mission to "provide vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risk from disasters." This study is consistent with the USACE Campaign Plan. The second goal of the USACE Campaign Plan "Deliver enduring and essential water resources solutions…" is addressed by this study which collaborated with partners to develop a solution to the ecosystem degradation that has occurred from ponding floodwaters, habitat fragmentation, and disconnection from the main channel river. This solution should produce lasting benefits for the nation with the proper OMRR&R. The tentatively selected plan is also consistent with the third goal "Deliver innovative, resilient, sustainable solutions…". This study addresses the goal through the application of the planning process to formulate, analyze, and evaluate alternative designs in pursuit of a sustainable, environmentally beneficial, and cost-effective ecosystem restoration design.

5.4.4 Consistency with USACE Environmental Operating Principles

The U.S. Army Corps of Engineers has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" (EOP) applicable to all its decision-making and programs. The formulation of alternatives considered for implementation met all of the principles. However, as a function of the entire Upper Mississippi River Restoration-Environmental Management Program, the only principle not met fully is EOP#1 – Foster sustainability as a way of life throughout the organization. Sustainability is a goal of any Corps project. This project, as a part of the Upper Mississippi River restoration, is just one part of many pieces that in their entirety, or cumulatively, lead to a more sustainable end result. Therefore, as a standalone project, in the context of Upper Mississippi River restoration, this project falls short of EOP #1 because it does not address the entire system, but when added to other near-term, long-term, and other ongoing efforts, it provides its share of reaching sustainability.

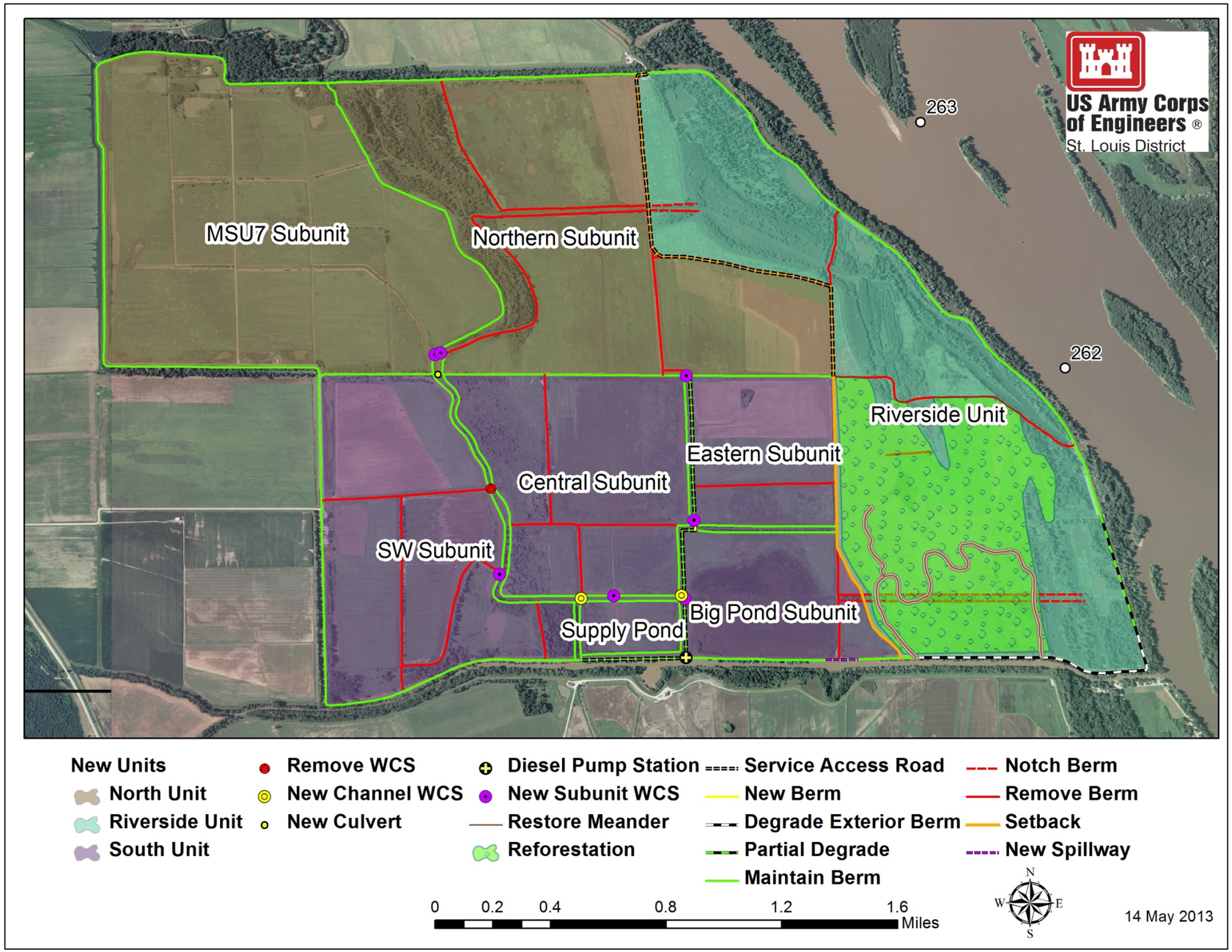

Figure 15. The features required for the tentatively selected plan

Chapter 6 Environmental Consequences*

Chapter 2 identified the existing conditions of the resources at Clarence Cannon National Wildlife. Chapter 6 describes the environmental consequences of the proposed action alternatives and is organized by the same resource topics as described in Chapter 2. The depth of analysis of the alternatives corresponds to the scope and magnitude of the potential environmental impact. This chapter provides the scientific and analytic basis for the comparisons of the alternatives and describes the probable consequences (impacts, effects) of each alternative on the selected environmental resources. The purpose of characterizing the environmental consequences is to determine whether the resources, ecosystems, and human communities of concern are approaching conditions where additional stresses will have an important cumulative effect (CEQ 1997).

The tentatively selected plan would result in positive long-term benefits to emergent wetland, forested wetland, and aquatic habitat in and around CCNWR (Table 11). The project would result in some conversions of cover types, but the resulting changes would provide habitat to a greater diversity of species. 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 properties are anticipated.

This chapter compares the effects of the following considered alternatives described in Chapter 4:

- Alternative 1 (No Action Alternative)
- Alternative 8 (Tentatively Selected Plan)
- Alternative 9

Besides the No Action Alternative and Alternative 8 (the tentatively selected plan), the effects of Alternative 9 are also examined. This is because this alternative contains a feature (*i.e.*, excavation of existing water bodies) that is not present in Alternative 8. Unless otherwise stated only this additional feature's potential effects are described and other effects are assumed to be the same as Alternative 8. Alternatives 2-7 will not be discussed explicitly because Alternative 8 contains all of the features that would be in these alternatives and is assumed the effects would be the same. When environmental effects of these alternatives are the same, they will be discussed collectively.

Table 11. Summary and comparison of long-term environmental effects of considered alternatives.

		No Action	Alternative 8 (Tentatively Selected Plan)	Alternative 9
Natural Resources	Floodplain Habitat	Negative	Positive	Positive
	Aquatic	Negative	Positive	Positive
	Geology & Soils	No Effect	Minor	Minor
	Wildlife	Negative	Positive	Positive
	MO Species of Concern	Negative	Positive	Positive
	T&E Species	Negative	Positive	Positive
	Fisheries	Negative	Positive	Positive
	Water Quality	Negative	Positive	Positive
	Air Quality	No Effect	No Effect	No Effect
	HTRW	No Effect	No Effect	No Effect
Historic & Cultural Resources		No Effect	No Effect	No Effect
Socioeconomics		No Effect	Positive	Positive
Aesthetics		No Effect	Positive	Positive
Noise Levels		No Effect	No Effect	No Effect

6.1 Natural Resources

6.1.1 Floodplain Habitat

Beneficial impacts to floodplain habitat resources under the considered action alternatives include decreased habitat fragmentation and improved forested and emergent wetlands.

Impacts of No Action Alternative - Under the No Action Alternative, floodwaters that overtop the exterior berm would continue to pond on the interior. These floodwaters would be drained through the large water control structure along the river and the existing pump station. Floodplain forest would continue to be negatively impacted by overtopping flood events and resulting prolonged inundation. Inability to drain spring floods and inadequate water conveyance to provide the summer drawdowns at the site limit food production needed for fall migrants and degrade wetland plant communities. These factors would result in continued declines of ecosystem structure and function. The persistent wet conditions would continue to promote reed canary grass domination which shades and crowds out tree seedlings preventing natural regeneration and native wetland species establishment. The existing fragmented management units would continue to prevent habitat connectivity, and aquatic connectivity between adjacent units would still be restricted. Overall, the quantity and quality of the existing floodplain habitat resources would continue to decline due to poor water management capabilities and reed canary grass invasion.

Impacts of Considered Action Alternatives - Positive impacts would result primarily from the increased water level management, setback, and approximately 300 acres of reforestation. Reducing habitat fragmentation by degrading interior berms and constructing larger capacity water control structures would result in larger contiguous management units improving habitat connectivity. The increased pumping capacity would allow the site to remove floodwaters quicker as well as more naturally mimic the historic hydrograph of spring flood, summer drawdown, and minor fall flooding; which will improve invasive plant species management (*i.e.*, reed canary grass).

The location of the setback with exterior berm degrade was chosen to avoid impacts to mature forest. No trees are located on the existing exterior berm, and the direct impacts of degrading the exterior berm will be done to minimize loss of mature trees; however, there is a slight chance that some trees on the riverside of the berm may be removed to allow for the construction activity to occur. Minor impacts resulting from the tree removal would be outweighed by the benefit of increasing connectivity between the floodplain and the Mississippi River. Degrading the existing exterior berm would reduce the length of time the existing forest is flooded when the exterior berm is overtopped. This would greatly reduce the risk of tree mortality from ponded floodwaters thus protecting the remaining mature forests.

The degrading of the interior berms to reduce habitat fragmentation would result in short-term negative effects on wetlands due to excavation and clearing caused by construction equipment. However, disturbed sites would be restored to native wetland vegetation resulting in overall improvement. The location of the setback follows existing roads, berms, and/or higher ground resulting in minimal loss of existing wetlands. Degrading of the existing exterior berm would result in short-term disturbance due to construction activity, but the disturbed sites would be restored with native wetland vegetation. The restoration of the historic meanders would convert approximately 21 acres of agricultural fields to aquatic habitat as a result of the excavation. The footprint of water control structures would be located within the proximity of existing structures which will be removed; therefore, no additional loss of wetland habitat is expected.

Improved water conveyance from the new water control structures and pump station would allow the site to provide predictable water level management and improves site hydrology (See Appendix D,

Hydraulics and Hydrology for depiction of future water flow) This would facilitate development of quality wetland habitats and aid in management and reduction of invasive plant species.
Overall, the long-term effects of the considered action alternatives would have positive effects to the forested and non-forested floodplain habitats.

6.1.2 Aquatic Resources

Impacts of No Action Alternative - Within the interior, backwater sloughs and lakes were historically connected to the river through the annual flood pulse; however, the exterior berm prevents this historic floodplain connectivity. Without the project, the area's interior aquatic resources would likely remain the same as they are today: shallow, low flow, and low dissolved oxygen. In addition, only 8.97 AAHUs were derived for this alternative through the AHAG analysis (Appendix E, *Habitat Evaluation & Quantification*).

Impacts of Alternative 8 (Tentatively Selected Plan) - Short-term negative impacts to aquatic resources, such as increased water turbidity, would be expected due to construction activities. In the long-term the project would improve aquatic resources. Specifically, the setback would restore the connectivity of the Mississippi River to approximately 800 acres of floodplain. This would allow aquatic organisms access to the flooded habitat providing benefits to the project area as well as the Mississippi River. Restoration of the historic meanders would increase aquatic connectivity of these old meanders to Bryants Creek, increase floodplain topographic diversity, and promote additional aquatic habitat within the project area, generating 395.26 AAHUs from the AHAG analysis (Appendix E, *Habitat Evaluation & Quantification*). The reforestation would provide shade and wind breaks for the restored historic meanders benefiting water temperature and reducing wind-induced wave action.

Impacts of Alternative 9 - Alternative 9 provides an additional feature not included in Alternative 8, which is excavation of existing water bodies (*i.e.,* Crane Pond, Rabourn Slough, Buttonbush Pond, and Heron Pond). The excavation would improve aquatic depth in these water bodies and provide seasonal refugia for a suite of aquatic organisms. This alternative generated 454.52 AAHUs from the AHAG analysis (Appendix E, *Habitat Evaluation & Quantification*).

6.1.3 Geology and Soils

Impacts of No Action Alternative - No major impacts to geology and soils would be expected, although breaches and adjacent scour would continue to occur with overtopping flood events. No impacts to prime farmland would be expected.

Impacts of Considered Action Alternatives - Temporary, minor impacts to geology and soils would be expected due to construction activities and project features. Construction of the setback, excavation of channels, berm degrades, and use of borrow areas would impact existing topography and drainage. Improved drainage would allow for summer drawdowns which would improve soil compaction and bulk density. Connectivity between units would have minimal effects on soil characteristics. Sediment loads from the Mississippi River may be deposited in the Riverside Unit during flooding.

No impacts to acres that qualify as prime farmland would be expected because these acres are currently forested and not farmed; therefore, the project will not contribute to conversion of farmland to nonagricultural uses. Areas designated as prime farmland are currently in forest and will remain in forest.

6.1.4 Wildlife

Impacts of No Action Alternative - Wetland wildlife would be negatively impacted through the continued degraded ecosystem structure and function within the project area, including emergent

wetlands, forested wetlands, and aquatic resources. With continued degradation of ecosystem function and structure, wetland wildlife use of the area is expected to decline if no improvements are made. No net AAHUs were generated for this alternative from the WHAG analysis (Appendix E, *Habitat Evaluation & Quantification*).

Impacts of Considered Action Alternatives - Due to improved water conveyance and water level management, native wetland plants would increase habitat quality and also result in increased food resource production and access for a variety of resident and migratory wetland species. Reforestation would result in an increase in forest diversity and mast production, benefitting a variety of wetland wildlife resources. Construction activity may lead to short-term negative effects as well as indirect effects to wildlife. Wildlife would most likely avoid or be displaced from the areas under construction. However, the long-term impacts of the proposed project features should off-set any short-term or indirect effects caused by construction by providing improved habitat and ecosystem resources for wildlife resources. The Tentatively Selected Plan generated a total of 1,308 net AAHUs from the WHAG analysis (Appendix E, *Habitat Evaluation & Quantification*).

6.1.5 Missouri Species of Concern

The American Bittern, Common Moorhen, King Rail, Least Bittern, Little Blue Heron, Marsh Wren, Sora, and Virginia Rail have similar wetland habitat including preference for freshwater marshes with emergent vegetation. These species prefer grasses, sedges, rushes, and cattail interspersed with woody vegetation and open water. Given the similar habitat, impacts for these species would be similar and will be discussed collectively as "marsh birds". Impacts to the Mississippi Kite which prefers riparian forests near grasslands and the Bald Eagle which has been known to nest at CCNWR will be discussed individually.

Impacts of No Action Alternative - Similar to other wildlife, marsh birds, Mississippi Kite, and Bald Eagle are negatively impacted by disturbed and degraded ecosystem structure and function that would continue to exist under the No Action Alternative.

Impacts of Considered Action Alternatives - Collectively, short-term negative effects may occur to these species due to construction activities. However, the long-term positive effects should off-set these short-term effects by providing improved habitat and ecosystem resources for Missouri species of concern.

Marsh Birds - Reducing habitat fragmentation via interior berm degrades and improving emergent wetland habitats through improved water conveyance and drainage as well as reduce habitat fragmentation of the site should result in positive effects to marsh birds.

Mississippi Kite - Reforestation will provide a larger contiguous tract of floodplain forest and is expected to have a positive effect to this species which prefers to nest and roost in riparian forest.

Bald Eagle - There are known active nests within the project area and eagles frequently utilize the site. Because new nests may be built or old nests abandoned, consultation with the USFWS will continue throughout the design and construction phase to ensure no eagles are impacted. Visibility of construction activities is a factor because, in general, eagles are more prone to disturbance when an activity occurs in full view. USFWS (2007) recommend that activities be shielded (*e.g.*, rolling topography, trees, etc.) from full view of the nest to reduce disturbance. The National Bald Eagle Guidelines issued in 2007 by USFWS indicate:

1) If the activity will be visible from the nest, then 660-foot landscape buffers are recommended.
2) If the activity will not be visible from the nest, then any clearing, external construction and landscaping between 330 feet and 660 feet of nest should be done outside breeding season.

3) Avoid clear cutting or removal of overstory trees within 330 feet of the nest at any time.

During planning, the proposed project features are not located within the 660-ft buffer for known nests. During each design phase, the project partner will be consulted and if necessary, site visits conducted, to determine the location of all nests and determine if they are active as defined in the USFWS guidelines. The plans and specs would delineate the 660 ft. area and include timelines (December - August) to avoid all active nests and minimize effects to this species during the breeding season (USFWS 2007). In the long-term the proposed project features would improve the wetland habitat and ecosystem resources which are expected to result in positive effects to this species.

6.1.6 Federally Threatened and Endangered Species – Biological Assessment

In accordance with the Endangered Species Act a list of Federally Threatened and Endangered animals and plants was obtained from the USFWS. This satisfies the "request for species list requirements" for ESA Section 7 Consultation. This section along with Section 2.6 will also serve as the effects determination portion of the Biological Assessment required by the Endangered Species Act. The Gray Bat, Indiana Bat, Decurrent False Aster, and Fat Pocketbook, are listed as federally threatened or endangered, and the Northern long-eared bat is a proposed endangered species for Pike County, Missouri.

Gray Bat

Impacts of No Action Alternative - No caves would be impacted by the No Action Alternative or any of the considered alternatives. Project alternatives would have no affect to gray bat winter hibernation or summer roosting locations. However, many habitats suitable for foraging exist within the project area and would continue to degrade if no action is taken. Thus, gray bat habitat would be negatively impacted by the continued degradation of existing ecosystem resources in the project area.

Impacts of Considered Action Alternatives - Clarence Cannon National Wildlife Refuge does have suitable foraging habitat. The project may affect, but is not likely to adversely affect gray bat due to construction activities associated with the interior and exterior berm degrades, and setback construction. Existing bottomland forest habitat would benefit from the setback which would provide additional summer roosting and foraging habitat.

Northern long-eared Bat

Impacts of No Action Alternative - Many habitats suitable for Northern long-eared Bat exist within the project area and would continue to degrade if no action is taken. Thus, Northern long-eared bat habitat would be negatively impacted by the continued degradation of the existing ecosystem resources in the project area.

Impacts of Alternative 8 (Tentatively Selected Plan) - The project may affect, but is not likely to adversely affect Northern long-eared Bat due to construction activities associated with the interior and exterior berm degrades. In order to avoid adverse effects to summer roosting Northern long-eared bats, the USFWS guidance will be followed which includes: no tree clearing from April 1 to September 30. To avoid the potential "take" of endangered Indiana bats, tree clearing to degrade the external berm or forested interior berms would occur outside this time frame. Aside from tree clearing, existing bottomland forest habitat would benefit from the setback which would provide additional summer roosting habitat.

Impacts of Alternative 9 - This alternative may affect, but is not likely to adversely affect Northern long-eared bat due to construction activities associated with excavation of the existing water bodies. No tree clearing is associated with the excavation and USFWS guidance will also be followed; therefore, construction activities should only temporarily disturb any bats in the area.

Indiana Bat

Impacts of No Action Alternative - Many habitats suitable for Indiana Bat exist within the project area and would continue to degrade if no action is taken. Thus, Indiana bat habitat would be negatively impacted by the continued degradation of the existing ecosystem resources in the project area.

Impacts of Alternative 8 (Tentatively Selected Plan) - The project may affect, but is not likely to adversely affect Indiana Bat due to construction activities associated with the interior and exterior berm degrades. In order to avoid adverse effects to summer roosting Indiana bats, the USFWS guidance will be followed which includes: no tree clearing from April 1 to September 30. To avoid the potential "take" of endangered Indiana bats, tree clearing to degrade the external berm or forested interior berms would occur outside this time frame. Aside from tree clearing, existing bottomland forest habitat would benefit from the setback which would provide additional summer roosting and foraging habitat.

Impacts of Alternative 9 - This alternative may affect, but is not likely to adversely affect Indiana bat due to construction activities associated with excavation of the existing water bodies. No tree clearing is associated with the excavation and USFWS guidance will also be followed; therefore, construction activities should only temporarily disturb any bats in the area.

Decurrent False Aster

Impacts of No Action Alternative - Based on observations by the project partner, no documentation of this plant has occurred in the project area; the no action alternative would have no affect on the species.

Impacts of Considered Alternatives - The setback will reconnect the floodplain to the Mississippi River. This area may experience scour and deposition providing suitable habitat for decurrent false aster to colonize. The considered alternatives may affect (beneficially) the decurrent false aster.

Fat Pocketbook

The fat pocketbook has not been found in or adjacent to the project area, consequently the No Action Alternative and the considered action alternatives will not likely adversely affect the species.

6.1.7 Fisheries

Impacts of No Action Alternative - The fisheries throughout the project area would likely continue their gradual decline. The fisheries resources would continue to be poor due to the lack of connectivity with the river (except during overtopping flood events). Without the project, the fisheries resources would continue to degrade and fish species diversity is expected to decline and become dominated by species tolerant of harsh aquatic conditions.

Impacts of Alternative 8 (Tentatively Selected Plan) - The proposed features would have a positive effect on fish populations. Restoring the historic meanders would provide a persistent connection between these meanders and Bryants Creek. This would provide additional aquatic habitat that is currently limited within the project area. Fisheries resources within Bryants Creek may experience a one-time negative effect during construction of the historic meanders due to disturbance (e.g. noise and turbidity) where the meanders connect with the Creek; however, in the long-term, the benefits of restoring the historic meanders and providing additional aquatic habitat to the project area, which is currently limited, would improve fisheries resources. The setback would increase the area available to the annual flood pulse and fish spawning along the Mississippi River. Based on investigating the hydrograph from the past 70 years, it is estimated that the setback area would flood 85% of those years. This would provide fish access to inundated emergent herbaceous and woody vegetation providing beneficial habitat for many life stages (*e.g.,* spawning, rearing, and foraging) of native fish species. It is

expected that the setback's benefits to the fisheries resources would extend beyond the project area into Bryants Creek and the Mississippi River.

Impacts of Alternative 9 - Excavating the existing water bodies (*i.e.,* Crane Pond, Rabourn Slough, Buttonbush Pond, and Heron Pond), would provide additional deepwater habitat which would provide additional seasonal refugia for fish and other aquatic species. Construction activities would lead to short-term negative effects to fisheries resources due to increased turbidity; however, the long-term impacts of the proposed project features should off-set any short-term effects caused by construction by providing improved aquatic habitat through increased depth and connectivity benefiting fisheries resources.

6.1.8 Water Quality

Impacts of No Action Alternative - The project area's water quality would likely remain similar to current conditions. The interior water bodies would continue to have low dissolved oxygen, shallow depth, and be isolated from the river.

Impacts of Alternative 8 (Tentatively Selected Plan) - Long-term water quality improvements would occur as a result of improved water management and reforestation. Improved water management would allow for summer drawdowns to consolidate sediment which reduces re-suspension and lowers turbidity promoting aquatic plant growth. Reforestation would decrease sun and wind exposure. The setback reconnects over 800 acres of floodplain to the Mississippi River which is expected to provide some improvements to water quality outside the project area. The wetlands in the setback area would act as a filter which is expected to reduce sediment and nutrient loading during flood events. Short-term minor increases in turbidity would occur due to construction activities. A Clean Water Act Section 402 Storm Water Permit and Best Management Practices will be followed in order to minimize water quality impacts during construction.

Impacts of Alternative 9 - A short-term increase in turbidity is likely to result during excavation of the existing water bodies. The long-term effects should result in improved water quality of these water bodies through increased depth and by improving dissolved oxygen and temperature.

6.1.9 Air Quality

Impacts of No Action Alternative - The project area's air quality would likely remain similar to current conditions.

Impacts of Considered Action Alternatives - Minor, temporary increases in airborne particulates are anticipated to occur as a result of mobilization and use of construction equipment. The pumps to be used to manage water levels will be diesel; consequently, air quality will be affected for a short-time by diesel fumes during pumping activities. 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 Pike County, Missouri.

6.2 Hazardous, Toxic and Radioactive Waste

Impacts of No Action Alternative - No HTRW impacts would be expected.

Impacts of Considered Action Alternatives - A short-term risk for a fuel spill during construction activities would exist. 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 for the project, a slight risk of a diesel fuel spill would exist at the proposed pump station. A containment berm would be built around the diesel tanks if any future spills occurred. Additionally, the diesel fuel storage tank would be

removed prior to major flood events. If a spill or damage to the tank occurred as a result of flooding, unforeseen circumstances, or regular maintenance activities, natural resources would be impacted.

6.3 Historical and Cultural Resources

Impacts of No Action Alternative - No impacts to cultural or historical resources are anticipated.

Impacts of Considered Action Alternatives - The various alternatives include a variety of features. Proposed features include vegetative plantings, installing water control structures, setback construction, interior berm degradation, installing a pump station, and restoring historic meanders. Some of these features would result in new ground disturbance. No features in any of the considered alternatives are expected to negatively impact the historic or cultural resources of the site due to the area's past intense agricultural practices and ground disturbances.

A pedestrian archaeological reconnaissance survey of the identified sites in the 1992 study was conducted by James Barnes, USACE MVS District Archaeologist, in September 2011 to determine if proposed project features, primarily the setback, would impact the documented historic and cultural resources. No artifacts were found; therefore, it was determined that the proposed setback would not impact the site. A letter dated 30 January 2012 was sent to the Missouri State Historic Preservation Office (SHPO) describing the project. USACE received a letter dated 5 March 2013 from the SHPO concurring with the recommendation that there will be no historic properties affected by the project and have no objection to the initiation of the project activities (Appendix B, *Correspondence*). If project plans change, information documenting the revisions will be resubmitted to SHPO for further review.

There is potential for historical shipwrecks to be buried near the river and the exterior berm. The proposed exterior berm degrade and spillway construction would result in ground disturbance, but primarily with material within the existing berm itself. Based upon the potential impacts of proposed construction activities, the documented resources in the project area, and the potential for previously unrecorded resources, the proposed project is unlikely to have any impacts to historic properties. Should resources be found during construction, investigation and consultation with the Missouri Historic Preservation Office will be pursued to avoid or mitigate any impacts to historic properties.

The results of tribal coordination efforts resulted in a response letter received from the Osage Nation dated 30 November 2012 (Appendix B, *Correspondence*) requesting to receive copies of any cultural resource survey reports regarding the project; and anticipates reviewing and commenting on any materials for the proposed project in the future. The District will continue to consult with the Osage Nation as the project goes forward.

In the event any cultural properties are located, these will be evaluated for National Register eligibility, in consultation with the Missouri Historic Preservation Officer, and appropriate mitigation completed before construction. If sites will be impacted, the tribes who have indicated they have an interest in the area will be contacted, and consultation will 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) will be followed on Federal lands.

6.4 Socioeconomic Resources

Impacts of No Action Alternative - No impact to socioeconomic resources would be expected. Human use of the project area would likely continue to decline as the ecosystem resources degrade. Additionally, future overtopping flood events would prevent public access to the project area for extended periods of time.

Impacts of Considered Alternatives - The considered alternatives have no measurable impacts on community cohesion; property values; industrial growth; life, health and safety; or privately owned farms. 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 project area, but could also create short-term employment opportunities.

Employment opportunities are evaluated using the U.S Army Corps of Engineers (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. This model will be used as a means to document the performance of direct investment spending of the USACE as directed by the American Recovery and Reinvestment Act (ARRA).

The analysis evaluated economic impacts at three levels of geography: region, state, and nation. For this project, the region and state impact areas are: Rural Area of the State of Missouri.

The USACE is planning on expending an average of $1,251,800 on this project annually (May 2013 price estimate). Of this annual project expenditure, $661,000 will be captured within the regional impact area. The remainder of the expenditure will be leaked out to the state or the nation. Construction funds expended on various services and products are expected to generate additional economic activity featured in both output and jobs (Table 12).

Table 12. Summary of economic impact of the $1,251,800 in average annual construction funding on the region, state, and nation during project construction

	REGION	STATE	NATION
Local Capture	$661,000	$1,019,000	$1,246,000
Total Output	$897,000	$1,927,000	$3,484,000
Total Jobs	11	15	17
Total Labor Income	$439,000	$854,000	$1,390,000
Total GRP	$555,000	$1,152,000	$2,006,000

6.5 Aesthetic Resources

Impacts of No Action Alternatives - A decline in aesthetics may occur due to degrading habitat, declining wildlife populations, and further expansion of reed canary grass requiring more mechanical and chemical control.

Impacts of Considered Alternatives - Short-term impacts would occur with construction equipment and soil disturbance. In the long-term, aesthetic resources would improve as a result of vegetative plantings, reduction in reed canary grass, higher quality habitat, and increased wetland wildlife.

6.6 Noise Levels

Impacts of No Action Alternative - No change in noise levels would be expected.

Impacts of Considered Action Alternatives - The construction of the considered action alternatives would generate a temporary increase in noise levels. This may lead to temporary displacement of some wildlife species. No long-term impacts would be expected.

6.7 Environmental Justice

Impacts of No Action Alternative - No change in environmental justice would be expected.

Impacts of Considered Action Alternatives - No differential impacts to minority or low income populations are expected with any of the action alternatives. Short-term increases in employment could be realized during construction.

6.8 Probable Unavoidable Adverse Impacts (on all resources)

Temporary, unavoidable adverse impacts including increased turbidity, noise, and clearing of vegetation would result from construction activities. Turbidity and noise levels would return to normal when construction is completed and vegetation established. Borrow areas, constructed berms, and any other disturbed areas would be re-vegetated after construction with native vegetation. However, benefits to floodplain habitat, wildlife, aquatic resources, water quality, fisheries and endangered species would outweigh these unavoidable adverse impacts.

6.9 Relationship of Short-Term Uses and Long-Term Productivity (on all resources)

Construction activities would temporarily disrupt fish, wildlife, and human recreational use in the immediate vicinity of the project area. Construction activities would likely provide positive, short-term economic opportunities and a few jobs for the surrounding communities. Degrading the existing exterior berm may remove approximately 13 acres of floodplain forests that currently exists on the riverside of the exterior berm. In the long-term, the 300 acres of proposed reforestation would improve the remaining forest diversity and increase mast production. Overall, the long-term health and productivity of the project area's ecosystem is anticipated to increase with the project. Additionally, the ecosystem benefits served by the project would increase. Therefore, short-term human use impacts would be offset by long-term increases in productivity.

6.10 Irreversible and Irretrievable Commitment to Resources (on all resources)

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 will temporarily disrupt natural resource productivity. The construction activities signal an irretrievable loss in exchange for the benefits of the habitat improvements.

Chapter 7 Cumulative Effects*

This chapter 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 projects or actions. Cumulative effects are not caused by a single project, but 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, decision-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 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 Clarence Cannon National Wildlife Refuge Habitat Rehabilitation and Enhancement Project followed these 11 steps, shown in Table 13. The following subsections are organized by the three main components – scoping, describing the affected environment, and determining the environmental consequences.

Table 13. CEQ's Approach for Assessing Cumulative Effects

Component	Steps
Scoping	1. Identify resources
	2. Define the study area for each resource
	3. Define time frame for analysis
	4. Identify other actions affecting the resources
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 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 14. 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.

Navigation Pool 25 governs the hydrology of the floodplain and is thus a natural geographic boundary for several of the resources identified in Table 14, while for other resources the entire watershed for the area was used (Figure 16; The Sny Watershed HUC 07110004). In addition to Clarence Cannon National Wildlife Areas, there are several protected areas within The Sny watershed (Figure 16).

Table 14. Geographic Boundaries for Cumulative Effects

Resource	Geographic Boundary
Floodplain Habitat	The Sny Watershed
Aquatic	Pool 25 Watershed
Geology & Soils	Pike County
Wildlife	The Sny Watershed
MO Species of Concern	Total range
Threatened & Endangered Species	Total range
Fisheries	Pool 25 Watershed
Water Quality	Pool 25 Watershed
Air Quality	Pike County
HTRW	Pool 25 Watershed
Historic & Cultural Resources	Pike County
Socioeconomics	Pike County
Aesthetics	Pike County
Noise Levels	Pike County

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 ends in 2065 (end of 50 year period of analysis for project).

7.2.2 Identifying Past, Present, and Reasonably Foreseeable Future Actions

Chapter 2 described the condition of each resource by describing the existing condition and providing historical context for how the resource got to its current state. The PDT used information from field surveys, discussions with project partner, and literature searches to assess the existing conditions of the resource.

To identify present and reasonably foreseeable actions, the PDT compiled information from the project partner, state agencies, and other comments received during the scoping process.

“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
- Actions where budgets have been requested

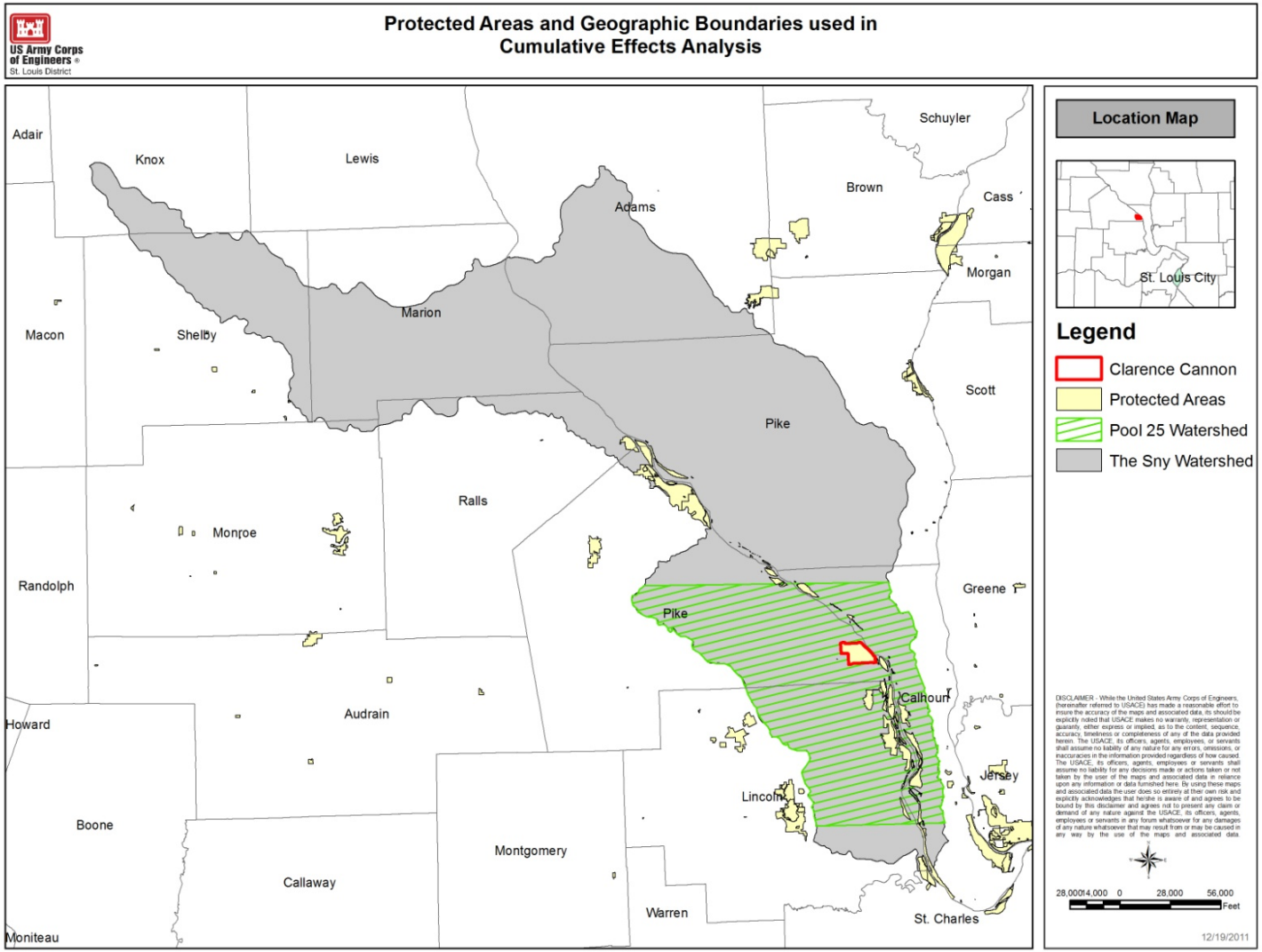

Figure 16. Geographic boundary scopes used in cumulative effects analysis for Clarence Cannon National Wildlife Refuge. Protected areas are also depicted.

Based on these criteria, the following projects were identified as being reasonably foreseeable and were included in this cumulative effects analysis:

- Permitted Projects: From 1995 to 2011, 282 permits were issued which had impact to aquatic resources within the vicinity of the Pool 25 Watershed. Of these, 83% fell under a nationwide permit, 11% were a regional general permit, and 6% were a standard permit. The most common nationwide permit issued was for bank stabilization (NWP 13), linear transportation crossings (NWP 14), and stream and wetland restoration (NWP 27). Forecasting future permit activities is not well developed; therefore, it is assumed that future permit activities within the Pool 25 watershed would be similar to the period from 1995 to 2011.
- Master Plan for the Mississippi River (RM 300-0): Identifies all known plans for new channel improvement structures or modifications to existing structures within the St. Louis District USACE through the year 2014. In Pool 25, 23 areas of revetment (5.2 miles) are planned and 30 new river training structures. Most of the planned river training structures are downstream of CCNWR HREP. In the vicinity of the project area, one dike (RM 266.0L), one chevron (RM 265.7R), and one bullnose dike (RM 261.3L) are planned.
- Environmental Restoration Projects within Pool 25:
    - UMRR-EMP Batchtown State Fish and Wildlife Management Area (In Construction)
    - UMRR-EMP Ted Shanks Conservation Area (In Construction)
    - UMRR-EMP RipRap Landing (In Planning)
    - UMRR-EMP Red's Landing (Proposed)
    - UMRR-EMP Pools 25 & 26 Islands (In Construction)
    - B.K. Leach State Conservation Area (restoration efforts conducted by MDC)

The Clarence Cannon National Wildlife HREP complements these present and future actions. Even though some permitted activities allow for impacts to wetlands, others allow for wetland and stream restoration activities which complement the efforts to improve habitat and wildlife resources within the vicinity of Navigation Pool 25 of the Mississippi River.

7.3 Cumulative Effects by Resource

The remainder of this chapter describes the results of the cumulative effects analysis for each of the considered resources from Chapters 2 and 6. Table 15 is a checklist identifying potential incremental cumulative effects on the resources affected by Clarence Cannon National Wildlife Refuge HREP. If a resource was not identified to have a cumulative effect then this resource was not discussed in detail within the chapter (see Table 15). The cumulative effects analysis discusses future conditions as follows:

- Without the project – No Corps Action
- With the project – All considered action alternatives (including tentatively selected plan) are discussed as a whole unless otherwise noted.

Table 15. Checklist for identifying potential cumulative effects of CCNWR HREP

Resource	Without Project	With Project		Past Actions	Other Present Actions	Other Future Actions	Project's Incremental Cumulative Impact
		Construction	Operation				
Floodplain Habitat	S	S[1]	+	H	+	◆	+
Aquatic	S	S[1]	+	H	+	◆	+
Geology & Soils	◆	S[1]	◆	M	◆	◆	◆
Wildlife	S	S[1]	+	M	+	◆	+
MO Species of Concern	S	S[1]	+	M	◆	◆	+
T&E Species	M	S[1]	+	H	◆	◆	+
Fisheries	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 wetland resources within the Sny watershed through floodplain disconnection, floodplain constriction, agricultural practices within the floodplain, elevated water table, and altered hydrology due to lock and dam construction, and spread of invasive species. Resource managers have projected the continued decline and identified a need for improved management of floodplain forests, including bottomland hardwoods, within the watershed (Theiling *et al.* 2000). Additionally, the predominance of agriculture within the watershed is likely to remain into the foreseeable future.

Without Project: The density, diversity, and quality of the bottomland forest and wetland plants would continue to decline within Clarence Cannon National Wildlife Refuge which would also lead to declines in wetland habitat within the surrounding watershed. The gradual deterioration of the wetland habitat would have a negative impact on the management of the project area and its contribution to wetland resources within the Sny watershed.

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 wetland habitat within Clarence Cannon National Wildlife Refuge and will contribute to improving habitat within the watershed.

7.3.2 Aquatic

Past and present actions have degraded aquatic resources within Pool 25. Many cumulative effects are discussed in the Navigation Study by WEST (2000) and will not be repeated here. In summary, the assessment acknowledges the tremendous changes brought about by the construction of the 9-foot

Channel Project in conjunction with other impacts occurring throughout the watershed resulting in declines in fish, submerged aquatic vegetation, and backwaters/secondary channels.

Without Project: The existing water bodies within the project area (*i.e.*, Crane Pond, Buttonbush Pond, Heron Pond, and Rabourn Slough) would continue to degrade due to lack of connectivity with the main channel of the Mississippi River and sedimentation. The gradual deterioration of aquatic resources would have a negative impact on the management of the project area and its contribution to aquatic resources within Pool 25.

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. Present and proposed restoration efforts, including the considered action alternatives, will improve the aquatic conditions within the watershed.

7.3.3 Wildlife

Clarence Cannon National Wildlife Refuge 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 in the North American Waterfowl Management Plan as a habitat of major concern. Past actions within the watershed have deteriorated the physical habitat (both aquatic 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 gradual deterioration of the physical habitat (both aquatic and wetland) within the refuge would have negative impacts on the management of the project area and its contribution to wildlife resources within the Sny watershed. With no improvements to ecosystem function and structure, wetland wildlife use of the project area is expected to decline. It is also expected that with the declines in wildlife use within the refuge, the public use of the project area would also decline.

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 considered action alternatives aim to restore and improve the ecosystem which will provide positive effects to the wetland wildlife resources using the refuge. The considered action alternatives, along with other present and foreseeable future restoration projects, will have a positive impact to the wetland wildlife resources within the watershed.

7.3.4 Missouri Species of Concern

Several Missouri species of concern are identified for Pike County, Missouri (see sections 2.1.5 and 6.1.5 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.*, American Bittern, Common Moorhen, King Rail, Least Bittern, Little Blue Heron, Marsh Wren, Sora, and Virginia Rail) prefer freshwater wetlands with emergent vegetation. 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 Missouri 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 Missouri 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 will provide positive effects to the Missouri species of concern using the refuge. The considered action alternatives, along with other present and foreseeable future restoration projects, should counter some of the long-term adverse impacts to the Missouri 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 2.1.6 and 6.1.6 above have been adversely impacted by habitat loss, fragmentation, degradation, and conversion throughout the range of each of these species (*i.e.*, Gray Bat, Indiana Bat, Decurrent False Aster, Fat Pocketbook, and Northern long-eared Bat). Present and future actions, including the considered action alternatives, are aimed to offset these 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 project 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 on Gray Bat, Indiana Bat, Decurrent False Aster, Fat Pocketbook, or Northern long-eared Bat. With the considered action alternatives, wetland 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 not likely to adversely affect these species long-term.

7.3.6 Fisheries

All water bodies located within the project area may hold fish; however, they are isolated from the river except during overtopping flood events, active pumping, or when the large water control structure along the Mississippi River is open. The past actions (*i.e.*, locks and dams, channel training structures, dredging, and levees) within the Mississippi River basin, which includes Pool 25, have adversely impacted the fisheries by disconnecting the river from its floodplain, resulting in loss of access to spawning and rearing fish habitat. Present and future actions, including the considered action alternatives, are aimed to offset these past negative actions to fisheries resources.

No Action: The fisheries throughout the project would likely continue their gradual decline due to poor aquatic habitat condition and isolation from the river.

Considered Action Alternatives: No negative cumulative impacts would be expected. The considered action alternatives should have long-term benefits to the fisheries resources using Clarence Cannon National Wildlife Refuge through improved aquatic habitat and floodplain connectivity.

7.3.7 Water Quality

Past actions have degraded water quality within the Upper Mississippi River, including Pool 25. In general, past and present laws and regulations have led to improved water quality; however, site-specific problems will likely persist into the future. Within the project area, the water quality of the aquatic habitat suffers from lack of connectivity with the main river channel, low dissolved oxygen and shallow water depth making conditions unfavorable for species depending on aquatic habitat. Present and future actions, including the considered action alternatives, are aimed to offset these past negative

actions and improve the water quality within the project area, which will improve the water quality within Pool 25.

Without Project: The project area's water quality would likely remain similar to current conditions. The interior water bodies would continue to have low dissolved oxygen, shallow depth, and be isolated from the river.

Alternative 8 (Tentatively Selected Plan): No negative cumulative impacts to water quality would be expected long-term. The tentatively selected plan aims to improve water quality by 1) improving water level management which allows for summer drawdowns resulting in consolidation of sediment, decreasing turbidity, and promoting wetland plant growth; and 2) reconnecting the floodplain to the Mississippi River.

Considered Action Alternatives: No negative cumulative impacts to water quality would be expected long-term. In addition to the features included in alternative 8, alternative 9 aims to improve water quality by improving depth of existing water bodies which should improve dissolved oxygen levels throughout the year.

Chapter 8: Tentatively Selected Plan: Description with Design, Construction, Operations, Maintenance, Repair, Rehabilitation, and Replacement Considerations

This chapter provides further information on the Tentatively Selected Plan (TSP). The TSP for ecosystem restoration at the Clarence Cannon National Wildlife Refuge includes construction of a setback berm with exterior berm degrade; historic meander restoration; North, South, and Riverside management units with water control structures and interior berm degrades; diesel pump station and associated improved pump station channel structures; and reforestation. The details of this plan are described below and illustrated in Figure 15. Construction, operation, maintenance, repair, rehabilitation, and replacement considerations are discussed. The project schedule and initial cost estimates are provided.

The features of the TSP are designed to address study objectives (Table 16). A detailed description of the project features included in the TSP is provided in Chapter 4, and summarized in Table 17.

Table 16. Goals, objectives, and the features of the tentatively selected plan that address them. Some features of the tentatively selected plan address multiple objectives.

Restoration Features	GOAL: Restore and improve wetland ecosystem resources OBJECTIVES		
	Increase acreage and connectivity of native wetland plant communities	**Improve aquatic ecosystem resource**	**Improve water drainage and delivery**
South, North, and Riverside new management units	X		X
Setback with exterior berm degrade	X	X	X
Reforestation	X		
Restoration of historic meanders		X	X
Diesel Pump Station		X	X

8.1 Design Considerations

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

8.1.1 Location

The entire CCNWR HREP is located within the floodplain of the Mississippi River between river miles 263.8 and 261.1 in Pool 25. Lock and Dam 25 (RM 241.1) headwater maximum regulated pool elevation is 434.0 feet NGVD (1929) and minimum regulated pool is 429.7 feet NGVD. The land surface elevation (excluding water channels and exterior berm) in CCNWR based on the SAST[2] data ranges from 437.0 to 446.0 feet NGVD (1929), with the majority of the refuge lying within 440.0 to 442.0 feet NGVD (1929). The entire refuge is disconnected from the river by an exterior ring berm.

[2] SAST stands for Scientific Assessment Strategy Team (http://egsc.usgs.gov/isb/pubs/factsheets/fs10399.html)

Table 17. Clarence Cannon HREP Feature Summary of the Tentatively Selected Plan.

Feature	Measurement	Unit of Measure
South Unit		
Berm Degrade		
Southwest Subunit (SW1)	33,998	CY
Central Subunit (C1)	20,049	CY
Eastern Subunit (E1)	17,145	CY
Big Pond Subunit (BP1)	9,633	CY
Southwest Subunit Water Control Structure (SW2)		
Number of pipes	3	each
Size	4.5 x 4.5	Feet
Length	85	Feet
Central Subunit Water Control Structure (C2)		
Number of pipes	3	each
Size	4.5 x 4.5	Feet
Length	84	Feet
Eastern Subunit Water Control Structure (E2)		
Number of pipes	3	each
Size	4.5 x 4.5	Feet
Length	97	Feet
Big Pond Subunit Water Control Structure (BP2)		
Number of pipes	3	each
Size	4.5 x 4.5	Feet
Length	97	Feet
Native herbaceous plantings (*Carex* spp.)		
Southwest Subunit (SW3)	6	acres
Central Subunit (C3)	5	acres
Eastern Subunit (E3)	12	acres
Big Pond Subunit (BP3)	5	acres
Pump Station Service Access Road (PS-RD)		
Crushed stone base & surfacing	8900	TN
New Berm Length	91	Feet
New Berm Embankment	350	CY
North Unit		
Berm Degrade		
Northern Subunit (N1)	49,216	CY
North Subunit East Water Control Structure (NE2)		
Number of pipes	3	each
Size	4.5 x 4.5	Feet
Length	81	Feet
North Subunit West Water Control Structure (NW2)		
Number of pipes	3	each
Size	4.5 x 4.5	Feet
Length	93	Feet
Native herbaceous plantings (N3) (*Carex spp.)*		
Northern Subunit	20	acres
MSU7 Subunit Water Control Structure (MSU7)		
Number of pipes	6	each
Size	4.5 x 4.5	Feet
Length	109	Feet
Riverside Unit		

Berm Degrade (RV1)	6,480	CY
Native herbaceous plantings (*Carex* spp.)	18	acres
Setback (SET-D)		
Embankment	225,000	CY
Crown width	12	Feet
Side Slopes	1:3	V:H
Appx Elevation	452	Ft NGVD
Average Height	10	Feet
Length	13,700	Feet
Spillway		
Crown width	23.5	Feet
Side slopes	1:3	V:H
Elevation	449	Ft NGVD
Length	850	Feet
Articulated concrete block	10,000	Sq Yards
Setback Service Access Road	8414	Feet
Diesel Engine Driven Pump Station-Gravity Drain (PS-D)		
Pumps		
Number	2	each
Flow per pump	30,000	gpm
Sluice gate	6	each
Intake Pipe		
Bryants Creek invert elevation	425.5	Ft NGVD
Number of pipes	2	each
Pipe-arch size	103 x 71	inch
Landside invert elevation	425.5	Ft NGVD
Discharge Pipe to Bryants Creek		
Number of pipes	1	each
Diameter size	6	Feet
Invert elevation	425.5	Feet
Discharge Pipe to Landside		
Number of pipes	1	each
Diameter size	6	Feet
Invert elevation	425.5	Ft NGVD
Gravity Drain Structure #1		
Number of pipes	3	Each
Size	6.0 x 6.0	Feet
Length	147	Feet
Gravity Drain Structure #2		
Number of pipes	2	Each
Size	6.0 x 6.0	Feet
Length	147	feet
Pump Station Delivery Channel Water Control Structures		
PS1		
Number of pipes	3	Each
Size	4.5 x 4.5	Feet
Length	123	Feet
PS2 – Removal of existing culvert		
PS3		
Number of pipes	3	Each
Size	4.5 x 4.5	Feet

Length	113	Feet
PS4		
Number of pipes	3	Each
Size	4.5 x 4.5	Feet
Length	131	Feet
Historic Meander Excavation (HM1)		
Channel Length	9600	Feet
Side Slopes	1:6	V:H
Bottom Width	35	Feet
Depth	5	Feet
Channel Excavation	115,000	CY
Reforestation (T1)	300	acres

8.1.2 Survey Data

Survey data obtained includes the following:

- Field surveys using conventional survey methods were obtained during 2012. Ground surveys were conducted in proposed locations for water control structures, pump stations, and at points along the interior and exterior berms. Surveys were also conducted of all existing water control structures and of the berms in the immediate vicinity of these structures. These data were used with the SAST data to develop surface elevations for the project area which were used in the hydraulic modeling and preliminary design of features.
- Depths of existing water bodies were obtained during biological monitoring conducted by the Corps in May 2011. The depths were recorded using a boat-mounted Hummingbird.
- LiDAR was obtained by the Corps for the UMRR-EMP of the area, but as of November 2013 was still undergoing quality control checks. These data may be used for design in P&S.

It is recommended that the following surveys be collected or resurveyed during P&S prior to construction in order to obtain more accurate quantities:

- Additional topographic data of the refuge (field surveys or LiDAR)
- Water channel and creek surveys
- Additional geotechnical explorations and testing at excavation, structural and setback alignment locations

It is anticipated that earthwork associated with shallow borrow and subsequent embankment construction can be accomplished using traditional earth-moving equipment. Dewatering likely will be required for foundation work associated with the pump station and water control structures.

8.1.3 Access

Access to the site and all proposed features will be accomplished by land over existing service accesses.

8.1.4 Hydrologic/Hydraulic

Division Regulations DIVR 1110-1-403 "Mississippi Valley Division/Mississippi River Commission Policy on River Diversions": The tentatively selected plan requires construction of a pump station to remove water (and some sediments) from the Mississippi River. Features were designed and constructed to minimize the local and system-wide impacts to hydrologic systems gaining and losing flow and sediments. The proposed diversion of Mississippi River water for operation of the proposed pump station is minimal (113 cfs). Due to its small size and localized area of effect, District technical experts have determined that the proposed pump station operation should not impact existing engineering

features and projects, such as levees or other river training structures, nor is it expected to have any significant cumulative impacts on the system. Per *DIVR 1110-2-240 "Preparation of Water Control Plans and Manuals*", a water control plan for pump station operation will be developed during Plans and Specifications.

8.2 Construction Considerations

8.2.1 Storm Water Pollution/Erosion Control

Storm water run-off from nearly all construction activities would be contained within the confines of the project area due to the exterior berm. Preparation of the fields for reforestation, berm removal and setback construction, and borrow excavation would expose soil. Temporary stabilization features would be employed until vegetation is re-established. These features may include mulching, temporary seeding, and/or erection of silt fencing or placement of other filter material. Overall, the long-term storm water run-off characteristics are not expected to change.

8.2.2 Permits

Public review and an application for water quality certification from the State of Missouri, as required by Section 404 and 401 of the Clean Water Act, was applied for through the Regulatory Branch of the Corps based upon the 404(b)(1) evaluation in Appendix H, *Clean Water Act*. The St. Louis District Regulatory Branch has determined that the proposed activity will have no affect on endangered species, and is authorized under Section 404 of the CWA by an existing Department of the Army General Permit Number 27 for *Aquatic Habitat Restoration, Establishment, and Enhancement Activities* (Appendix H, *Clean Water Act*). The Missouri Department of Natural Resources Water Protection Program has conditionally issued Section 401 water quality certification, subject to special conditions that are part of the Corps permit (Appendix H, *Clean Water Act*).

Clean Water Act Section 402 Storm Water Permit will be obtained prior to construction activities using a Storm Water Pollution Protection Plan and Best Management Practices in order to minimize water quality impacts during construction.

8.2.3 Protected Species

Bald Eagles – Consideration (in coordination with the USFWS) will be given during plans and specifications preparation sequencing construction activities in a manner that minimizes impacts. Specific restrictions relative to any sequencing will be included as part of the contract specifications. The contracting officer will ensure appropriate compliance.

Indiana Bat and Northern long-eared Bat – Special conditions on the construction work will require that tree clearing activities be scheduled outside May 1 thru August 31 when Indiana bats are known to inhabit summer habitat. If tree clearing activities must occur during this period, coordination with the USFWS will occur. At a minimum, a site visit by a team of biologists will be required to determine if any roost trees are among those proposed for removal. If removal of a roost tree is proposed, then the District must enter into Section 7 consultation with the USFWS. This consultation will determine if the proposed action is likely to jeopardize the continued existence of the Indiana Bat or Northern long-eared bat.

Migratory Wildlife – The development of plans and specifications will attempt to minimize disruption of migratory wildlife during fall and early winter.

8.2.4 Construction Sequence

The probable construction sequence for the tentatively selected plan features is summarized in Table 18. Multiple features may be packaged into one contract depending on the amount of construction funding available. No sequence would be required contractually.

Table 18. The construction work items for the TSP, instructions for their construction, their purpose and the tentative construction sequence.

Order	Construction Work Item	Purpose	Instructions
1	50% Setback + Historic Meanders	Protect the managed units of CCNWR and allow the Riverside Unit to be connected to the river Restore meanders that historically existed on the refuge	Setback needs to be started before exterior degrade in order to maintain a level of protection. Construct as detailed in report, excavated material from meanders to be used in setback construction
2	50% Setback + Exterior Berm Degrade	Connect the Riverside unit to the river	Degrade material to be used in setback construction.
3	Spillway	To allow controlled release of water into CCNWR during high river	Construct as detailed in report, degraded material may be suitable for use as borrow.
4	Riverside Unit	Connect the small units into fewer large units	Construct as detailed in report
5	North Unit (WCSs and berm degrades)	Connect small units into fewer large units with improved water conveyance	Construct as detailed in report
6	South Unit (WCSs and berm degrades)	Connect small units into fewer large units with improved water conveyance	Construct as detailed in report
7	Diesel Pump Station and Gravity Drains	Water delivery and drainage	Construct as detailed in report
8	Pump Station Delivery Water Channel Structures	Water delivery and drainage	Construct as detailed in report
9	Reforestation	Restore forests that historically existed on the refuge	Construct as detailed in report

8.3 Operational Considerations

Operation and maintenance of UMRR-EMP habitat projects is similar to that undertaken by the project partner's day-to-day management of wildlife areas and other public use areas. The purpose of assigning OMRR&R costs is to ensure commitment and accountability to the UMRR-EMP by the project partner. USFWS will be responsible for 100% of the operation and maintenance of the project features. Total estimates of annual operation costs for the tentatively selected plan are shown in Section 10.1. A brief description of pump operation and water control structures is given below. A detailed operation description would be provided in the OMRR&R Manual after construction completion.

8.3.1 Pump

There are two 30,000 gpm diesel engine driven pumps in the proposed pump station. Prior to pumping, the pump station trash rack will be inspected and cleared of debris. Existing site staff would be required to fuel and operate these pumps.

8.3.2 Water Control Structures

Multiple large water control structures are a part of the tentatively selected plan. All of the structures include several gates (sluice or weir) to control water movement. The sluice gate and weir gate

operators are mounted on individual concrete corbels on the front upper edge of the wall. All gate operators would be constructed to allow manual operation, using a hand crank, or using a portable electric gate operator. The portable electric gate operator, any necessary adapter, and a portable generator would be included.

8.4 Maintenance Considerations

The proposed features have been designed to ensure low annual maintenance requirements. Maintenance may include performing inspections, performing routine tree planting maintenance activities or manipulating vegetation mechanically or with herbicides and performing routine maintenance on the pump station. Routine maintenance would include periodic inspection and lubrication of the pumps and water control structures. The pump station would require annual maintenance to include: lubricating flap gate hinges, pillow block bearings, sluice gate operators and stems. The following would need to be checked: lube level in the gear reducer, and diesel engine fluid levels, filters, and battery. On an annual basis, water control structures would need grease added to the gate hoist operator gear housing, the gate stem threads greased, and debris removed. Berms would require inspection for erosion, mowing, and access road surfacing maintenance. Planted trees would be established prior to project completion, and the primary maintenance would be mowing around these trees to reduce competition from annual vegetation. Additional activities that would not occur on an annual basis include pump station rehabilitation. This would involve removing the pump and likely shipping it to a shop. The shop would disassemble the pump rotating elements; blast them clean; inspect: intermediate shafts, impeller, pump column, flange register fits, suction bell and pump bowl; replace: bearings, sleeves, bushings, grease seals, packing, gaskets, pump shaft, enclosing tubes, fasteners, and flexible coupling; and paint and reassemble the pump components. The pump would then be reinstalled and tested. The estimated annual maintenance costs are discussed in Section 10.1. These quantities and costs may change during final design. A complete list of maintenance needs at Clarence Cannon National Wildlife HREP will be published in an OMRR&R manual after construction.

8.5 Repair, Rehabilitation, and Replacement Considerations.

Repair, rehabilitation, and replacement considerations may extend outside the typical 50-year period of analysis; as such, the project partner is expected to maintain the HREP project until it is no longer authorized and should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. See section 10.1 below for estimated costs and frequency schedule.

Chapter 9 Schedule for Design and Construction

Table 19 outlines the project milestones and tentative date for completion.

Table 19. Tentative Project Schedule for the CCNWR HREP

Requirement	Scheduled Date
Value Engineering Functional Analysis Study	Completed 29-31 March 2011
Feasibility Scoping Meeting	Completed 30 June 2011
Distribute Draft Report	Completed 13 June 2013
District Quality Control	Completed 01 July 2013
Agency Technical Review #1	Completed 06 Nov 2013
Submit Draft DPR to Mississippi Valley Division (Alternative Formulation Briefing)	15 November 2013
Submit Draft DPR for Public and Agency Review	January 2014
Agency Technical Review #2	February 2014
Submit Final DPR to Mississippi Valley Division	March 2014
Initiate Plans and Specifications	Phased, May 2014
Complete Plans and Specifications	Phased, 2014-2019
Advertise Contract	Phased, 2015-2019
Award Contract	Phased, 2015-2019
Complete Construction	Phased, 2015-2019
Prepare OMRR&R Manual	Phased, 2014-2019

Chapter 10 Cost Estimates

Table 20 compares costs for the fully funded estimate (FFE) and the current working estimate (CWE). The FFE which is calculated based on the proposed construction schedule, expected escalation costs, and a contingency factor, and represents the money expected to be spent at the end of project construction. The CWE, with an approximate 31% contingency factor is calculated using present worth (30 October 2013) and does not include future escalation. The detailed estimate of the project design and construction costs are provided in Appendix I, *Cost Estimate;* however due to the sensitivity of providing this detailed cost information which could bias construction contract bidding, this material has been omitted prior to public review. Quantities and costs may vary during final design.

Table 20. Project Design and Construction Cost Estimates (Effective Price Level Date 30 Oct 2013)

Account Code	Feature	Current Working Estimate (CWE) ($K)	Fully Funded Estimate[1] (FFE) ($K)
01	Lands and Damages	$0	$0
06	Fish and Wildlife Facilities	$23,567	$25,476
30	Planning, Engineering, and Design	$3,986	$4,516
31	Construction Management	$2,344	$2,531
	TOTAL PROJECT COSTS[2]	**$29,897**	**$32,523**

[1]FFE estimate is marked up to midpoint of construction. Mark-up equals 9.2%
[2]Project features are on Federal land and therefore 100% Federally funded

10.1 Operation, Maintenance, Repair, Rehabilitation, and Replacement Considerations

The proposed project features have been designed to ensure low annual operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) requirements (Table 21). For analysis purposes, the costs presented for OMRR&R used the 50-year period of analysis. However, the USFWS is expected to operate and maintain the project until it is no longer authorized. As such, USFWS should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. The estimated total average annualized OMRR&R cost (with 15% contingency) of the tentatively selected plan cost is $61,500. USFWS is 100% responsible for OMRR&R costs. These quantities and costs may change during final design. A complete list of OMRR&R needs will be provided in the OMRR&R Manual following construction. OMRR&R costs are included in the annualized costs for alternative selection but are not included in the total project cost.

Table 21. Estimated OMRR&R costs for the tentatively selected plan

Component	Qty	Unit	Unit Cost	Cost[2]	Frequency
OPERATIONS					
Pump Station Fuel	6100	Gallons	$3.50[1]	$24,550	Annual
Inspection	16	Hr	$50	$920	Annual
South Unit Inspection	8	Hr	$50	$460	Annual
North Unit Inspection	8	Hr	$50	$460	Annual
Riverside Unit Inspection	8	Hr	$50	$460	Annual
Setback Inspection	8	Hr	$50	$460	Annual
Reforestation Inspection	8	Hr	$50	$460	Annual
Historic Meander Inspection	8	Hr	$50	$460	Annual
MAINTENANCE					
Reforestation Mowing (1 time/yr)	300	Acres	$50	$17,250	Annual, 1st 5 yrs
Setback Mowing (25 acres twice/yr)	50	Acres	$50	$2,875	Annual
REPAIR					
Pump Station	1	Lump sum	$1,000	$1,150	Annual

South Unit WCS		1	Lump Sum	$1,000	$1,150	Annual
North Unit WCS		1	Lump Sum	$1,000	$1,150	Annual
REPLACEMENT						
Diesel Pump Station	30,000 gpm pump	2	Each	$213,000	$489,900	Every 25 yrs
	36" dresser coupling	2	Each	$2,200	$5,060	Every 25 yrs
	Portable operator	1	Each	$5,000	$5,750	Every 25 yrs
	72 x 72 sluice gate	2	Each	$30,000	$69,000*	Every 60 yrs
	108 x 84 sluice gate	4	Each	$55,000	$253,000*	Every 60 yrs
	54 x 54 channel WCS	6	Each	$27,400	$189,060*	Every 60 yrs
	Gravity Drain 72 x 72	5	Each	$31,100	$178,825*	Every 60 yrs
South Unit WCS	Sluice gate 54 x 54	12	Each	$27,400	$378,120*	Every 60 yrs
	Weir gate	4	Each	$24,900	$114,450*	Every 60 yrs
North Unit WCS	Sluice gate 54 x 54	12	Each	$27,400	$378,120*	Every 60 yrs
	Weir gate	3	Each	$24,900	$85,905*	Every 60 yrs
Historic Meanders	Excavation	1	Lump Sum	$345,000	$396,750	Every 50 yrs
REHABILITATION						
Diesel Pump Station	Gates and operator	17	Each	$6,000	$117,300	Every 25 yrs
South Unit WCS	Gates and operator	16	Each	$6,000	$110,400	Every 25 yrs
North Unit WCS	Gates and operator	15	Each	$6,000	$103,500	Every 25 yrs
AVERAGE ANNUAL OMMR&R						
Average Annual OMRR&R over the 50-year period of analysis						$62,300

[1] Price as of 06 May 2013
[2]Includes 15% contingency; Annualized the Net Present Value of the expected stream of OMRR&R costs over the 50 year period of analysis at the Federal Discount Rate of 3.5%
* Not included in annualized OMRR&R costs since outside the 50-yr period of analysis

10.2 Monitoring and Adaptive Management Considerations

Costs for monitoring and adaptive management are listed in Table 22. Monitoring includes forest and plant species diversity surveys, bird use days, fish survey, habitat complexity (*i.e.,* bathymetry of historic meanders), and water conveyance (*i.e.,* duration and frequency of inundation of land affected by setback, and time it takes to reach desired water levels). Further details are provided in Chapter 12, *Project Performance Evaluation and Adaptive Management,* and in Appendix J, *Monitoring and Adaptive Management.* The estimated cost of the proposed monitoring and adaptive management plan will be included in the total project cost estimate (Per CECW-PB Memo dated 31 August 2009 Section 3.b of the Implementation Guidance for Section 2039 of WRDA 2007), but are not included in the annualized OMRR&R cost discussed in Section 10.1. The estimated total monitoring and adaptive management costs with contingencies for 10 years is $108,100 and is included in total project costs, with an average annualized cost of $4,000.

Table 22. Estimated Total Monitoring and Adaptive Management Costs ($) for 10 years post-construction (May 2013 Price Level)

Item	Cost ($)
Pre-construction Monitoring	$18,000
Post-construction Monitoring and Adaptive Management*	$76,000
SUBTOTAL	$94,000
Pre-construction contingency (15%)	$2,700
Post-construction contingency (15%)	$11,400
TOTAL	$108,100
Average Annualized Cost[1]	$4,000

[1]Annualized the Net Present Value of the expected stream of monitoring costs over the 10-year period of analysis at the FY14 Federal Discount Rate of 3.5%

*Includes cost of performance evaluation reports at year 5 and year 10

Chapter 11: Relevant Laws and Regulations*

This chapter discusses the laws and regulations applicable to the Clarence Cannon National Wildlife Refuge Habitat Rehabilitation and Enhancement Project. The action alternatives within this review were subject to compliance review with all applicable environmental regulations and guidelines. Table 23 summarizes the compliance status for each Federal policy. The following sections discuss additional laws applicable to the CCNWR HREP that have not been discussed in previous chapters.

Table 23. Summary of the compliance status with respect to applicable statutes and laws

Federal Policy	Compliance Status
Floodplain Management (EO 11988 as amended by EO 12148)	Full
Protection of Wetlands (EO 11990 as amended by EO 12608)	Full
Rivers and Harbors Act, 33 USC 401-413	Full
Clean Water Act, 33 USC 1251-1375	Full
Prevention, Control, and Abatement of Air and Water Pollution at Federal Facilities (EO 11282 as amended by EO's 11288 and 11507)	Full
Comprehensive Environmental Response, Compensation, and Liability Act, 42 USC 9601-9675	Full
Clean Air Act, 42 USC 7401-7542	Full
Invasive Species, EO 13112	Full
Migratory Bird Treaty Act of 1918, 16 USC 703-712	Full
Bald and Golden Eagle Protection Act, 42 USC 4151-4157	Full
Fish and Wildlife Coordination Act, 16 USC 661-666c	Partial[2]
Protection and Enhancement of Environmental Quality (EO 11991)	Full
Farmland Protection Policy Act, 7 USC 4201-4208	Full
Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (EO 12898)	Full
Noise Control Act, 42 USC 7591-7642	Full
National Environmental Policy Act, 42 USC 4321-4347	Partial[1]
Resource Conservation and Recovery Act, 42 USC 6901-6987	Full
Water Resources Development Acts of 1986, 1990, 2000 and 2007	Full
Endangered Species Act, 16 USC 1531-1543	Partial[2]
National Historic Preservation Act, 16 USC 470 et seq.	Full
Protection and Enhancement of the Cultural Environment (EO 11593)	Full

[1]Full compliance after submission for public comment and signing of the FONSI
[2]Full compliance to be achieved upon receipt of documentation from the appropriate agency

Floodplain Management, Executive Order 11988. Under this Executive Order, Federal agencies are to "provide leadership and take action to reduce the risk of flood loss, to minimize the impacts of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains". With the setback, the project would restore natural and beneficial floodplain values.

Protection of Wetlands, Executive Order 11990. Under this Executive Order, Federal agencies shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities. Existing wetland habitat would be temporarily impacted by construction and approximately 10 acres would be permanently converted to non-wetland. The long-term impact to the wetlands within the project area would be restoration.

Rivers and Harbors Act. This Act regulates activities in, under, or over navigable water, such as the Mississippi River. The Section 404 authorization process would address issues that could be regulated by this Act. Completing the Section 404 permit process would result in full compliance with Section 10 of the Rivers and Harbors Act. Section 10 activities include the installation of the pump station pipes,

degrading berms, and excavation. Any required permits would be acquired prior to the initiation of project construction.

Clean Water Act, as amended. The Clean Water Act authorization process has been initiated. Any required permits will be acquired prior to the initiation of project construction.

Clean Water Act - Section 401 requires the state to set water quality standards including designating water use and pollutant levels. The program is administered by the State of Missouri which reviews applications to ensure that the proposed project would not degrade water quality. The Section 401 water quality certification review process will begin when the Public Interest Review is begun. A Section 401 water quality certificate from the State of Missouri is included in Appendix H, *Clean Water Act.*

Clean Water Act Section 402 - Land disturbances of greater than 1 acre associated with this project require a National Pollutant Discharge Elimination System (NPDES) permit, or Section 402, issued by the state for storm water discharges. This permit would be acquired prior to construction initiation.

Clean Water Act Section 404 - Section 404 of the Clean Water Act regulates the placement of fill, such as rock, in waters of the United States. This project has been authorized under nationwide permit 27 (Appendix H, *Clean Water Act).* A draft Section 404(b)(1) document has been prepared for this project and discusses the impacts of the project (see Appendix H, *Clean Water Act*).

Air and Water Pollution Prevention and Control, Executive Order 11282. Under this Executive Order, Federal agencies shall ensure that all necessary actions are taken for the prevention, control, and abatement of environmental pollution with respect to Federal facilities and activities under the control of the agency. Because no HTRW was found and the project area meets air quality standards, project construction activities are not expected to significantly contribute to air and water pollution. The project would result in dust and exhaust from equipment and slight increases in turbidity within the adjacent waters. Therefore, a minor short-term reduction in air and water quality would occur.

Clean Air Act, as amended. The Clean Air Act sets standards requiring the U.S. Environmental Protection Agency (EPA) to designate measurable targets for various air pollutants: National Ambient Air Quality Standards (NAAQS). They have identified standards for seven pollutants: lead, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter less than 10 microns in diameter, and particulate matter less than 2.5 microns. Pike County, Missouri is in attainment for all EPA air quality standards under the Clean Air Act Conformity Rule. No aspect of the proposed project has been identified that would result in violations of air quality standards.

Invasive Species, Executive Order 13112. This executive order 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". 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 project area.

Migratory Bird Treaty Act of 1918, as amended. Under this law, Federal agencies shall not take, kill or possess migratory birds. Migratory birds are recognized as being of great ecological and economic value. Millions of Americans study, watch, feed, or hunt migratory birds throughout the United States. The proposed project area is along the Mississippi Flyway, a major migratory path for millions of birds. Construction equipment and activities would cause temporary noise affecting and potentially disrupting birds near the proposed project area. Additionally, tree removal for the degrading of the berm has the potential to negatively impact nesting birds. Tree removal would not occur from April 1 to September 30 to avoid impacts to Indiana Bat; this would also prevent impacts to nesting birds. The impact from noise would be temporary and cease following construction completion. In the long term, the

proposed project would restore forested and emergent wetland habitat benefiting numerous species of migratory birds.

Bald and Gold Eagle Protection Act of 1940. Bald Eagles (*Haliaeetus leucocephalus*) range over most of North America. They build large nests in the tops of large trees near rivers, lakes, marshes, or other aquatic areas. The staple food of most bald eagle diets is fish, but they will also feed on waterfowl, rabbits, snakes, turtles, other small animals, and carrion. In winter, eagles that nest in northern areas migrate south and gather in large numbers near open water areas where fish or other prey are plentiful (USFWS 2011).

On August 9, 2007, the bald eagle was removed from the Federal list of threatened and endangered species. It remains protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The Bald and Golden Eagle Protection Act prohibits unregulated take of bald eagles. The U.S. Fish and Wildlife Service recently finalized a rule defining "take" that includes "disturb." "Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior" (USFWS 2007). Based on this rule, the USFWS developed the National Bald Eagle Management Guidelines in 2007. These guidelines indicate that in undisturbed areas no construction activities should occur within 660 ft. of a visible eagle's nest and 330 ft. of a non-visible nest during breeding season.

Fish and Wildlife Coordination Act, as amended. Project plans have been coordinated with the USFWS. A draft Fish and Wildlife Coordination Act Report was received on 2 August 2013 from USFWS. Coordination with the USFWS, as well as others, is detailed in the Appendix B, *Coordination*. USFWS concludes and recommends that the proposed project to be beneficial to the Mississippi River and biota dependent upon the river and its floodplain. USFWS fully supports the proposed project because it will restore a larger component of habitat diversity in this portion of the Upper Mississippi River. The service recommends that coordination continue through design and construction phase of the proposed project to ensure impacts to bald eagles are avoided.

Protection of Environmental Quality, Executive Order 11991. Under this Executive Order, Federal agencies shall take action to provide leadership in protecting and restoring the quality of the Nation's environment to sustain and enrich human life. Federal agencies shall initiate features needed to direct their policies, plans and programs so as to meet national environmental goals." The proposed project is designed to restore and improve the habitat within CCNWR. Thus, the project would protect and enhance the Nation's environment.

Farmland Protection Policy Act, as amended. The proposed action would not result in the conversion of any prime, unique state or locally important farmland to non-agricultural uses. Under the Council on Environmental Quality Memorandum (11 Aug 80), prime farmland is defined as land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. Unique farmland is defined as land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as, citrus, tree nuts, olives, cranberries, fruits, and vegetables (7 U.S.C. 4201(c)(1)(A) & (B)).

Within CCNWR, 87 acres qualify as prime farmland, if used for farming (NRCS 2006). The areas classified as prime farmland are not currently in agricultural production and are primarily forested and will remain in forest with the project; therefore no conversion of farmland to nonagricultural uses is expected to occur.

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Noise Control and Quiet Communities Act. Noise is usually defined as "unwanted sound", and is recognized as an environmental pollutant that can interfere with communication, work, rest, recreation, and sleep. Sound is represented on a logarithmic scale with a unit called the decibel (dB). The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB. A-weighted decibels (dBA) are used to express the relative loudness of sounds as perceived by the human ear because the human ear is less sensitive at low frequencies than high (Generac Power Systems, Inc. 2004). A 24-hour average of 55 dBA was identified by USEPA as a level below which there are effectively no adverse impacts (USEPA 1974).

Noise levels surrounding the project area are varied depending on the time of day and climatic conditions. The current human activities causing elevated noise levels include running diesel powered generators, trucks, and farming equipment.

Project construction would generate a temporary increase in noise levels. Construction would occur during daylight hours. Noise levels would not be altered at night. Common construction equipment for this project generates noise levels of approximately 65 - 95 dBA. Attenuation from 90 dBA to 55 dBA occurs at a distance of approximately 2,600 ft. depending on climatic conditions, topography, vegetation, and man-made barriers (Generac Power Systems, Inc. 2004). Due to the rural nature of the project area, there are no homes or buildings within one mile of the project area. Increased noise may lead to temporary displacement of wildlife species. After construction completion, noise levels would return to current conditions

National Environmental Policy Act, as amended. The completion of the Environmental Assessment (EA) and signing of the Finding of No Significant Impact (FONSI) would fulfill NEPA compliance. The EA is integrated into this DPR. A draft version of the FONSI is provided at the end of this document. The FONSI would be finalized and signed into effect only after having carefully considered all comments on the environmental effects of this project and it is determined that an EIS is not required.

Protection and Enhancement of the Cultural Environment, Executive Order 11593. Under this Executive Order, Federal agencies "shall provide leadership in preserving, restoring and maintaining the historic and cultural environment of the Nation". An inventory of archeological sites and collections in the Mark Twain National Wildlife Refuge (including Clarence Cannon National Wildlife Refuge) was conducted in 1992 (ISMS 1992). Five recorded archaeological sites are located within the project area. The proposed project features avoid the areas of all sites with the possible exception of a site located near Crane Pond. As proposed, the setback berm would not impact this site. This was verified with a site visit conducted in September 2011. In the event any cultural properties are located, these will be evaluated for National Register eligibility, in consultation with the Missouri Historic Preservation Officer, and appropriate mitigation completed before construction. If sites will be impacted, the tribes who have indicated they have an interest in the area will be contacted, and consultation will 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) will be followed on Federal lands.

Chapter 12: Project Performance Evaluation and Adaptive Management

This chapter summarizes the project performance evaluation and adaptive management needed to assess the habitat changes resulting from the implementation of the HREP. The primary project objectives have been summarized elsewhere in this document, and the performance assessment is designed to gauge progress toward meeting these objectives.

Section 2039 of WRDA 2007 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 implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires that an adaptive management plan be developed for all ecosystem restoration projects. At the programmatic level, knowledge gained from monitoring one project can be applied to other projects. Opportunities for this type of adaptive management are common within the UMRR-EMP.

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties, which can 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 alternatives; and ambiguous management and decision-making processes.

The restoration features in the Tentatively Selected Plan have been operating successfully for over 20 years at several locations within the UMRS. Upstream within Pool 24, a similar project has been in construction. Using an adaptive management approach during project planning enabled better selection of appropriate design and operating scenarios to meet the CCNWR HREP project objectives. Lessons learned in designing, constructing, and operating similar restoration projects within the UMRS have been incorporated into the planning and design of this HREP to ensure that the Tentatively Selected Plan represents the most effective design and operation to achieve project goals and objectives. As with other HREPs implemented through UMRR-EMP, a monitoring and performance assessment plan has been developed, and the results of the plan will be used to measure success of the project and determine whether adjustments in operation may be made to promote its success.

The monitoring and adaptive management plan was developed with input from state and Federal resource agencies and is detailed in the Appendix J, *Monitoring and Adaptive Management*. Performance indicators were developed to measure the success of project objectives. The indicators were developed to be specific, measurable, attainable, realistic, and timely. The project objectives, performance indicators, monitoring target, time of effect, frequency of monitoring, adaptive management triggers, and responsibilities of monitoring and data collection for the Clarence Cannon National Wildlife Refuge HREP are summarized in Table 24. Per Section 2039 guidance, monitoring costs (not to exceed 10 years after project construction) were considered as part of project cost (Table 25).

The monitoring information will be compiled, reviewed, and summarized in a Performance Evaluation Report that will be written 5 years after data collection has started. This report will evaluate the performance of the constructed features in meeting the objectives of the Clarence Cannon National Wildlife Refuge HREP.

Table 24. Project objectives, indicators, and time before the effects of the Clarence Cannon National Wildlife Refuge HREP become apparent

Objective	Performance Indicator	Monitoring Target (Desired Outcome)	Action Criteria (AM triggers)	Time of Effect[1]	Responsible Party
Restore native wetland communities (forested and non-forested)	Species composition and quality of annual and perennial herbaceous vegetation (relative cover and frequency)	Diversity threshold = 30:70 ratio of annuals and perennials per management subunit Species Richness Threshold = ≥ 8 species per management unit Quality Threshold = importance value score of ≥ 3.5 % invasive species = maintain below 5% relative cover and frequency per management subunit	Apply adaptive management actions if any of the monitoring targets fall outside the desired thresholds	4- years post-construction	Project partner
	Survival and growth of existing and planted forest in the Riverside Unit	[a]Initial and [b]long-term survival of planted trees of at least 70%. Increased height and basal diameter & positive relative growth rate over time[b]	<50% survivability	[a]1 year post-planting [b]10 year post-planting	USACE
	Bird Use Days	Increasing trend over time for use of wetland habitats by migratory and resident wildlife	Lack of increasing trend	4-years post-construction	Project partner
Improve aquatic ecosystem resources	Duration & frequency of inundation of land affected by setback	Increase duration and frequency of inundated land above existing conditions in the Riverside Unit	None identified	Construction completion	Project partner
	Native fish assemblage	When Riverside Unit is inundated, an increase by ≥ 20% of native fish species	<20% native fish species	5-years post - construction	USACE
	Aquatic habitat complexity	An increase of more than 20% habitat complexity	Average depth < 2.5 feet	Construction completion	USACE
Improve water level management	Water delivery and drainage	For water delivery, management subunits should reach target water levels[2] in < 7 days After large overtopping flood event, drainage of project area < 40 days	Further identified during plans and specifications	Construction completion	Project partner
	Species diversity and quality of annual and perennial herbaceous vegetation	See above			Project partner
	Bird Use Days	See above			Project partner

[1]Full realization of results is highly dependent upon river levels in the project area post-construction; several high water events may be necessary before benefits are realized and a state of relative equilibrium is reached. Therefore, should river levels be unusually low subsequent to project construction, more time may be needed in order to fully realize anticipated results.
[2]See Table 3 in Monitoring Appendix for estimated annual target water gauge levels for each management subunit

Table 25. CCNWR HREP conceptual monitoring schedule and estimated monitoring costs. Construction completion is set at year 0.

Performance Indicator	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**	**+6**	**+7**	**+8**	**+9**	**+10**
Plant Species Diversity*	X	Construction	X	X	X	X	X	X	X	X	X	X
Forest	x		X				X					X
Bird Use*	X		X	X	X	X	X	X	X	X	X	X
Setback			X									
Fish	X				X				X			
Habitat Complexity	X				X				X			
Water Conveyance	x		X									
Performance Evaluation Report							X					X
Est. Cost ($)	$18,000		$12,000	$0	$12,000	$0	$20,000	$0	$12,000	$0	$0	$20,000
SUBTOTAL	**$94,000**											
Contingencies (15%)	**$14,100**											
TOTAL	**$108,100**											
Average Annual Cost[1]	**$4,000**											

[1]Annualized the Net Present Value of the expected stream of monitoring costs over the 10-year period of analysis at the FY2014 Federal Discount Rate of 3.5%
*These data will be collected annually by the project partner as part of standard refuge management. These data are appropriate for use in assessing the success of the HREP and will be used at no additional cost to the HREP.

Chapter 13: Implementation Responsibilities

This chapter discusses the implementation responsibilities for the USFWS (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 OMRR&R would be required for features of the project as discussed previously in the OMRR&R considerations (Chapter 10) of this report. The USFWS would be responsible for OMRR&R of the project.

Should rehabilitation that exceeds the annual maintenance requirements be necessary (as a result of a specific storm or flood event), a mutual decision between the participating agencies would be made whether to rehabilitate the damaged portions of the project. If rehabilitated, the Federal share of rehabilitation would be the responsibility of the Corps of Engineers.

Performance evaluation, which includes monitoring of physical/chemical conditions and some biological parameters, would be a Corps of Engineers responsibility, as outlined in Chapter 12 of this report.

Appendix L, *Memorandum of Agreement*, contains a draft copy of the formal agreement that would be entered into by the Corps of Engineers and the USFWS before implementation of the project. This draft Memorandum of Agreement (MOA) formally establishes the relationships between the Department of Army (DOA), represented by the Corps of Engineers, and the USFWS in constructing, operating, and maintaining the implemented features of the Clarence Cannon National Wildlife Refuge 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 percent Federally funded (per Section 906(e) of WRDA 1986) because it is taking place on a National Wildlife Refuge.
2. The project has no local sponsor because the project is 100 percent Federally funded.
3. OMRR&R is also a 100 percent Federal cost when the project is located on Federal lands, and, therefore, per Section 107(b) of WRDA 1992, OMRR&R costs shall be borne by the Federal agency that is responsible for fish and wildlife management activities on such lands (here, the USFWS).

DOA will develop an OMRR&R Manual for the project and will provide the manual to USFWS at project completion and turnover. The MOA shall remain in effect for a period of no more than 50 years after initiation of construction of the project.

USFWS has provided a letter of support for the project on 2 August 2013 (Appendix A, *Coordination*).

Chapter 14: Conclusions*

The ecosystem structure and function of the Clarence Cannon National Wildlife Refuge HREP is not being fully realized due to disconnection of the floodplain from the river, forest loss, habitat fragmentation, domination of invasive reed canary grass, and degraded wetland quality and quantity due to inadequate water level management. Critical ecosystem functions and services provided by wetland and floodplain habitats of CCNWR have been impaired or lost from the project area in recent decades.

The Tentatively Selected Plan features (setback berm with levee degrade, restoration of historic meanders, three new larger management units, reforestation, and diesel pump station) are designed to meet the project's goal to restore and improve the quality of wetland resources. This goal would be met by increasing the quantity and quality of native wetland plant communities (forest and emergent wetlands); by improving aquatic ecosystem resources; by restoring seasonal connectivity with the river; and by improving water conveyance of the site.

Assessment of the future-with-project scenario shows definite increases in total habitat units over the 50-year period of analysis for all evaluated species. These increases represent quantification of the projected outputs - improved habitat quality and increased preferred habitat quantity.

This project is consistent with and fully supports the overall goals and objectives of the Upper Mississippi River Restoration Environmental Management Program.

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Certification of Legal Review

The Clarence Cannon National Wildlife Refuge Habitat Rehabilitation and Enhancement Project Draft Definite Project Report, including all associated documents required by law and regulation, has been fully reviewed by the Office of Counsel, St. Louis District and is approved as legally sufficient.

10/23/13
Date

Mark A. Wunsch
Office of Counsel, St. Louis District
Mark A. Wunsch, Acting District Counsel
for William P. Levins

Keli N. Robertson
Office of Counsel, St. Louis District
Keli N. Robertson, Asst. District Counsel

Recommendations

I have weighed the outputs to be obtained from the full implementation of *Clarence Cannon National Wildlife Refuge Habitat Rehabilitation and Enhancement Project* against its estimated cost and have considered the various alternatives proposed, impacts identified, and overall scope. In my judgment, this project, as proposed, justifies expenditures of Federal funds. I recommend the Mississippi Valley Division Engineer approve the proposed project to include:

- Setback berm with exterior berm degrade
- Restoration of historic meanders
- Riverside, North and South new interior management units
- Reforestation
- Diesel pump station

Because the project is located on national wildlife refuge lands, project costs would be 100-percent Federal in accordance with Section 906(e) of Public Law 99-662, 33 U.S.C. 2283(e). Total Federal estimated Federal construction cost of this project is $29,897,000. Total Federal estimated project cost, including general design and construction management is $32,523,000. The full implementation of this project would generate 1,703 average annual habitat units at an average cost of $787 per habitat unit. Upon project completion, the USFWS would be responsible for Operation, Maintenance, Repair, Rehabilitation, and Replacement at an estimated annualized cost at FY2014 price levels of $62,300.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the project partner, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

_____ _____

Date

CHRISTOPHER G. HALL
COL, EN
Commanding

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

CLARENCE CANNON NATIONAL WILDLIFE REFUGE
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 25, MISSISSIPPI RIVER MILES 261.1 THROUGH 263.8
PIKE COUNTY, MISSOURI

Draft Finding of No Significant Impact*

Significant opportunities exist to restore, improve, and increase wetland and aquatic habitat for migratory and resident wetland and aquatic species by increasing floodplain connectivity, reducing habitat fragmentation, improving water conveyance and supply, reforestation of bottomland forest, restoring historic meanders and improving floodplain topographic diversity at the Clarence Cannon National Wildlife Refuge.

An array of potential features and alternatives were considered for habitat restoration. Features evaluated in detail were:

- No Federal Action
- New management units constructed by interior berm modifications and new water control structures
- New Setback berm
- New pump station
- Historic meander restoration
- Excavation of existing water bodies
- Reforestation

The preferred alternative consists of: degrading interior berms and installing new water control structures to establish 3 new management units with independent water level management; constructing a new setback with exterior berm degrade to increase floodplain connectivity; constructing a new pump station to improve water conveyance throughout the project area; restoring historic meanders; and restoring floodplain forest.

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

A. The project is anticipated to improve the value of Clarence Cannon National Wildlife Refuge for migratory and resident wetland and aquatic species.
B. Aside from temporary disturbance, no long-term adverse impacts to natural or cultural resources are anticipated. No state or Federal endangered or threatened species would be adversely affected by the proposed action.
C. The project is in compliance with Sections 401 and 404 of the Clean Water Act.
D. The project is in compliance with Section 106 of the National Historic Preservation Act.
E. No significant social or economic impacts are expected to occur as a result of the proposed action.
F. No hazardous or toxic waste issues are expected.
G. No adverse significant cumulative impacts are anticipated.

Prior to construction, all applicable permits will be obtained. Construction activities and sequencing will follow any specific restrictions for protected species as outlined by the U.S. Fish and Wildlife Service in order to minimize impacts to these species. Specific restrictions relative to any construction sequencing will be included as part of the contract specifications. The contracting officer will ensure appropriate compliance.

The "No Federal Action" Alternative was evaluated and is unacceptable to recommend as it does not meet the project goal of restoring and improving the quality and diversity of wetland habitat in the project area.

I have reviewed the information provided by this Environmental Assessment, along with data obtained from Federal and state agencies having jurisdiction by law or special expertise, and from the interested public. I find that the proposed habitat restoration project at the Clarence Cannon National Wildlife Refuge would not significantly affect the quality of the human environment. Therefore, it is my determination that an Environmental Impact Statement is not required. This determination may be reevaluated if warranted by further developments.

_____	_____
Date	Christopher G. Hall Colonel, U.S. Army District Commander