DRAFT ENVIRONMENTAL IMPACT STATEMENT
for the
ST. JOHNS BAYOU
NEW MADRID FLOODWAY
PROJECT

U.S. Army Corps of Engineers
Memphis District

ST. JOHNS BAYOU AND NEW MADRID FLOODWAY DRAFT ENVIRONMENTAL IMPACT STATEMENT July 2013

Volume 1 – Environmental Impact Statement

Volume 1

Draft Environmental Impact Statement and Appendices

U.S. Army Corps of Engineers
Memphis District

2013 Draft Environmental Impact Statement St. Johns Bayou and New Madrid Floodway Project

ABSTRACT

This draft Environmental Impact Statement (EIS) provides information regarding the formulation and evaluation of proposed actions to lessen the risk of damage, dislocation, and disruption due to recurrent heavy flooding in portions of New Madrid, Mississippi, and Scott Counties in southeast Missouri. This would be accomplished by constructing a flood protection levee, two floodwater pumping stations, ditch modifications, and other related water features in the St. Johns Bayou Basin and the adjacent New Madrid Floodway.

As built, the New Madrid Floodway is open at its southern end where an approximately 1500-foot gap exists between the frontline and setback levees, through which Mud Ditch flows. It is through this opening that the floodway drains, but it is also where flooding, known as backwater flooding, regularly occurs, when the rising Mississippi River backs up into New Madrid Floodway. The Flood Control Act of 1954 authorized construction of a levee, with an outlet structure for Mud Ditch that would close the gap, thereby effectively eliminating the backwater flooding threat. However, the New Madrid Floodway would continue to be activated in the event of catastrophic flooding. Because of concerns that closing the gap would create a flooding problem from waters impounded within the floodway, the gap-closing levee has not been built.

The St. Johns Bayou Basin is a 324,173-acre watershed situated between Commerce, Missouri and New Madrid, Missouri, bounded by the New Madrid Floodway setback levee and frontline levee on the east, Sikeston Ridge on the west, and the Commerce Hills to the north. St. Johns Bayou, which runs to the east of East Prairie, Missouri, flows out of the basin through a gated outlet structure in the New Madrid Floodway setback levee (consisting of six 10- by 10-foot culverts) that was built in 1953 as part of a levee constructed to close a 4,200-foot gap between the setback levee and the Sikeston Ridge levee. These features prevent backwater flooding in the St. Johns Bayou Basin, but when the outlet structure is closed, St. Johns Bayou and waters from other streams and the basin’s extensive system of agricultural ditches are impounded, causing or contributing to other flooding, sometimes severe, in East Prairie and elsewhere in the St. Johns Bayou Basin. The Water Resources Development Act of 1986 authorized construction of a pumping station and channel modifications to reduce the flood threat. In addition to flood control improvements in the St. Johns Bayou Basin, the Water Resources Development Act also authorized the construction of a pumping station in the New Madrid Floodway.

The flood pulse is the principle driving force responsible for the existence, productivity, and interactions of the major biota in river-floodplain ecosystems (Junk *et al.*, 1989). Its role in unaltered ecosystems is understood. However, the St. Johns Bayou and New Madrid Floodway are manipulated environments with flood regimes that can be described as highly anthropogenically modified. The flood pulse provides wetland hydrology and fish and wildlife habitat while flooding destroys property and causes other

damage, dislocation, and disruption. This makes flood risk reduction and environmental protection competing—but not necessarily or wholly incompatible—interests in this case, in an area that is both economically important and ecologically valuable.

The draft EIS analyzes a reasonable range of alternatives including avoid and minimize measures that result in a reduction of environmental impacts compared to the originally authorized project. Avoid and minimize measures were formulated to reduce the direct impact as well as to maintain connectivity with the Mississippi River to a significant portion of the New Madrid Floodway. These measures include, but are not limited to: conducting channel work from only one stream bank (as opposed to both), reducing proposed channel bottom widths by 80 feet in St. Johns Bayou, and allowing a floodplain connection to 289.5 feet during the winter period (15 November to 28/29 February) in the New Madrid Floodway.

Alternative 3.1 is the tentatively selected plan. It consists of closure of the New Madrid Floodway at the location of the 1,500-foot gap, construction of a 1,500 cubic foot per second (cfs) pumping station in the New Madrid Floodway, construction of a 1,000 cfs pumping station in the St. Johns Bayou Basin, modifications to 23 miles of ditches in the St. Johns Bayou Basin, waterfowl management during waterfowl season in both basins, and manages flood risks in a manner that recognizes the benefit of the flood pulse to the remaining natural environment.

The estimated cost of the tentatively selected plan is $164,779,000. Average annual cost of the project is $7,249,000. Average annual benefits are $15,501,000. The combined benefit to cost ratio is 2.1 (discount rate of 4.000). Benefit to cost ratio of the New Madrid Floodway closure only is 3.3 at the authorized rate of 2.50%.

Comments: Please send your comments regarding the draft EIS to:

District Engineer
US Army Engineer District, Memphis
Attn: Project Management Branch (SJNM)
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Comments should arrive no later than September 9, 2013, which is 45 days following the July 26, 2013 publication of the Notice of Availability in the Federal Register. For further information or to submit comments via email, please contact:

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Summary

S1. Introduction

This draft Environmental Impact Statement (EIS) prepared according to the National Environmental Policy Act (NEPA), NEPA regulations of the Council on Environmental Quality, and NEPA directives of the Department of the Army and of the U.S. Army Corps of Engineers (USACE), assesses the reasonably foreseeable impact on the human environment of a proposal to alleviate flooding in portions of New Madrid, Mississippi, and Scott Counties in southeast Missouri, by constructing flood risk reduction features in the St. Johns Bayou Basin and in the adjacent New Madrid Floodway.

Although this draft EIS supplements the document prepared in 1976 entitled *Mississippi River and Tributaries Project* for the Closure of the New Madrid Floodway and its supplement, the 1982 St. Johns Bayou and New Madrid Floodway supplemental EIS; it does not incorporate or supplement the 2002 Revised Supplemental Environmental Impact Statement or the 2006 Revised Supplemental Environmental Impact Statement 2. Both of these NEPA documents were set aside by the U.S. District Court decision and are no longer applicable due to the major changes made for the completion of the 2013 draft EIS. However, applicable sections of prior documents as well as previous feasibility level analysis were included in the draft EIS where appropriate. Unless specifically indicated in this draft EIS, past comments, interagency agreements, and compensatory mitigation decisions were not considered as updated data and more accurate environmental methodologies, analyses, and results were used in this analysis.

Elevations presented in this draft EIS are in feet above sea level. Unless otherwise indicated, elevations in the St. Johns Bayou Basin are based on National Geodetic Vertical Datum (NGVD) of 1929 and those presented in the New Madrid Floodway are based on North America Vertical Datum (NAVD) of 1988. Applicable adjustments have been made to account for the different survey datum. To correlate a Mississippi River NGVD elevation at New Madrid to stage (MS115 gage located at river mile 889) subtract 255.48 (gage zero) from the applicable elevation; to correlate a Mississippi River NAVD elevation at New Madrid to stage subtract 255.71 (gage zero) from the applicable elevation.

For clarity, flood frequency is expressed in return periods instead of probability format. For example, a flood that has a 50 percent annual chance of exceedence is expressed as the 2-year flood. Similarly, a flood with a 1 percent annual chance of exceedence is expressed as the 100-year flood. Specific terms that required defining are presented in the glossary.

S2. Project Purpose and Need

USACE is obliged by law to accomplish the will of Congress for flood risk management[1] in Southeast Missouri. The statutory authority for and requirement to act in this case direct USACE to reduce the likelihood and adverse effects—on agricultural and urban lands—of backwater flooding in the New Madrid Floodway and flooding due to the impounding of waters in St. Johns Bayou Basin (currently) and the New Madrid Floodway (in the future).

Using its project-specific and other civil works authorities, the challenge before USACE is to perform its mission, serving public welfare and national economic development, within the constraints of applicable environmental and natural resources laws. Beginning with the Chief of Engineers report of 1952, and continuing with the 1975 environmental impact statement *St. Johns Bayou and New Madrid Floodway Missouri* and the 1983 Chief of Engineers report, USACE has undertaken extensive studies in the project area, resulting in not only a better understanding of the environment but also in a number of modifications to the nature and number of the flood risk management features and activities being considered. USACE also sought and heavily utilized extensive input from its local partner (the St. John Levee and Drainage District of Missouri), a variety of federal and state agencies, and the public.

With the exception of flood waters entering via the 1,500-foot gap located at the lower end of the New Madrid Floodway, the entire New Madrid Floodway is protected from high Mississippi River stages. Table S.1 provides existing flood frequencies and inundated acres[2] in both basins.

Table S.1. Existing flood frequencies and associated inundated acres, St. Johns Bayou Basin and New Madrid Floodway.

Event	St. Johns Bayou Basin		New Madrid Floodway		Total
	Elevation (Feet)	Acres	Elevation (Feet)	Acres	Acres
1.01 year	281.6	753	279.3	404	1,157
2-year	291.0	11,904	292.1	33,391	45,295
5-year	294.1	20,407	296.6	58,990	79,397
10-year	295.6	26,972	298.7	70,749	97,721
20-year	296.9	38,433	300.5	81,758	120,191
50-year	298.4	43,483	302.5	93,396	136,879

[1] Additional information on the history of USACE activities in New Madrid Floodway and St. Johns Bayou Basin, along with information on previous USACE studies and other relevant legislation, may be found in Appendix D, Part 2.

[2] Associated inundated acres were calculated by interpolating between contour elevations. For example, acreages associated with 281.6 were calculated by calculating the difference in acreages from 281 and 282, multiplying by 0.6, and adding the amount to the acreages of 281.

Within the project area, flooding causes social impacts primarily associated with community isolation and economic impacts primarily to agricultural areas and to a lesser extent infrastructure.

Although flooding impacts socio-economic resources, it is also the principal driving force responsible for the existence, productivity, and interactions of the major biota in river-floodplain systems (Junk *et al.*, 1989).

S3. Collaborative NEPA and Review Process

An Independent External Peer Review (IEPR) was utilized throughout the development of the draft EIS. Figure S.1 provides an example of the significant amount of independent expert involvement in development, review, and application of environmental models throughout the progress of the draft EIS. The independent panel was staffed with nationally-recognized experts to ensure objective, scientifically accurate information is presented in this draft EIS to assist in agency decision making. In addition to IEPR involvement, inter-agency coordination was maintained throughout the formulation of the draft EIS, including the independent external peer review process, model certification review process, scoping, project work plan, alternatives, impact analyses, and compensatory mitigation measures.

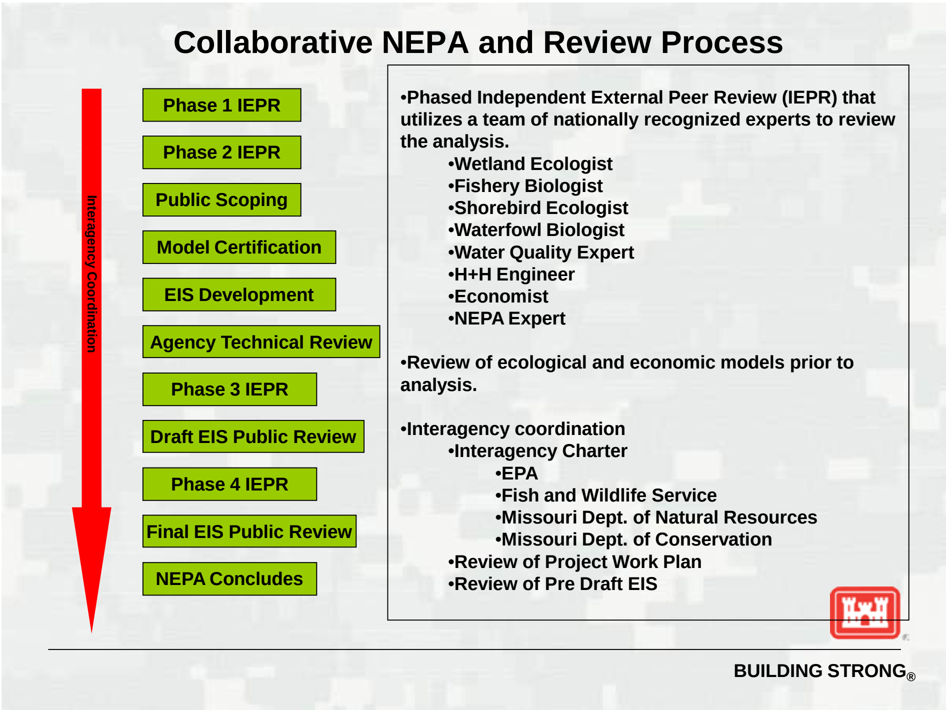

Figure S.1. Overview of IEPR involvement in review of environmental models used in analysis associated with the St. Johns Bayou and New Madrid Floodway Project.

The IEPR process was conducted in four phases. During Phase 1 IEPR, the panel reviewed past NEPA documentation to determine the adequacy of past NEPA documents and ensure that the scope of any future NEPA document would be complete and scientifically accurate. In addition to the consolidated 2002 and 2006 NEPA documents, the U.S. District Court decision was also submitted to ensure that the panel was aware of environmental concerns contrary to that of USACE. A project briefing was held for the panel as well as the interagency team on 4-5 August 2009. The project briefing included a tour of the project area. Based on the outcome of the Phase 1 IEPR, USACE determined that a new EIS was required in lieu of a revision or supplement.

Based on recommendations from the Phase 1 IEPR as well as interagency coordination, a Project Work Plan was developed that specifically outlined the methodologies and assumptions that were to be used to complete the new environmental impact analysis. The Project Work Plan also contained preliminary alternatives and mitigation options that would likely be analyzed. A draft of the Project Work Plan was submitted to the interagency team for comment and an interagency meeting was conducted in December 2009 to discuss the overall aspects of the plan. The plan was revised and resubmitted to the interagency team for additional comment on 4 February 2010. The revised plan and interagency comments were submitted to the same panel of experts to conduct Phase 2 IEPR. The purpose of submitting the interagency comments was to ensure that the panel was aware of any opinions and views that were contradictory to that of USACE.

The panel identified numerous issues with the Project Work Plan that required extensive coordination between the USACE and the panel. A series of teleconferences occurred between USACE and the independent panel to clarify and discuss all of the issues. The interagency team was invited to participate in all discussions with the independent panel. With the exception of one issue relating to shorebird mitigation, the panel and USACE were able to reach resolution on all issues. An Addendum to the Phase 2 IEPR report was prepared to document the extensive coordination between USACE and the panel.

Utilizing the methodologies outlined in the Project Work Plan and revisions as a result of the Phase 2 IEPR, USACE conducted environmental analysis. The environmental analysis included the results of public scoping. A pre-draft EIS was completed that documented all of the preliminary conclusions. The pre-draft EIS was submitted for USACE Agency Technical Review as well as preliminary review by the interagency team. Although the entire team was requested to provide feedback, comments were only received by the EPA. USACE revised the pre-draft EIS based on Agency Technical Review and interagency preliminary review. The revised pre-draft EIS and EPA's comments were submitted to the same panel of experts for Phase 3 IEPR.

The panel provided numerous recommendations on the pre-draft EIS. Following discussions with the panel, revisions were made to the draft EIS to incorporate recommendations or address the panel's concerns. The final phase of IEPR will consist of a pre-final EIS that will include USACE's response to public comments.

In addition to IEPR for the overall NEPA effort, ecological models underwent a separate review by independent panels of nationally-recognized experts selected by an impartial party (e.g., Battelle). The purpose of these reviews was to ensure the scientific integrity of the models that would be employed to support project decisions.

S4. Alternative Analysis

The alternative development process begins by identifying a wide array of preliminary flood control alternatives and then, by application of carefully formulated selection criteria, establishing a reasonable range of feasible alternatives. Ultimately, eight alternatives were carried forward for detailed analysis, including the required no action alternative, and the process by which they were selected. These are:

- Alternative 1: no action;
- Alternative 2.1: construct and operate flood control improvements in the St. Johns Bayou Basin only;
- Alternative 2.2: construct and operate flood control improvements in New Madrid Floodway only;
- Alternative 2.3: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway;
- Alternative 3.1: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway, with seasonal flood pulse management and measures to avoid and minimize environmental impact;
- Alternative 3.2: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway, with seasonal flood pulse management affording greater springtime flood protection and measures to avoid and minimize environmental impact;
- Alternative 4.1: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway with floodplain connectivity maintained up to an elevation of 289.5 feet and measures to avoid and minimize environmental impact; and
- Alternative 4.2: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway with floodplain connectivity maintained up to an elevation of 289.5 feet, reforestation of agricultural lands below an elevation of 289.5 feet, and measures to avoid and minimize environmental impact.

S5. Tentatively Selected Plan

Alternative 3.1 is the tentatively selected plan. The tentatively selected plan consists of the following:

- Closure of the 1,500 gap by means of a closure levee. The levee would be constructed of 233,000 cubic yards of earth and have a crown elevation of 317.0 feet, top width of 16 feet, base width of approximately 302 feet, and side slopes of 4.5:1.

- Construction of four gated 10-foot by 10-foot box culverts across Mud Ditch. Gates would only be closed during periods of waterfowl management or high Mississippi River stages.
- Raising the lower section of the Frontline Levee to an equivalent grade of 317.0 feet. This would require approximately 127,000 cubic yards of material. The levee would have a similar footprint as the closure levee.
- Raising the crown elevation along 14.1 miles of the Setback Levee. It is anticipated that 2.4 million cubic yards of material would be required. No changes to the base width are proposed. Therefore, construction would be entirely confined to the existing levee footprint.
- Construction of a 1,500 cfs pump station in the New Madrid Floodway at the closure location.
- Management of water levels in the New Madrid Floodway by means of the gated structure and pump as follows:
    - 15 Nov – 28 Feb – 289.5 feet maximum
    - 1 March – 15 April – 288 feet maximum
    - 16 April – 31 May – 284 feet maximum
    - 1 Jun – 14 Nov – 280 feet maximum
- Impoundment of water in the New Madrid Floodway to an elevation of 284.4 feet from 1 December to 31 January to benefit waterfowl.
- Modification of St. Johns Bayou Basin channels as follows:
    - 3.7 miles of the lower St. Johns Bayou would be enlarged from one side to a bottom width of 120 feet. Material would be deposited along the bank and would revegetate naturally as a conservation easement.
    - The lower 8.1 miles of Setback Levee Ditch would be enlarged from 40 feet to 50 feet along the left descending bank. Approximately 675,000 cubic yards of material would be placed in a 120-foot wide embankment and allowed to revegetate naturally as part of a conservation easement.
    - The lower 3.5 miles of St. James Ditch would be enlarged along the left descending bank by increasing the bottom width from 35 feet to 45 feet. The remaining 7.8 miles of channel work would increase the top bank width to 80 feet. Approximately 630,000 cubic yards of excavated material would be placed on a 100-foot wide embankment along the left descending bank.
- Construction of a 1,000 cfs pump station in the St. Johns Bayou Basin.
- Maintain of the current operation plan for the St. Johns Bayou gravity outlet structure (*i.e.*, close gates to prevent backwater flooding).
- Impoundment of water in the St. Johns Bayou Basin to an elevation of 285.0 feet from 1 December to 31 January to benefit waterfowl.

S6. Compensatory Mitigation

Compensatory mitigation is proposed for unavoidable project-induced adverse impacts. Project-induced impacts were calculated by the model developers in consultation with USACE and the inter-agency team using the specific methodologies and assumptions outlined in the Project Work Plan[3] and model-specific parameters.[4]

To compensate for unavoidable impacts to different resource categories associated with the St. Johns Bayou Basin portion of the project, the following mitigation plan is proposed:

- Restore impacted ditch functions in channel modification reaches by:
    - Constructing nine transverse dikes in the lower 3.7 miles of St. Johns Bayou to create a low flow sinuous channel.
    - Constructing a bank stability structure (*i.e.,* weir) at the confluence of St. Johns Bayou and Setback Levee Ditch to provide stability as well as structure.
    - Constructing a bank stability structure at the confluence of Setback Levee Ditch and St. James Ditch.
    - Creating stream bank slopes that are designed to prevent erosion and maximize fish and wildlife habitat.
    - Establishing buffer strips consisting of both woody vegetation and warm season grasses along reaches of ditches that were previously farmed to top bank as well as replanting vegetation in areas cleared by construction efforts.

- Restore vegetated wetlands on 400 acres of agricultural land below an elevation of 285 feet.
- Restore vegetated wetlands on 1,816 acres below the post project 5-year floodplain.
- Ecologically design and construct 387 acres of borrow pits.
- Seasonally inundate 244 acres of farmland during the spring shorebird migration period.

To compensate for unavoidable impacts to different resource categories associated with the New Madrid Floodway portion of the project, the following mitigation plan is proposed:

- Restore hydrology to Big Oak Tree State Park by means of a gated culvert through the Mississippi River Frontline Levee.
- Restore vegetated wetlands on a minimum of 1,800 acres of farmland surrounding Big Oak Tree State Park.

[3] The Project Work Plan was reviewed during Phase 2 IEPR.
[4] Each model underwent a review by different panels of recognized experts.

- Restore vegetated wetlands on 387 acres of farmland below an elevation of 285 feet.
- Restore vegetated wetlands on 1,970 acres of farmland below the post project 5-year floodplain.
- Remove 3,050 acres of cropland from production in the batture and allow them to revert to bottomland hardwoods/riverfront forest naturally (vegetated wetlands).
- Ecologically design and construct 60 acres of borrow pits.
- Seasonally inundate 1,286 acres of farmland during the spring shorebird migration period. This would be accomplished by crediting the existing shorebird habitat provided by Ten Mile Pond Conservation Area (*i.e.*, 993 acres of moist soil units) pursuant to the project's specific Congressional authorization as well as the creation of an additional 293 acres of seasonally inundated farmland.
- Restore 432 acres of floodplain lakes, such as Riley Lake.
- Plant buffer strips surrounding ecologically designed borrow pits.

As seen in the proposed mitigation measures, a holistic watershed approach to compensatory mitigation has been proposed. USACE has developed, through collaboration with the interagency team and completion of a historic land use inventory of the project area, mitigation measures that incorporate a full range of resource management activities, including:

- Improving ecological services, such as water quality in the project area watershed, and subsequently the Mississippi River Basin. Currently, over 80 percent of the project area is devoted to agricultural production and agricultural drainage ditches are a common feature throughout the landscape. While some reaches of larger ditches and streams have areas of appropriate riparian buffer, a vast majority of the project area ditches have little to no buffer and are farmed to top bank. The intensive soybean and corn farming operations coupled with the lack of protective buffers along ditches capable of retaining sediments and nutrients result in the area being a top contributor to Gulf of Mexico hypoxia. Water quality analysis conducted for the project concluded that the project showed little effect on total phosphorous, total nitrogen, and organic carbon export in the St. Johns Bayou Basin. However, in the New Madrid Floodway, net average export of total phosphorus and total nitrogen would be reduced by about 15-20 percent by the tentatively selected plan due to the establishment of compensatory mitigation features. In addition, the tentatively selected plan reduces organic carbon export by approximately 40 percent. Results comparing nitrogen loading analysis post-project with mitigation indicate that agricultural land taken out of production and reforested would yield significant nitrogen loading reductions, roughly 12,000 tons over the project life, leading to a reduction in non-point source pollution being delivered to the Mississippi River and possibly a reduction in growth of the hypoxic zone in the Gulf of Mexico. Carbon sequestration is also substantially increased with project mitigation measures in place, nearly 2 million tons more than with the no action alternative, helping to offset the effects of global climate change by sequestering greenhouse gas emissions.

- Providing forest management planning, including restoration of over 9,400 acres of wetlands. Historically, bottomland hardwoods covered much of the Mississippi Alluvial Valley and periodic flooding was commonplace. However, less than 20 percent of this important habitat remains and water resource developments for flood control and agricultural enhancement have drastically reduced the flood return interval on remaining habitats. The tentatively selected plan proposes to take agricultural land, most of which is at low elevation and frequently subject to Mississippi River flood pulses, and revert it to historic forest habitat. With the exception of shorebirds, flooded agricultural land provides little to no habitat and the prior conversion of bottomland hardwoods to cropland is responsible for the vast majority of wetland and habitat losses throughout the Mississippi River Alluvial Valley and Nation. Bottomland hardwood forests can support as many as five times as many game animals as nearby pine and upland forests. Many non-game species, such as small mammals, owls, raptors, and neotropical migrants also find ideal habitat in bottomland hardwood forests. The tentatively selected plan proposes to acquire mitigation land in large blocks which provides much needed wildlife travel corridors in the project area. In addition to forest restoration within the floodway, restoration is also proposed in the batture area. Forested areas along the Mississippi River are among the nation's most important wetlands. They provide space for dispersal and temporary storage of flood waters, reducing potential damages from floods. Bottomland hardwoods growing in the batture are especially important to various fish species during annual flooding for food production, feeding, spawning, and rearing of young. Spring flooding allows many species of fish to spawn in the forested wetlands. Bottomland hardwoods also contribute to water quality by reducing sediment loads, filtering out chemical and organic wastes, and reducing nutrients, as well as reducing erosion by binding the soil with root systems.

- Providing year round fish habitat in the form of ecologically designed borrow pits and floodplain lakes. Borrow pits are an excellent method to compensate for impacts to floodplain spawning and rearing habitat (*i.e.*, inundated agricultural lands) and provide excellent nursery habitat. Each pit would be designed so approximately half of the pit would be an average of six feet in depth, and the remaining half would be an average of three feet in depth. Shoreline sinuosity would also be incorporated into the design. Although there are many floodplain lakes located in the batture, many of these lakes are degraded due to past drainage projects and high sediment loads of the Mississippi River. Additionally, there are fewer of these lakes and new lakes are not forming due to the levee system and navigation structures. Floodplain lakes located in the Mississippi Alluvial Valley have large aquatic populations of plants and animals. The total biomass of fish averages roughly 600 lbs/acre, indicating high fishery production. Periodic flooding recharges and relieves periodic overpopulation in floodplain lakes and results in a net export of fish to Mississippi River habitats. Furthermore, providing floodplain lakes and ecologically designed borrow pits would provide a reliable source of food for the interior least tern.

- Providing parkland management planning through hydrologic restoration of Big Oak Tree State Park and acquisition of 1,800 of prior converted cropland surrounding the park which would be restored to historic bottomland hardwood forest. Under existing conditions, Big Oak Tree State Park, of which 80 acres has been designated a National Natural Landmark by the U.S. Department of Interior is experiencing drier conditions due to adjacent flood control practices. A hydrologic connection to the Mississippi River would be restored to the park by constructing a water delivery system. The restored flood pulse would inundate the park and mimic a flood regime as if the levees had not been constructed. Otherwise, the current drying condition is expected to continue under future without project conditions.

The project would be monitored and adaptive management reports would be prepared at prescribed intervals until mitigation has been determined to be successful. All aspects of the project would be monitored including flood risk management structures and compensatory mitigation (according to the requirements of the Mitigation Rule). Adaptive management would recommend if changes are warranted. Adaptive management reports may conclude that the overall management of water levels should be adjusted or no changes are warranted. The cost of monitoring and adaptive management is included in the project's total cost and would also be reflected in the Project Cooperation Agreement with the non-Federal sponsor.

S7. Section 404 Findings

As required by Section 404(b)(1) of the Clean Water Act (CWA), an evaluation to assess the short- and long-term impacts associated with the discharge of dredged and fill materials into Waters of the United States resulting from this project has been completed. The tentatively selected plan includes features that were designed to avoid to the extent practicable wetlands and Waters of the United States, including reducing impacts in the St. Johns Bayou Basin by reducing channel dimensions and in the New Madrid Floodway by allowing for a much greater level of connectivity with the Mississippi River. Unavoidable project-induced adverse impacts to wetlands will be compensated.

S8. Findings on Executive Order 11988, Floodplain Management

Executive Order 11988, Floodplain Management (signed 24 May 1977), requires Federal agencies to recognize the significant values of floodplains and to consider the public benefits that would be realized from restoring and preserving floodplains. The Executive Order has an objective the avoidance, to the extent possible, of long and short-term adverse impacts associated with the occupancy and modification of the base floodplain and the avoidance of direct and indirect support of development in the base floodplain wherever there is a practical alternative. Under this Order the Corps of Engineers is required to provide leadership and take action to:

a. Avoid development in the base floodplain unless it is the only practical alternative;

b. Reduce the hazard and risk associated with floods;
c. Minimize the impact of floods on human safety, health, and welfare; and
d. Restore and preserve the natural and beneficial values of the base floodplain.

It is the policy of the Corps of Engineers to formulate projects which, to the extent possible, avoid or minimize adverse impacts associated with the use of the base floodplain and avoid inducing development in the base floodplain unless there is no practical alternative. The tentatively selected plan complies with the project for the following reasons:

- The significant value of the floodplain to fish and wildlife resources and wetland functions were assessed and mitigation is proposed to compensate for unavoidable significant impacts.
- Floodplain restoration of Big Oak Tree State Park is a priority of the project's mitigation.
- With the exception of conversion of agricultural land to forested areas as a result of the project's mitigation or WRP enrollment no land use change is expected. Although agricultural areas will intensify, no significant residential development is expected to occur.
- The project reduces the flood hazard and risk to residents, infrastructure, and agricultural areas within the floodplain.
- The tentatively selected plan recognizes the importance of the floodplain by maintaining a level of connection between the Mississippi River and the New Madrid Floodway during portions of the year and at elevations that do not impact socio-economic resources.
- The project will not significantly increase flood heights to adjacent or downstream areas during significant flood events.
- The project will not change the operation of the Birds Point to New Madrid Floodway. The Floodway will continue to be operated as authorized by law. The project will not result in increased time period of operation or an increased time period for a decision to operate. No significant impacts are anticipated to adjacent and downstream areas.

Additional information is found throughout the draft EIS.

S9. Findings on Executive Order 11990, Protection of Wetlands

Executive Order 11990 directs Federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands if a practical alternative exists. Furthermore, agencies shall consider the action's effect on (a) public health, safety, and welfare, (b) maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources, and (c) other wetland uses. Avoidance is determined first by demonstrating that the proposed project is water dependent, and secondly by demonstrating that the proposed project is the least environmentally damaging practicable alternative. Since the purpose and need of the project is to mange flood risks in the area, impacts on Waters of the United States, other waters, and wetlands would be unavoidable.

Alternatives were formulated that minimize the impacts to wetlands. With the exception of direct impacts as a result of channel modifications and fill, the project would indirectly impact wetlands as a result of changes to flood frequencies and durations. The wetlands would still exist following the completion of the project. However, they would not be flooded as frequent or as long as presently observed under existing conditions. Although the project will not impact overall acreages of wetlands, the impacts to functions as a result of hydrologic changes have been assessed and mitigation is proposed to compensate for the impacts to significant wetland functions.

S10. Findings on Executive Order 12898, Environmental Justice in Minority and Low Income Populations

This Executive Order directs all Federal agencies to take the appropriate steps to identify and address any "disproportionately high and adverse" human health or environmental effects of Federal programs, policies, and activities on minority and low-income populations. Implementation of the proposed action in the project area would manage flood risks in an area with existing lower level protection. Thus, implementation will benefit all residents of these areas alike. Likewise, the project will not impact Mississippi River flood stages or future operation of the Birds Point to New Madrid Floodway. Therefore, the project will not impact adjacent communities including minority and low-income populations.

S11. Unresolved Issues

S11.1 State of Missouri Water Quality Certification

USACE will request water quality certification from the State of Missouri.

S11.2 Endangered Species

The U.S. Fish and Wildlife Service did not concur with the biological assessment completed for the interior least tern. The Fish and Wildlife Service deferred formal consultation until the draft EIS, or similar document was submitted. Consultation is on-going and is anticipated to be complete prior to the final EIS.

S11.3 U.S. Fish and Wildlife Service Coordination Act Report

The U.S. Fish and Wildlife Service (USFWS) provided a Fish and Wildlife Coordination Act Report (FWCAR) on July 11, 2013 (see Appendix Q, Part 1). The document contains USFWS's findings and recommendations, outlining its vision for what is best for the project area insofar as fish and wildlife are concerned, and raising several issues for further exploration, especially those pertaining to uncertainties in scientific information, analytical methodologies, and statutory constraints. USACE will continue to work collaboratively with USFWS and others on issues raised in the FWCAR during and after the public comment period (e.g., during Independent External Peer Review Phase IV and in developing a Final EIS).

In summary, USFWS recommends that flood risk reduction improvements be constructed in St. Johns Bayou Basin only (Alternative 2.1), and that no action be taken in the New Madrid Floodway. If, however, limiting construction to St. Johns Bayou Basin is not possible, USFWS urges USACE to select Alternative 4.1 over the preferred alternative, Alternative 3.1.

There are challenges associated with water resources development interests regarding the St. Johns Bayou Basin and New Madrid Floodway (i.e., socio-economic impacts vs. fish and wildlife habitat) that must be balanced. The objectives for the project area are derived from the statutes that are the basis for the proposed action. That is, flood risk management focuses on protecting people, places, and social and economic activity in the project area. However, it is also true that bottomland hardwoods connected to the Mississippi River and subject to its flood pulse provide a host of ecological goods and services. Currently, the New Madrid Floodway is a working landscape, providing flood risk reduction as a Floodway, agricultural production, and fish and wildlife habitat. With or without a project, it is expected that the majority of the area will continue as agricultural lands. Harmonizing competing socio-economic and environmental interests is thus a complex, at times a controversial task, one that demands careful consideration of federal investment towards preferred uses of the project area. And it is precisely for this reason that public comment on the FWCAR and on this draft EIS are vitally important.

USFWS has recommended, and USACE has considered and will continue to investigate, the value of retaining connectivity between the Mississippi River and the New Madrid Floodway, as a means of preserving the benefit of the flood pulse to that floodplain, and thereby serving the interests of conservation and preservation advocated by USFWS.[5] The project's statutory authority is to reduce the likelihood and adverse effects—on agricultural and urban lands—of backwater flooding in the New Madrid Floodway and flooding due to the impounding of waters in St. Johns Bayou Basin. With the exception of restoration activities of sustaining some degree of connectivity associated with compensatory mitigation, USACE is not authorized to implement ecosystem restoration measures as a project purpose. To do so, USACE would have to obtain reconnaissance study authorization from Congress and appropriation to determine a federal interest, conduct a cost-shared feasibility study, obtain additional authorization to implement such a plan, and work with a cost-share sponsor to implement the plan.

Additionally, the USFWS's recommendation to implement flood control improvements only in the St. Johns Bayou basin is economically justified (project benefits are greater than project costs, including mitigation). However, such a plan does not consider the

[5] As noted by USFWS, the New Madrid Floodway has considerable potential for conservation and restoration, the floodplain being one of but a very few places in the Lower Mississippi River Valley, outside of batture lands, where this could be accomplished.

socio-economic impacts in the New Madrid Floodway. When project costs and benefits from both basins are combined, constructing a St. Johns Bayou Basin only alternative does not result in the greatest excess benefits.

USACE acknowledges that implementing other alternatives, as urged by the USFWS, would reduce environmental impacts because a larger geographic area remains subject to flooding. Although the decrease in environmental impacts results in less mitigation, when net excess benefits are compared, they do not result in the greatest net excess benefits.

While a preferred alternative has been identified in this draft EIS, one that delivers the greatest annual net excess benefit, according to National Economic Development criteria, USACE has not made a decision on which, if any, alternative to implement. Public comments are beneficial to the holistic decision making process and will also aid in the continued discussion between USFWS and USACE regarding the benefits and impacts of each alternative and the policy implications of each approach. All comments will be given full consideration, and the final EIS will be revised accordingly.

S12. Relationship of Plans to Environmental Requirements

FEDERAL STATUTES	*Alt. 2.1*	*Alt. 2.2*	*Alt. 3.1*	*Alt 3.2*	*Alt. 4.1*	*Alt 4.2*
1. Archaeological and Historic Preservation Act of 1974. Compliance requires Corps to undertake recovery, protection, and preservation of significant cultural resources whenever its activities may cause irreparable loss or destruction of such resources.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
2. Clean Air Act, as Amended. Compliance requires coordination with the U.S. Environmental Protection Agency and analysis of potential impacts on air quality.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
3. Clean Water Act of 1977. Compliance requires preparation of 404(b)(1) Evaluation and submission of such to Congress with the draft EIS or procurement of state water quality certification (WQC). See, Appendix E, for the 404(b)(1) evaluation. Pending State WQC.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
4. Endangered Species Act of 1973, as Amended. Compliance requires coordination with the U.S. Fish and Wildlife Service (USFWS) to determine if any endangered or threatened species or their critical habitat would be impacted by the project.	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*
5. Federal Water Project Recreation Act. Compliance requires review by the Department of the Interior. Coordination of the draft EIS will bring	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*

the project into full compliance.						
6. Fish and Wildlife Coordination Act. Compliance requires coordination with the USFWS and recommendations are discussed in, Appendix Q, which includes the Fish and Wildlife Coordination Act Report (CAR).	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
FEDERAL STATUTES	*Alt. 2.1*	*Alt. 2.2*	*Alt. 3.1*	*Alt. 3.2*	*Alt. 4.1*	*Alt. 4.2*
7. Land and Water Conservation Fund Act. Compliance requires Secretary of the Interior approval of replacement property that would be acquired to mitigate converted property purchased with LWCFA funds.	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
8. National Historic Preservation Act. Compliance requires Corps to take into account the impacts of project on any property included in or eligible for inclusion in the National Register of Historic Places.	*FC*	*FC*	*FC*	*FC*	*FC*	*PC*
9. National Environmental Policy Act. Compliance requires preparation of this draft EIS, consideration of public comments, and preparation and public review of the final EIS. Signing of the Record of Decision would bring this project into full compliance.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
10. River and Harbor Act.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
11. Farmland Protection Policy Act. Compliance requires coordination with the Natural Resources Conservation Service to determine if any designated prime or unique farmlands are affected by the project.	*FC*	*FC*	*FC*	*FC*	*PC*	*PC*
12. Watershed Protection and Flood Prevention Act. No requirements for Corps projects.	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
13. Wild and Scenic River Act. Compliance requires coordination with Department of the Interior to determine if any designated or potential wild, scenic, or recreational rivers are affected by the project. Coordination has been accomplished and there are no such rivers in the project area.	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
EXECUTIVE ORDER/MEMORANDA	*Alt. 2.1*	*Alt. 2.2*	*Alt. 3.1*	*Alt. 3.2*	*Alt. 4.1*	*Alt. 4.2*
1. Executive Order 11988, Floodplain Management. Compliance requires an assessment and evaluation together with the other general implementation	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*

procedures to be incorporated into EIS.						
2. Executive Order 11990, Protection of Wetlands. Compliance requires results of analysis and findings related to wetlands be incorporated into the EIS.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
3. Executive Memorandum, Analysis of Impacts on Prime and Unique Farmlands in EIS. Compliance requires inclusion of effects of proposed action on prime and unique farmlands in EIS.	*FC*	*FC*	*FC*	*FC*	*PC*	*PC*
4. Executive Order 11593, Protection and Enhancement of the Cultural Environment. Compliance requires Corps to administer cultural properties under their control in stewardship for future generations; preserve, restore or maintain such for benefit of the people; and assure that its plans contribute to preservation and enhancement of non-federally owned sites.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
5. Executive Order 13112, Invasive Species. Compliance requires assessment of potential for the project to introduce invasive species to the project area.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
6. Executive Order 12898, Environmental Justice in Minority and Low-income Populations. Compliance requires assessment of project effects on minority and low-income populations.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*

FC - In Full Compliance
PC - In Partial Compliance
NA - Not Applicable
NC – Not in Compliance, to date

GLOSSARY OF TERMS AND ACRONYMS

AAHU – Average Annual Habitat Units

BMP – Best Management Practices

CD – Connected Depression

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act

CEQ – Council on Environmental Quality

CRP – Conservation Reserve Program

EC – Enterprise Community

EIS – Environmental Impact Statement

EMAP – Environmental Monitoring and Assessment Program

EPA – Environmental Protection Agency

ERDC – Engineer Research and Development Center

ERS – Economic Research Service

FCA – Flood Control Act

FCI – Functional Capacity Index

FCU – Functional Capacity Unit

FEMA – Federal Emergency Management Agency

FPC – Flood Pulse Concept

FSA – Farm Security Administration

HEP – Habitat Evaluation Procedure

HGM - Hydrogeomorphic

H+H – Hydraulics and Hydrology

HSI – Habitat Suitability Index

HTRW – Hazardous, Toxic, and Radioactive Waste

HU – Habitat Units

GRTS – Generalized Random Tessellation Stratified

IEPR – Independent External Peer Review

LGRB – Low Gradient Riverine Backwater

LGRO – Low Gradient Riverine Overbank

LIDAR – Light Detection and Ranging

LMRCC - Lower Mississippi River Conservation Committee

LRR – Limited Reevaluation Report

MDC – Missouri Department of Conservation

MDNR – Missouri Department of Natural Resources

MEA – Millennium Ecosystem Assessment

MINT – Missouri Innovative Nutrient Trading Project

MoDOT – Missouri Department of Transportation

MR&T – Mississippi River and Tributaries Project

NAWQA – National Water Quality Assessment Program

NAACP – National Association for the Advancement of Colored People

NAVD – North American Vertical Datum

NED – National Economic Development

NEPA – National Environmental Policy Act

NGVD – National Geodetic Vertical Datum

NLCD – National Land Cover Dataset

NOI – Notice of Intent

NRCS – Natural Resources Conservation Service

NTT – Nutrient Trading Tool

NTU – Nephelometric Turbidity Unit

RSEIS – Revised Supplemental Environmental Impact Statement

SEIS – Supplemental Environmental Impact Statement

SPARROW – SPAtially Referenced Regressions on Watershed

STFU - Southern Tenant Farmers Union

TMDL – Total Maximum Daily Load

TN – Total Nitrogen

TP – Total Phosphorus

USACE – United States Army Corps of Engineers

USDA – United States Department of Agriculture

USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey

WRP – Wetland Reserve Program

WRDA – Water Resources Development Act

LIST OF DEFINITIONS

Batture - Undeveloped land, lying between the artificial levee and the river.

Backwater Flooding – Overflowing by water of the normal confines of a stream channel due to downstream conditions, such as impounded interior runoff produced by closure of a gravity structure, a debris blockage, or higher stages produced by a receiving stream channel.

Converted wetland - Wetland that had been drained, dredged, filled, leveled, or otherwise manipulated (including the removal of woody vegetation or any activity that results in impairing or reducing the flow and circulation of water) for the purpose of or to have the effect of making possible the production of an agricultural commodity without further application of the manipulations described herein if:

(i) Such production would not have been possible for such action, and

(ii) Before such action such land was wetland, farmed wetland, or farmed – wetland pasture and was neither highly erodible land not highly erodible cropland

Farmed Wetland - Wetland that prior to December 23, 1985, was manipulated and used to produce an agricultural commodity, and on December 23, 1985, did not support woody vegetation and met the following hydrologic criteria:

(i) Is inundated for 15 consecutive days or more during the growing season or 10 percent of the growing season, whichever is less, in most years (50 percent chance or more).

Growing Season - The average date (defined as 50 percent chance; as many freeze dates before as after the date), of the last spring moderate freeze (defined as temperatures in the range of 24-28°) is March 16. The average date of the first fall moderate freeze is November 20. Thus, the average length of the growing season in southeastern Missouri is 250 days (http://climate.missouri.edu/climate.php).

Headwater Flooding - Overflowing by water of the normal confines of a stream channel not due to downstream conditions, such as impounded interior runoff produced by closure of a gravity structure, a debris blockage, or higher stages produced by a receiving stream channel.

Impounded Interior Runoff – Waters produced within a drainage basin that are retained due to closure of a gravity outlet structure or other obstruction such as a debris blockage.

Moist Soil Units – Constructed habitats designed to provide food and cover for a wide variety of waterfowl and other migratory birds. Since quality moist-soil habitats are primarily composed of annual grasses, sedges and forbs, these areas must be maintained in an early successional stage. Management techniques most commonly used are water level management, shallow and deep disking, farming, and herbicide application.

Prime Farmland – Land as determined by the USDA that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. Prime farmland includes land that possesses the above characteristics but is being used currently to produce live stock and timber. It does not include land already in or committed to urban development or water storage.

Prior Converted Cropland - Converted wetland where the conversion occurred prior to December 23, 1985, an agricultural commodity had been produced at least once before December 23, 1985, and as of December 23, 1985, the converted wetland did not support woody vegetation and met the following hydrologic criteria:

> (i) Inundation was less than 15 consecutive days during the growing season or 10 percent of the growing season, whichever is less, in most years (50 percent change or more).

Riverfront Forest – Forest type that is predominant on sites immediately adjacent to large rivers and streams, which occurs over a large portion of the eastern U.S., most abundantly within the Mississippi River watershed and along the east coast. Soils are alluvial, range in texture from sand to clay, and generally moist year-round due to their topographic position and proximity to open water. Flooding occurs seasonally on most sites. The eastern riverfront hardwood forest contains many species, but is usually dominated by sycamore, silver maple, green ash, sugarberry, sweetgum and American elm. Common associates are red maple, boxelder, hackberry, black walnut and slippery elm.

Significant Resource – Resources identified from public scoping, interagency coordination, and/or IEPR in which both the context of the resource importance (e.g., local, regional, national) as well as the intensity of the proposed action on that resource require discussion. Intensity of the action can be beneficial or adverse and must consider the degree to which the proposed action affects those resources.

Sump Area – Level pool area that forms at the outlet of a drainage basin due to backwater flooding or impounded interior runoff.

Unique Farmland - Land other than prime farmland that is used for production of specific high-value food and fiber crops, as determined by the USDA. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality or high yields of specific crops when treated and managed according to acceptable farming methods.

Wetland – Lands as determined by USACE and EPA that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. For the purpose of the draft EIS, this term was only used to describe those wetlands that were also estimated to be Waters of the United States (*i.e.*, jurisdictional). Wetland (non-bold and times new roman font) was used to define classification of others that do not signify jurisdiction.

Waters of the United States –

(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(2) All interstate waters including interstate wetlands;

(3) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:

> (i) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
>
> (ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
>
> (iii) Which are used or could be used for industrial purpose by industries in interstate commerce;

(4) All impoundments of waters otherwise defined as waters of the United States under the definition;

(5) Tributaries of waters identified in paragraphs (a) (1) through (4) of this section;

(6) The territorial seas;

(7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) (1) through (6) of this section.

(8) Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other Federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA.

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1.0 PURPOSE OF AND NEED FOR ACTION

1.1 Introduction, Background, and Proposed Action

The U.S. Army Corps of Engineers (USACE) proposes to lessen the risk of damage, dislocation, and disruption due to recurrent heavy flooding in portions of New Madrid, Mississippi, and Scott Counties in southeast Missouri. This would be accomplished by constructing a flood protection levee, two floodwater pumping stations, ditch modifications, and other related water features in the St. Johns Bayou Basin and the adjacent New Madrid Floodway. The project area is shown in Figure 1.1. This draft Environmental Impact Statement (EIS), prepared according to the National Environmental Policy Act (NEPA), NEPA regulations of the Council on Environmental Quality (CEQ), and NEPA directives of the Department of the Army and of USACE, assesses the reasonably foreseeable impact of the proposed action on the human environment.

The mission of USACE under federal law is to deliver to the American people the flood risk management[1] benefits approved by Congress. USACE, as a partner with states and localities in shared responsibility, is the lead federal agency in charge of protecting people and places from the ravages of flooding in the Mississippi River watershed. Driven largely by the Great Flood of 1927 and the resulting Flood Control Act of 1928, USACE has built, and with local sponsor participation has maintained and operated, an extensive but still incomplete system of flood prevention and control works along the Mississippi River and its tributaries. The very great benefits of the system to the Nation were convincingly demonstrated by how well it performed during the Great Flood of 2011, preventing some $230 billion in flood damages (see Appendix L).

The Birds Point-New Madrid Floodway, a component of the protective system that grew out of the 1928 Flood Control Act, is an approximately 130,000-acre area between a frontline levee (running along the Mississippi River from Bird's Point, Missouri, in the north, to New Madrid, Missouri, in the south) and a setback levee (to the west). It was designed to divert floodwaters from the Mississippi and thereby reduce the likelihood or severity of catastrophic flooding from levee failure or overtopping of mainline levees protecting more than 2.5 million acres at the confluence of the Mississippi and the Ohio River. Since its construction in 1933, the floodway has been opened only twice, the most recent occasion being in 2011 (see Appendix L).

As built, the New Madrid Floodway is open at its southern end where an approximate 1500-foot gap exists between the frontline and setback levees, through which Mud Ditch flows. It is through this opening that the floodway drains, but it is also where

[1] Flood risk management is the term USACE now uses to describe its flood prevention and control and consequence management missions. Flood risk management is the process of identifying, evaluating, selecting, implementing, and monitoring actions taken to reduce flooding-related risks. Social, cultural, ethical, environmental, political, and legal aspects are considered in the process (USACE, 2009). The ultimate purpose of flood risk management is to protect people and places by making them less susceptible to flooding, by limiting how often and how severely flooding occurs.

flooding, known as backwater flooding, regularly occurs, when the rising Mississippi River backs up into New Madrid Floodway. The Flood Control Act of 1954 authorized construction of a levee, with an outlet structure for Mud Ditch that would close the gap, thereby effectively eliminating the backwater flooding threat. However, the New Madrid Floodway would continue to be activated in the event of catastrophic flooding. Because of concerns that closing the gap without a pumping station would create a flooding problem from waters impounded within the floodway, the gap-closing levee has not been built.

The St. Johns Bayou Basin is a 324,173-acre watershed situated between Commerce, Missouri and New Madrid, Missouri, bounded by the New Madrid Floodway setback levee and frontline levee on the east, Sikeston Ridge on the west, and the Commerce Hills to the north. St. Johns Bayou, which runs to the east of East Prairie, Missouri, flows out of the basin through a gated outlet structure in the New Madrid Floodway setback levee (consisting of six 10- by 10-foot culverts) that was built in 1953 as part of a levee constructed to close a 4,200-foot gap between the setback levee and the Sikeston Ridge levee. These features prevent backwater flooding in the St. Johns Bayou Basin, but when the outlet structure is closed, St. Johns Bayou and waters from other streams and the basin's extensive system of agricultural ditches are impounded, causing or contributing to other flooding, sometimes severe, in East Prairie and elsewhere in the St. Johns Bayou Basin.

Mud Ditch and St. Johns Bayou meet just south of the New Madrid Floodway setback levee outlet structure and flow into the Mississippi River about one-half mile east of New Madrid, Missouri. The project area is shown in Figure 1.1. It consists of the drainage area that flows through the St. Johns Bayou outlet structure in the New Madrid Floodway setback levee and the portion of New Madrid Floodway that drains through Mud Ditch.

The flood risk in the St. Johns Bayou Basin and in the New Madrid Floodway are inter-related. Existing levees protect the St. Johns Bayou Basin from Mississippi River flooding. A 1500-foot gap permits Mississippi River flooding to back into the New Madrid Floodway (*i.e.*, backwater flooding). As noted, closing the St. Johns Bayou outlet structure in the New Madrid Floodway setback levee protects the St. Johns Bayou Basin from river flooding but creates a bathtub effect when the outlet structure is closed, by impounding water in the St. Johns Bayou Basin (*i.e.*, impounded interior runoff). Also as noted, a similar result is the main reason why a levee has not been constructed to close the 1500-foot gap in the New Madrid Floodway, leaving it vulnerable to, and at the same time the beneficiary of, Mississippi River backwater flooding. Accordingly, a prudent solution to the flooding problems in the St. Johns Bayou Basin and the New Madrid Floodway must address river flooding and the resulting impounding of waters. The proposed action therefore contemplates contemporaneous action in both the St. Johns Bayou Basin and the New Madrid Floodway.

Destructive backwater flooding in the New Madrid Floodway and equally harmful flooding from impounded interior runoff in the St. Johns Bayou Basin frequently occur, though not every year is equally severe or damaging. Closing the New Madrid Floodway gap, by connecting the frontline levee to the setback levee, would lessen the frequency and severity of backwater flooding there, but additional measures would be required to control waters that would then be impounded within the New Madrid Floodway.

Beginning in 1954, for purposes of the proposed action now under consideration, Congress passed several laws aimed at providing additional flood protection to people, places, and economic activity in the New Madrid Floodway and St. Johns Bayou Basin, directing and empowering USACE to build the civil works needed to do so. The proposed action is thus the means by which USACE would carry-out its congressional mandates. Two of the primary statutes requiring USACE to perform these missions are the Flood Control Act of 1954 and the Water Resources Development Act of 1986.

Section 203 of the Flood Control Act of 1954 states:

> The following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and the supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated and subject to the conditions set forth therein.
>
> …
>
> Lower Mississippi River
>
> …
>
> The project for flood control and improvement of the lower Mississippi River, adopted by the Act of May 15, 1928[2], as amended and modified, is hereby further modified and expanded to include the following items of work and authorization for said project is increased accordingly.
>
> …
>
> (d) Modification of the authorized project for the New Madrid Floodway substantially in accordance with the recommendation of the Chief of Engineers in House Document Numbered 183, Eighty-third Congress, at an estimated cost of $1,743,000.

This act authorized construction of a levee, with an outlet structure for Mud Ditch, which would close the 1500-foot gap between the New Madrid Floodway frontline levee and setback levee.

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[2] The title of the Flood Control Act of 1928 is "An Act for the control of floods on the Mississippi River and its tributaries, and for other purposes."

Section 401(a) of the Water Resources Development Act of 1986 states:

> AUTHORIZATION OF CONSTRUCTION – The following works of improvement for the control of destructive floodwaters are adopted and authorized to be prosecuted by the Secretary substantially in accordance with the plans and subject to the conditions recommended in the respective reports designated in this subsection, except as otherwise provided in this subsection:
>
> …
>
> St. Johns Bayou and New Madrid Floodway, Missouri
>
> …
>
> The project for flood control, St. Johns Bayou and New Madrid Floodway, Missouri: Report of the Chief of Engineers, dated January 4, 1983 at a total cost of $112,000,000, with an estimated first Federal cost of $78,500,00 and an estimated first non-Federal cost of $33,500,00, except that the land for mitigation of damages to fish and wildlife shall be acquired as soon as possible from available funds, including the Environmental Protection and Mitigation Fund established by section 908 of the Act, and except that lands acquired by the State of Missouri after January 1, 1982, for mitigation of damage of fish and wildlife within the Ten Mile Pond mitigation area shall be counted as part of the total quantity of mitigation lands required for the project and shall be maintained by the State for such purpose.

The 1983 report recommended channel clearing, enlargement, and modifications in St. Johns Bayou Basin and the New Madrid Floodway; a floodwater pumping station in the St. Johns Bayou Basin and another in the New Madrid Floodway; and, other environmental and recreational features.

Together, the 1954 act and the 1986 act provide the statutory basis for USACE to address the inter-linked flooding problems that continue to plague the New Madrid Floodway and the St. Johns Bayou Basin

1.2 Purpose and Need

USACE is obliged by law to accomplish the will of Congress for flood risk management[3] in Southeast Missouri. The statutory authority for and requirement to act in this case direct USACE to reduce the likelihood and adverse effects—on agricultural and urban lands—of backwater flooding in the New Madrid Floodway and flooding due to the impounding of waters in St. Johns Bayou Basin (currently) and the New Madrid Floodway (in the future).

[3] Additional information on the history of USACE activities in the New Madrid Floodway and in the St. Johns Bayou Basin, along with information on previous USACE studies and other relevant legislation, may be found in Appendix D, Part 1.

Using its project-specific and other civil works authorities, the challenge before USACE is to perform its mission, serving public welfare and national economic development, within the constraints of applicable environmental and natural resources laws. Beginning with the Chief of Engineers report of 1952, and continuing with the 1975 environmental impact statement *St. Johns Bayou and New Madrid Floodway Missouri* and the 1983 Chief of Engineers report, USACE has undertaken extensive studies in the project area, resulting in not only a better understanding of the environment but also in a number of modifications to the nature and number of the flood risk management features and activities being considered. USACE also sought and heavily utilized extensive input from its local partner (the St. John Levee and Drainage District of Missouri), a variety of federal and state agencies, and the public.

Concerns identified by the public during the scoping process are:

- Flood-induced hardships on residents;
- Flood-generated quality of life issues including community isolation, access to health care, contamination of drinking water sources, and disruption of wastewater treatment services;
- Flood-induced impacts to streets and roads;
- Flood-driven impacts on agricultural production; and
- Flood risk management-related impacts to wetlands, wildlife, waterfowl, shorebirds, fish, mussels, water quality, river connectivity, cultural resources, ecosystem services[4], and ditch habitat.

The lands in the St. Johns Bayou Basin and the New Madrid Floodway are predominantly (*i.e.,* over 80%) agricultural, and the majority of theses agricultural lands are prior converted croplands. Of the 79,397 acres of land in the 5-year flood floodplain, some 6,024 acres of wetlands (vegetated and farmed) remain in the St. Johns Bayou Basin and 9,113 acres in the New Madrid Floodway, scattered across the project area. These lands, due to their hydrological connection to the Mississippi River, especially that resulting from regular flooding, serve a variety of important ecological purposes. Junk *et al.* (1989) describes the phenomenon as the “flood pulse concept.”[5] The flood pulse provides wetland hydrology and fish and wildlife habitat while flooding destroys property and causes other damage, dislocation, and disruption. This makes flood risk reduction and environmental protection competing—but not necessarily or wholly incompatible—interests in this case, in an area that is both economically important and ecologically valuable. Additional information regarding the economic impacts of flooding and the environmental benefits of the flood pulse are discussed in Section 3.

[4] The Millennium Assessment Report (2005) defines ecosystem services as benefits people obtain from ecosystems. Services are categorized as supporting services, provisioning services, regulating services, and cultural services.
[5] Junk *et al.* (1989) developed the Flood Pulse Concept (FPC) that states the flood pulse is the principal driving force responsible for the existence, productivity, and interactions of the major biota in river-floodplain systems.

Agriculture has flourished in the St. Johns Bayou Basin and the New Madrid Floodway as a direct consequence of the protection afforded by the levee system and drainage, with the result that the formerly expansive bottomland hardwood forest landscape has been extensively modified. These alterations produced well-documented environmental changes, but both areas, despite prodigious agriculture-oriented development, remain ecologically valuable as well as economically productive. Table 1.1 illustrates the acreage inundated in the St. Johns Bayou Basin and the New Madrid Floodway by different flood frequencies.

Table 1.1. Existing flood frequencies and associated inundated acres,[1] St. Johns Bayou Basin and New Madrid Floodway.

Event	St. Johns Bayou Basin		New Madrid Floodway		Total
	Elevation (Feet)	Acres	Elevation (Feet)	Acres	Acres
1.01 year	281.6	753	279.3	404	1,157
2-year	291.0	11,904	292.1	33,391	45,295
5-year	294.1	20,407	296.6	58,990	79,397
10-year	295.6	26,972	298.7	70,749	97,721
20-year	296.9	38,433	300.5	81,758	120,191
50-year	298.4	43,483	302.5	93,396	136,879

[1]Associated inundated acres were calculated by interpolating between contour elevations. For example, acreages associated with 281.6 were calculated by calculating the difference in acreages from 281 and 282, multiplying by 0.6, and adding the amount to the acreages of 281.

Flooding within the project area is widely variable. By analyzing a 67-year hydrologic period of record, it can be seen that the Mississippi River may flood at nearly any time of year, but most often in winter and spring, and least often in fall. Likewise, the extent and duration of flooding is also variable. The floods of greatest intensity are most prevalent in winter and spring. Figures 1.2 and 1.3 plot the water surface elevations (*i.e.*, hydrograph) within the St. Johns Bayou Basin (SJBB) and the New Madrid Floodway (NMF), respectively. These non-continuous hydrographs[6] present the maximum (red), mean (blue), median (black), and minimum (green) daily elevations from 1943 to 2009.

As noted, agriculture is the dominant economic engine throughout the project area. Agribusinesses include agricultural commodities, agricultural transportation, and seed and fertilizer sales. The primary crops grown in the project area are soybeans (71 percent), corn (9.5 percent), grain (13.1 percent), sorghum (2.6 percent), and rice (3.3 percent). State and county agricultural profiles (New Madrid and Mississippi counties) are available in Volume 2, Part 2. As of 2007, there were 350 and 228 farms in New

[6] Note that the individual parameter lines do not represent continuous hydrographs. The maximum elevation for 1 January represents the highest elevation that occurred on 1 January considering all years in the period of record. Similarly, the minimum elevation that occurred on 15 March represents the lowest elevation that occurred on 15 March considering all years in the period of record. More detailed information regarding the hydrologic period or record, including yearly hydrographs, is found in Appendix C, Part 1.

Madrid County and Mississippi County with an average size of 1,088 acres and 1,134 acres, respectively. Market value of products sold totaled $141,262,000 (with a per farm average of $403,606), in New Madrid County, and $108,420,000 (with a per farm average of $475,525) in Mississippi County. Total government farm subsidy payments were $13,667,000 (with a per farm average of $42,845) in New Madrid County, and $4,459,000 (with a per farm average of $22,294) in Mississippi County.

When flooding occurs is a consideration that is highly important to area producers. Each year farmers must make risk-based decisions on what to plant and when to plant. More profitable crops such as corn must be planted by late April to early May to obtain profitable yields (Wiebold, 2010). The longer planting date is delayed, the smaller the yield (Table 1.2).). By comparison, less profitable soybeans can be planted later, from late April to 1 June. Delaying planting until June results in a loss of 1 bushel per acre per week, and delaying planting until July results in a loss of three bushels per acre per week (Helsel and Minor, 1993). In short, area farmers can choose to plant more profitable, higher yield crops early in the growing season, when the risk of flooding is greater, or to plant less profitable, lower yield crops later in the growing season, when the risk of flooding is lower. Either way, some risk that flooding would destroy recently planted crops always exists.

Table 1.2. State of Missouri estimates regarding corn planting dates (Wiebold, 2010).

Planting Date	Yield Estimate
1 May	94%
6 May	92%
11 May	89%
16 May	86%
21 May	83%
26 May	80%
31 May	77%
5 June	75%
10 June	71%
15 June	65%

Flooding in the SJBB has been identified by local communities as a primary impediment to prosperity. Flooding in and around East Prairie and other communities in SJBB adversely affects the heavily agriculture-oriented economy, just as it does throughout the rest of the project area. Among several ill effects, flood waters overtop roads, isolating communities, interrupt utility service and damage infrastructure, hinder emergency services and mail delivery, close schools and businesses, and curtail farming activity. East Prairie, one of the communities regularly affected by flooding, favors the congressionally-authorized flood control measures in order to improve the quality of life and living conditions for residents (City of East Prairie, 1994).

Several small communities rich in history are also located throughout the New Madrid Floodway, where flooding causes damage, disruption, and dislocation similar to the SJBB. New Madrid Floodway residents have also expressed strong support for the congressionally-authorized measures to minimize flood risk (see Volume 2, Part 1). Historically, NMF residents' support for the closure has always been conditioned on construction of the pump stations authorized by WRDA 1986, as they have witnessed the damage from waters impounded within SJBB. According to the 2010 Census, there were 307 residents in NMF, though that number may be smaller due to impacts within the floodway from the 2011 flood. Some residents are expected not to return to NMF, but others are returning and rebuilding, possibly reflecting the potentiality that NMF, which prior to 2011 was last flooded (i.e., used for its intended purpose) in 1937, would not have to be inundated again for many years. Additionally, farmers were able to plant upwards of 90,000 acres of soybeans by the summer of 2011 and an additional 30,000 acres of soybeans or corn by spring 2012, indicating that while individuals may not return to the floodway to live, farming continues (Olsen, 2013).

1.2.1 St. Johns Bayou Basin

The primary flood-related issues in the St. Johns Bayou Basin are the economic damages sustained by agriculture (crop and non-crop) and infrastructure (streets and roads), and the consequent social disruption that results from isolation, interruption of services, and other flood-related impacts.

High river stages on the Mississippi River usually occur in winter and spring, resulting in a need to close the gravity-operated St. Johns Bayou outlet structure. The 1.01-year flood covers lands lying at or below an elevation of 281.6 feet. With the exception of 710 acres, flooding is mostly contained within existing waterway channels and ditches in the lower portion of the watershed (Figure 1.4).

The 2-year flood (which has a 50 percent probability of annual occurrence) inundates lands lying at or below an elevation of 291 feet. Approximately 11,904 acres are flooded under these conditions (Figure 1.4). Among other adverse effects that occur when flood waters reach this elevation, County Road 732 is impassable, as are portions of Highway P.

A 5-year flood (which has a 20 percent probability of annual occurrence) submerges lands lying at or below an elevation of 294.1 feet (Figure 1.4). Approximately, 20,000 acres are flooded under these conditions. Agricultural lands make up approximately 14,000 (or 70 percent) of these 20,000 acres.

A 10-year flood (which has a 10 percent probability of annual occurrence) inundates lands lying at or below an elevation of 295.6 feet (Figure 1.4). Approximately 29,000 acres are flooded under these conditions. Agricultural lands make up approximately 19,930 (or 69 percent) of these 29,000 acres. When flood waters reach the 295.3-foot elevation the Missouri Department of Transportation (MoDOT) starts pumping in the median of Interstate 55. Without pumping and sandbagging, Interstate 55 would begin to be impassable when flood waters reach an elevation of 296.4 feet.

A 25-year flood (which has a 4 percent probability of annual occurrence) inundates lands lying at or below an elevation of 297.3 feet (Figure 1.4). Approximately 40,000 acres are flooded under these conditions. Agricultural lands make up approximately 31,000 (or 78 percent) of these acres. Although MoDOT can keep I-55 open with pumping and sandbagging, other transportation corridors (Highways 80 and OO) leading into East Prairie begin to be overtopped, leading to the isolation of East Prairie.

A 50-year flood (which has a 2 percent probability of annual occurrence) inundates land lying at or below an elevation of 298.4 feet. At this elevation, over 43,000 acres are inundated, of which 33,718 (or 78 percent) are agricultural lands. Transportation corridors leading into and out of East Prairie are cut. Depending on rainfall conditions, portions of East Prairie itself may lie beneath the deluge. Intensive pumping and sandbagging efforts are required to keep I-55 open.

Rising floodwaters impounded within St. Johns Bayou Basin follow the network of drainage ditches. Socio-economic problems are compounded when heavy rainfall coincides with high Mississippi River stages, exacerbating the problem caused by impounding St. Johns Bayou. For example, during high Mississippi River stages in April 2008, 7.98 inches of rain fell in Sikeston, Missouri, with a maximum 24-hour total of 3.95 inches (National Weather Service, 2011).

East Prairie and its surroundings drain into St. James Ditch, which flows south until it reaches Setback Levee Ditch, which continues south until it connects to St. Johns Bayou. The drainage ditches in this area are not of sufficient size (*i.e.,* depth and width) to effectively transport the run-off from heavy rain storms. As storm drains in and around East Prairie reach capacity, the water they carry pours into St. James Ditch and then St. Johns Bayou, which are themselves backing up when the St. Johns Bayou outlet structure is closed. Storm waters then flow over and out of the drains, ditches, and St. Johns Bayou, flooding the town and lands around it.

1.2.1.1 Agriculture Damages

Flooding in the St. Johns Bayou Basin imposes a stiff toll in foregone and lost economic opportunity. Reliable estimates of crop damage due to flooding do not exist. Therefore, an economic model was used to quantify the economic impact of flooding on agricultural areas. The model is based on Current Normalized Prices. Additional information can be found in Appendix B.

Flooding destroys recently planted crops, inhibits yield, and delays re-planting. The average annual flood-related economic crop damage in St. Johns Bayou Basin is $4,212,000.

Flooding also damages equipment, irrigation structures, and drainage structures. The average annual flood-related economic non-crop agricultural damage in St. Johns Bayou Basin is $1,326,000, for a total of $5,448,000.

Flooding also constrains what crops may be planted, where, and when. In areas that are subject to frequent floods, instead of planting more profitable crops such as corn, for example, producers are limited to less profitable late-season soybeans.

1.2.1.2 Infrastructure Damages

Floods damage streets and roads. St. Johns Bayou Basin flooding results in average annual economic damage to infrastructure of $102,000. In addition, flooding in the St. Johns Bayou Basin routinely threatens Interstate 55, a major north/south transportation artery that runs through its center. Raising I-55 and its interchanges above the 100-year floodplain would cost the State of Missouri and federal taxpayers approximately $83,000,000.

1.2.1.3 Social Impacts

Community Isolation

Community isolation is a concern to residents in both the SJBB and the NMF, as related during the public scoping meeting. Flooding severs roads causing area residents to sometimes resort to extraordinary measures to perform basic tasks such as going to work, attending school, purchasing groceries, and obtaining medical care. Residents either have to take miles-longer alternate routes or use boats or heavy equipment to navigate flood waters. Flooding also disrupts emergency vehicles from being able to service communities; for example ambulances cannot travel through floodwaters. In addition to emergency vehicles, flooding also disrupts important services such as U.S. Mail delivery, garbage pick-up, and sewage treatment. As previously noted, roads are put at risk when flood waters reach an approximate elevation of 290 feet. Based on the 67-year period of record studied, flood waters reach the 290-foot elevation in the St. Johns Bayou Basin an average of 17.4 days per year.

Health

Another major concern conveyed by residents during the public scoping meeting is the sickness and disease that can accompany flooding. Blastomycosis is of particular concern. Blastomycosis is a fungal infection caused by the organism *Blastomyces dermatitidis*. Found typically in moist soil where there is rotting vegetation, it is endemic in the Mississippi and Ohio River basins (Chapman 2000). Once inhaled into the lungs, the fungus multiplies affecting the blood, lymphatic system, vital organs, skin, bone, genitourinary tract, and brain. The incubation period is 30 to 100 days, although infection can be asymptomatic.

The annual incidence of blastomycosis is 0.2/100,000. However, Mississippi County has the highest incidence in the state of Missouri (12/100,000) with a much higher rate among blacks (43.2/100,000) than whites [Cano *et al.* 2003]. Cano *et al.* (2003) observed 36 cases of blastomycosis reported in the State of Missouri from 1992 to 1999. Twenty of the cases occurred in five counties in the southeastern part of the state and of those 12 (60 percent) were in Mississippi County, resulting in four deaths. Furthermore, Cano *et al.* (2003) stated:

> "Although the number of blastomycosis infections in humans documented during 1993 was not significantly greater compared with other years, the increase during that year may be related to environmental changes that occurred in the southeastern part of the state. Yearly floods are common in the areas bordering the Mississippi River, but in 1993, the Southeastern Missouri counties along the Mississippi River had a drought and then late flooding that lasted for several months. In particular, the amount of rainfall reported during 1993 in Mississippi County was the higher than in other years. During that year, river stages for the Ohio and Mississippi River were also the highest. Higher incidence rates of endemic blastomycosis, as well as outbreaks, had been previously associated with regions of low elevation containing acidic soil and bodies of water".

Drinking Water Wells

A total of 1,046 drinking water wells are located in the St. Johns Bayou Basin. Wells are the predominant source of water for rural residents, as well as the primary irrigation supply. Following floods, increased levels of contaminants can be expected, forcing residents to purge their drinking water wells. Although decontamination costs were not calculated, the public health risks associated with contaminated drinking water wells must be acknowledged.

Waste Water Treatment

Since the majority of the St. Johns Bayou Basin is rural, most wastewater treatment is by means of septic tanks. During periods of flooding, tile fields do not function, and waste water co-mingles with flood water (Chittenden, 2011). Although difficult to detect, co-mingled waste water may contaminate drinking water wells and poses other direct and indirect health risks.

There are 17 waste water outfalls in the SJBB that treat sewage. Flooding damages sewage treatments plants and sanitary sewer systems (Chittenden, 2011). Although difficult to quantify, costly repairs are required.

Since all flow out of SJBB passes through the St. Johns Bayou outlet structure in the NMF setback levee, when the structure is closed, treated waste water cannot flow into the Mississippi River, but remains trapped in the basin until the gates are opened and discharged into the Mississippi River.

1.2.2 New Madrid Floodway

The primary flood-related issues in the NMF, much like in SJBB, are the economic damages sustained by agriculture (crop and non-crop) and infrastructure (roadways and utilities, for example), and the consequent social disruption that results from isolation, interruption of services, and other flood-related impacts. When the Mississippi River is high, backwater flooding inundates the NMF.

The existing 1.01-year flood frequency elevation is 279.3 feet and is mostly contained within the existing channels and ditches in the lower part of the watershed. Out of bank flood events follow the network of drainage ditches and first inundate the Eagle's Nest area located approximately 8 miles upstream from the 1,500-foot gap. Approximately 800 acres are inundated at an elevation of 281 feet. Agricultural lands make up approximately 87 (or 11 percent) of these 800 acres. Flooding continues to follow the network of drainage ditches as Mississippi River stages rise. At an elevation of 284 feet floodwaters inundate portions of the Hubbard Lake area and Bogle Woods (Figure 1.5). Out of bank flooding occurs along Mud Ditch in the 1,500-foot gap at an elevation of 286 feet.

Approximately 12,507 acres are inundated at an elevation of 288 feet (Figure 1.5). Agricultural lands make up 7,539 (or 60 percent) of these 12,507 acres. As can be seen from the figure, the majority of flooding occurs in the lowest elevation areas (*i.e.,* Holocene Mississippi River meander belts) within the Floodway.

The existing 2-year flood frequency (50 percent probability of annual occurrence) inundates lands at an elevation of 292.1 feet (Figure 1.5). Highway WW is overtopped at this elevation along with numerous county roads (404, 515, 518, and 521). Approximately 33,000 acres are inundated at this elevation of which approximately 25,000 (or 76 percent) acres are agricultural. The perimeter levees surrounding Ten Mile Pond Conservation Area are overtopped.

Additional flooding continues to follow the network of drainage canals. The existing 5-year flood frequency elevation is 296.6 feet (Figure 1.5). There are approximately 60,000 acres inundated at this elevation. Agricultural lands make up approximately 48,130 (or 80 percent) of these 60,000 acres. The private levee along Wilkerson Ditch is overtopped, reconnecting Big Oak Tree State Park to the Mississippi River. Along with numerous county roads, portions of Highways VV, YY, FF, and 102 become inundated. Communities such as Bayouville become isolated.

As backwater flooding continues to rise, the Village of Pinhook[7] becomes isolated at the approximate 10-year flood elevation (298.7 feet), which has a 10 percent probability of annual occurrence (Figure 1.5). In addition to isolating Pinhook, there are approximately 71,000 acres inundated of which 60,000 acres (or 85 percent) are agricultural lands.

[7] As existed prior to the Flood of 2011.

Additional backwater flooding continues to inundate large areas of the New Madrid Floodway. The 20 and 50-year flood frequency (which has a 5 percent and 2 percent probability of annual occurrence, respectively) inundates lands at 300.5 and 302.5 feet, respectively (Figure 1.5). These elevations inundate approximately 82,000 and 93,000 acres, respectively. Of these lands, over 83 percent are agricultural. All transportation corridors in the project area are inundated and portions of residential areas are inundated. Floods of this magnitude warrant mandatory evacuations should operation of the Birds Point-New Madrid Floodway be anticipated.

1.2.2.1 Agriculture Damages

Similar to the SJBB, flooding imposes a stiff toll in foregone and lost economic opportunity. The major economic damage as a result of flooding in the NMF is to agricultural crop damages. Flooding destroys recently planted crops, inhibits yield, and delays re-planting. The average annual flood-related economic crop damage in the New Madrid Floodway is $3,501,000.

Flooding also damages equipment, irrigation structures, and drainage structures. The average annual flood-related economic non-crop agricultural damage is $1,821,000, for a total of $5,322,000.

Flooding also constrains what crops may be planted, where, and when. In areas that are subject to frequent floods, instead of planting more profitable crops such as corn, for example, producers are limited to less profitable late-season soybeans.

1.2.2.2 Infrastructure Damages

Floods damage streets and roads. New Madrid Floodway floods result in average annual economic damages of $205,000.

1.2.2.3 Social Impacts

The current population of the NMF is not known following the 2011 activation of the Birds Point-New Madrid Floodway. The Village of Pinhook has requested to be federally purchased and relocated at federal expense. In addition, the Village has requested that they be re-located as a single community. Three potential areas are being investigated, all within the St. Johns Bayou Basin in the vicinity of East Prairie, itself a community impacted by flooding. However, no plans or funding have been finalized or approved. Although the current population is not known, some residents have rebuilt within the Floodway following its activation. Likewise, some residents have moved back into Pinhook. It is anticipated that with time and the infrequency of Floodway operation, more residents would return. Regardless, the population of the Floodway would remain relatively low. Similar to floods in the SJBB, roads are threatened to become inundated at an approximate elevation of 290 feet. Based on the 67-year period of record studied, flood waters reach the 290-foot elevation in NMF an average of 20.4 days per year.

Impacts related to health, drinking wells, and wastewater treatment is similar to that described for the SJBB discussed in Section 1.2.1.3. The major difference is the NMF has a smaller population and no waste water outfalls. Although the population in the NMF is less than what occurs in the adjacent SJBB, flooding isolates communities (Pinhook, Dorena, Wolf Island, Bayouville), impacts health, and damages drinking water wells (approximately 132 wells).

1.3 Criteria

1.3.1 Objectives

The Water Resources Council's Economic and Environment Principles for Water and Related Land Resources Implementation Studies (1983) (Principles) state:

> The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable orders, and other Federal planning requirements.
>
> Contributions to national economic development (NED) are the net increases, expressed in monetary units, in the value of the national output of goods and services. Contributions to NED thus reflect the direct net benefit of a civil works project that accrues in a planning area and throughout the rest of the nation. Federal water resources policy requires that a planning study must recommend adoption of the plan that contributes to NED ("the NED plan," as it is called), unless there are sufficient overriding reasons for recommending another plan.

Consistent with the Principles, the NED objective, and the project-specific and other civil works authorities granted to USACE by Congress, the following objectives were formulated:

- **Reduce the number of days that communities are isolated by flood waters.** This criterion was quantified by measuring the average number of days that roads are made impassable by flooding. Community isolation reduces economic vitality, governance, and public safety.

- **Reduce crop and non-crop agricultural damage.** This criterion was quantified in monetary units in terms of net benefit within the St. Johns Bayou Basin and within the New Madrid Floodway. Flood risk management creates economic benefit in a variety of ways:

    - Crops are not destroyed and fields do not have to be re-planted or re-fertilized.
    - Crops may be planted at optimal times for optimal yields.
    - Farm equipment, irrigation equipment, drainage networks, and other infrastructure are not damaged or disabled.

- Wider varieties of crops and more profitable crops can be grown.

- **Reduce critical infrastructure damages to streets and roads.** This criterion was quantified in monetary units in terms of net benefits within the SJBB and the NMF. Street and road flooding result in damages that require repair. Thus, reducing floods would result in economic benefits. Likewise, reducing floods would prevent costly modifications necessary to keep traffic/commerce moving on Interstate 55.

1.3.2 Constraints

The following project constraints were used in the consideration and planning of project alternatives.

- **Preserve the benefits of the flood pulse.** This criterion was quantified utilizing non-monetary habitat units based upon the ecological resource analyzed, (*e.g.*, wetlands, waterfowl, fish spawning and rearing habitat).

- **Continued Operation of the Birds Point to New Madrid Floodway.** Features constructed and measures implemented in SJBB and the NMF must not prevent, hinder, or delay utilization of the floodway for its congressionally-authorized purposes.

1.4 Project Review

As a consequence of the manner in which Congress directs USACE to act, by granting authority and appropriating funds to construct and operate civil works projects according to congressionally-approved plans and specifications, USACE uses the term "project," as in *St. Johns Bayou – New Madrid Floodway Project*, both as a term of art and according to its usual and customary meaning, and sometimes synonymously with the NEPA term "proposed action." The project review process described in this section pertains not merely to the congressionally-authorized Mississippi River Levees New Madrid Floodway closure levee (FCA 1954) and the *St. Johns Bayou – New Madrid Floodway Project* (WRDA 1986), as now configured, but also to the proposed action being assessed in this draft EIS.

A project review plan was approved on 1 April 2009 that outlined the different levels of review that would be conducted to complete the EIS. Review consisted of model review, conducted by nationally-recognized independent experts (*i.e.*, PhD in respective field of study with peer reviewed research publications) and USACE subject matter experts; Agency Technical Review (ATR), conducted by USACE personnel that are located outside of the Memphis District; Inter-agency Team (IAT) coordination and review, conducted by personnel from the EPA, Fish and Wildlife Service, Missouri Department of Conservation, and Missouri Department of Natural Resources; and Independent External Peer Review (IEPR), conducted by nationally-recognized experts in the fields of wetland ecology, waterfowl biology, shorebird ecology, fisheries biology, water quality, hydrologic and hydraulic engineering, economics, and NEPA.

1.4.1 Model Review

Models were required to quantify project impacts and benefits. All models were developed by subject matter experts and were independently reviewed by nationally-recognized experts. Contracts were awarded to Battelle Memorial, a global research and development organization, to manage the independent review. Battelle Memorial recruited nationally-recognized experts to serve on review panels and comment on the scientific validity of EnviroFish Version 1.0 (See Volume 3, Part 6.1), Manual for Calculating Duck-Use-Days (see Volume 3, Part 6.2), Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook (see Volume 3, Part 6.3), and Assessment of Shorebird Habitat Within the St. Johns Bayou Basin -New Madrid Floodway, Missouri (see Volume 3, Part 6.4). Each model was reviewed separately. Comments received were addressed and all of the models have been certified or approved for use by USACE. Additional information regarding how the models were applied can be found in Section 4.

1.4.2 Inter-agency Coordination and Review

Inter-agency coordination was initiated early in, and has been maintained throughout the course of, developing this draft EIS. Issues addressed include the IEPR process, model review, scoping, the project work plan, alternatives, impact analysis, and mitigation measures.

1.4.3 Independent External Peer Review

The review plan prescribes a four-phased process of IEPR. IEPR is typically conducted at the conclusion of a project feasibility study or at the end of the environmental impact assessment (NEPA) process, but can be, and in this case was, commenced early in the NEPA process. Similar to the model review process, contracts were awarded to Battelle Memorial to autonomously manage the IEPR process and to independently obtain the necessary experts to serve throughout the IEPR process.

1.4.3.1 Phase 1 Independent External Peer Review

The first phase of IEPR reviewed prior USACE NEPA studies and made recommendations on the scope and content of future NEPA analyses. USACE briefed the IEPR panel in August 2009, providing a tour of the project area. Also attending the brief were the inter-agency team and representatives of the St. John Levee and Drainage District.

Battelle submitted the Phase 1 IEPR report on October 23, 2009. The report, which recommended an entirely new NEPA study, may be found in Volume 3, Part 2.

1.4.3.2 Phase 2 Independent External Peer Review

The second phase of IEPR focused on a Project Work Plan, prepared by USACE, outlining proposed assumptions, alternatives, methodologies, mitigation strategies, and ecological models to be used in a new EIS.

The proposed Plan was submitted to the inter-agency team in December 2009 and again, as revised, in February 2010. The Plan, along with inter-agency team comments, was then submitted to the IEPR panel.

Battelle submitted the Phase 2 IEPR report on April 28, 2010, after which a lengthy dialog occurred between USACE and the IEPR panel, in which the inter-agency team participated. An addendum to the Phase 2 report, dated November 5, 2010, documents the extensive collaboration among USACE, the IEPR panel, and the inter-agency team. The full report, with addendum, may be found in Volume 3, Part 3.

1.4.3.3 Phase 3 Independent External Peer Review

Utilizing the methodologies described in the Project Work Plan, as revised in Phase 2, a proposed draft EIS was prepared in July 2011. Following ATR and further IAT review, the proposed draft EIS and IAT comments were submitted to the IEPR panel. Battelle submitted the Phase 3 IEPR report on December 8, 2011, after which another lengthy dialog occurred between USACE and the IEPR panel on the panel's 27 comments and recommendations. The report, with all supporting material, may be found in Volume 3, Part 4.

1.4.3.4 Phase 4 Independent External Peer Review (RESERVED)

Note: Once public comments on this draft EIS have been considered and incorporated, a proposed final EIS will be submitted to the IEPR panel for review, comment, and collaboration.

1.5 Scoping Process

The scoping process consisted of publishing a Notice of Intent in the Federal Register, conducting a public scoping meeting, and numerous inter-agency communications throughout the development of the draft EIS.

1.5.1 Notice of Intent

A Notice of Intent (NOI) to prepare an EIS was published in the Federal Register on 6 April 2010 (Federal Register Volume 75, Number 65, pages 17393-17394). The NOI is included in Volume 2, Part 1. The NOI also served as a request for public scoping input and encouraged all interested parties to participate in the scoping process, including the public scoping meeting.

1.5.2 Public Scoping Meeting

A public scoping meeting was held on May 11, 2010 in East Prairie. The purpose of the meeting was to inform the public about the proposed action and to gather input on issues to be addressed in an EIS. Ninety-two persons attended the meeting, which began with a brief presentation on the history of the project, proposed construction and other features, and the purpose of NEPA and public scoping. The St. John Levee and Drainage District also made a statement on its role as project sponsor.

Following the presentations, the attendees were divided into three groups to facilitate comments. Information on the scoping process, including comments received, may be found in Volume 2, Part 1. A list of relevant issues and resources identified can be found in Section 1.6.

1.6 Relevant Issues and Resources

The issues for impact analysis identified through the IEPR process, public scoping, and inter-agency coordination are of four kinds: residents' hardships and quality of life, the local economy, agriculture, and fish and wildlife. Table 1.3 lists these and identifies where in this draft EIS they are discussed.

Table 1.3. Relevant issues, resources, and concerns, St. Johns Bayou and New Madrid Floodway, Missouri.

CATEGORY	ISSUEE	SECTION
Resident Hardships	Social	3.6
Quality of Life Issues	Community Isolation from Flooding	1.2.1.3, 1.2.2.3, 3.6.3.1
	Health	3.6.3.2
	Minority and Low Income Populations	3.16
	Decline of Local Populations	3.6.2
	Recreation	3.13 & 4.14
	Drinking Water Sources	3.6.3.3
	Waste Water Treatment	3.6.3.4
Local Economy	Economics	3.7
	Residential	3.7.1
	Roads and Infrastructure	3.7.1
Agricultural	Agriculture	3.3.1, 3.7.2, & 4.3.1
Ecological	Wetlands	3.8.1 & 4.8.1
	Terrestrial Wildlife	3.8.2 & 4.8.2
	Waterfowl	3.8.3 & 4.8.3
	Shorebirds	3.8.4 & 4.8.4
	Fish (Spawning and Rearing Habitat)	3.8.5 & 4.8.5.1
	Fish Access	3.8.5 & 4.8.5.3
	Freshwater Mussels	3.9.1 & 4.9.1
	Water Quality	3.10 & 4.10
	River Connectivity	3.5 & 3.8
	Ecosystem Services	4.12
	Ditch Habitat	3.11 & 4.11
Cultural Resources	Cultural	3.12 & 4.13

2.0 ALTERNATIVES

This section describes the process used to develop, screen, eliminate, and evaluate alternatives for implementing the proposed action. The alternative development process begins by identifying a wide array of preliminary alternatives and then, by application of carefully formulated selection criteria, establishing a reasonable range of feasible alternatives.[8] Described in this chapter are eight alternatives that were carried forward for detailed analysis, including the required no action alternative, and the process by which they were selected. These are:

- Alternative 1: no action;
- Alternative 2.1: construct and operate flood control improvements in the St. Johns Bayou Basin only;
- Alternative 2.2: construct and operate flood control improvements in New Madrid Floodway only;
- Alternative 2.3: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway;
- Alternative 3.1: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway, with seasonal flood pulse management and measures to avoid and minimize environmental impact;
- Alternative 3.2: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway, with seasonal flood pulse management affording greater springtime flood protection and measures to avoid and minimize environmental impact;
- Alternative 4.1: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway with floodplain connectivity maintained up to an elevation of 289.5 feet and measures to avoid and minimize environmental impact; and
- Alternative 4.2: construct and operate flood control improvements in both the St. Johns Bayou Basin and the New Madrid Floodway with floodplain connectivity maintained up to an elevation of 289.5 feet, reforestation of agricultural lands below an elevation of 289.5 feet, and measures to avoid and minimize environmental impact.

Alternative 3.1, the Tentatively Selected Plan for project planning purposes, is the preferred alternative.

2.1 Preliminary Flood Control Alternatives

A variety of structural and non-structural preliminary alternatives that improve flood control and manage flood risk were developed as means to address one or more of the

[8] A reasonable alternative is one that achieves the project's purpose and need.

planning objectives. These preliminary alternatives were drawn from previous engineering and environmental studies, congressional authorizations, input received from public scoping, the results of inter-agency collaboration, and recommendations of the IEPR panel. The preliminary alternatives underwent a screening process that analyzed each preliminary separately and as combinations. From this screening process, a number of alternatives were formulated that underwent detailed analysis.

2.1.1 St. Johns Bayou Basin Structural Preliminary Alternatives

2.1.1.1 St. Johns Bayou Basin Pumping Station

Pumping stations are a common, highly effective method of flood control in the Lower Mississippi Valley. For example, pumping stations have been constructed in the upper portion of the SJBB (Drinkwater Pumping Stations #1 and #2), in the upper portion of the New Madrid Floodway (Peafield Pumping Station), in the City of Cairo, Illinois, and in the City of Hickman, Kentucky. In the SJBB, pumping stations remove impounded water from the basin during periods in which outlet structure gates are closed due to high water in the Mississippi River. As discussed in Section 1, closing the St. Johns Bayou outlet structure does prevent backwater flooding from the Mississippi River, but it prevents the out-flow of water from the basin creating a bathtub effect. The resulting flooding (also referred to as impounded interior runoff) is exacerbated by any rainfall that occurs while the gates remain closed.

Initial planning for a pumping station began with the Chief of Engineers Report of September 26, 1975 and the Environmental Impact Statement *St. Johns Bayou and New Madrid Floodway, Missouri,* filed with the Council on Environmental Quality on June 2, 1976. The Water Resources Development Act of 1976 authorized USACE to undertake advanced engineering and design culminating in a Phase 1 General Design Memorandum (GDM). The resulting Chief of Engineers report was submitted to the Secretary of Army on January 4, 1983, and a Record of Decision was signed on January 5, 1983.

The Water Resources Development Act of 1986 authorized its construction. A Limited Reevaluation Review was completed in 1997 and did not modify its design. Previous studies and modeling are valid. Therefore, no modifications were made for the purpose of this EIS.

2.1.1.2 St. Johns Bayou Basin Ditch Modifications

Agricultural ditches in SJBB are not large enough to carry flood waters that rise within the basin during periods of heavy rainfall under conditions in which the St. Johns Bayou outlet structure is closed (during high Mississippi River stages) or open (Mississippi River non-flood period). In addition to a pumping station, previous USACE studies (Phase 1 GDM, 1983 Chief of Engineers Report, and Phase 2 GDM) analyzed modifying ditches as another means of alleviating the risk and consequences of such flooding. Modifications include channel enlargement and vegetative clearing. Enlargement entails increasing the bottom widths of ditches so they can carry a greater volume of flood waters. Vegetative growth in and along the channels inhibit effective drainage. Vegetative clearing entails removing trees and other vegetation along the channel banks to ensure drainage is not inhibited.

From these previous studies, proposals were developed to clear vegetation on 18.8 miles of rural channels and 3.0 miles of urban channel, and enlarge 93.3 miles of rural channels and 3.7 miles of urban channel. The combined 118.8 miles of modifications would protect against a 2-year flood in all areas except Sikeston, Missouri, where the level of protection would handle a 1.1-year flood involving agricultural lands and a 5- to 7.5-year flood involving urban areas. Additional information regarding the specific ditches and reaches can be found in the Phase 2 GDM.

The 1997 Limited Reevaluation Report examined the previous authorized proposals that would offer immediate benefit to East Prairie and vicinity (referred to as Phase 1 features or East Prairie Phase features). To help reduce flooding in and around East Prairie, channel enlargement and drainage improvements would only be constructed along the lower 4.5 miles of St. Johns Bayou, beginning at New Madrid, continue along Setback Levee Ditch, and extend 10.8 miles along St. James Ditch. Selective clearing and snagging has already been completed along a 4.3-mile reach of Setback Levee Ditch beginning at the confluence with St. James Ditch.

2.1.1.3 East Prairie, Missouri Ring Levee

A ring levee would be constructed surrounding East Prairie, Missouri. The levee would protect the city from high water on St. James Ditch and Lateral 2 to a 25-year flood.

This agriculture-oriented city of 3,227 people, which was designated an Enterprise Community in 1994, lies entirely above the 300-foot elevation. Therefore, flooding in the city occurs primarily as a result of two factors - high water in St. James Ditch and Lateral 2 (*i.e.,* headwater flooding) and poor drainage, mainly the result of a deficient storm water sewer system. Headwater flooding in East Prairie does not result directly from closure of the St. Johns Bayou outlet structure, but closure is a contributing factor. Heavy rainfall and Mississippi River floods frequently occur at the same time and thus the bathtub effect created by closing the St. Johns Bayou outlet structure.

Since 2006, four sewer collapses have caused flooding in East Prairie (EPA, 2009). EPA has awarded the City of East Prairie $194,000 for improvements to its existing storm water system. These improvements will alleviate flooding as a result of the deficient storm water system. Therefore, remaining flooding occurs primarily from high water in St. James Ditch and Lateral 2 as a result of headwater floods and compounded by closing the St. Johns Bayou outlet structure.

2.1.2 St. Johns Bayou Basin Non-Structural Preliminary Alternatives

2.1.2.1 St. Johns Bayou Basin Fish and Wildlife Refuge

This preliminary alternative involves the purchase in fee of low-lying portions of the SJBB that are prone to flooding for use as a wildlife refuge or conservation area.

A similar plan was investigated by USFWS in 1993 with USACE serving as a cooperating agency. The USFWS proposal called for the purchase of 11,425 acres of land in the SJBB (bounded on the north by County Road P, on the west by the Farrenburg Levee, and on the east/southeast by the Setback Levee) and re-foresting it. However, the local community did not support the proposal, which meant that land for a refuge could not be obtained through purchase. Consequently, the proposal was considered unachievable by the USFWS and was eliminated from further consideration.

Although the previous USFWS proposal was non-implementable, USACE was requested to re-analyze the proposal as a preliminary alternative. Flood damages occur to agricultural areas. A refuge would remove the agricultural area. Thus, the flood damage would be removed and a flood control benefit could be quantified according to the project's purpose.

2.1.2.2 Expanded St. Johns Bayou Basin Fish and Wildlife Refuge

This preliminary alternative would expand the proposed refuge/conservation area to 20,407 acres (approximately 14,327 agricultural acres), by making it coextensive with the 5-year flood frequency elevation. The previous USFWS proposal did not consider flood frequency as a factor in the establishment of boundaries. Therefore, under the previous USFWS proposal, damage would occur to other agricultural areas at or below the elevation of the refuge. This expanded refuge preliminary alternative would cover all agricultural lands at or below the elevation of 294.1 feet, the level of the 5-year flood frequency in the SJBB. Therefore, the flood damage would be removed from 14,327 acres of agricultural lands and a flood control benefit could be quantified according to the project's purpose.

2.1.2.3 St. Johns Bayou Basin - Agriculture to Silviculture

This preliminary alternative would convert frequently flooded agricultural land (within the 5-year flood frequency) to silviculture by means of a program similar to the Wetland Reserve Program (WRP) administered by the Natural Resources Conservation Service (NRCS). As previously stated, converting agriculture to silviculture would remove the flood damage since trees can tolerate flooding. Although this preliminary alternative is similar to the refuge preliminary alternative, it does not purchase land in fee. Instead, an easement would be obtained and lands would remain in private ownership with the opportunity to harvest timber. USACE, or the program agency, would obtain a conservation easement on 14,327 acres of agricultural lands located within the St. Johns Bayou Basin's 5-year flood frequency elevation.

2.1.2.4 St. Johns Bayou Basin - Convert Non-Flood Tolerant Crops to Flood Tolerant Crops

This preliminary alternative would convert agricultural commodities from mostly soybeans to switchgrass by means of a restrictive easement. Soybeans are the dominant crop grown within flood-prone areas (within the 5-year flood frequency) because they can be planted later in the growing season to manage flood risk. However, late planting reduces yield. For example, delaying planting until June could result in a loss of one bushel per acre per week and delaying until July could result in a loss of three bushels per week (Helsel and Minor, 1993). Although new technologies have recently been developed for alternative/renewable energy sources such as lignocellulose feedstock with agricultural commodities like switchgrass, implementation of those features is slow due to limited markets and competition with other more profitable crops. Several varieties of switchgrass are flood tolerant and could conceivably be grown in the project area.

Similar to the proposal to convert agriculture to silviculture within the 5-year floodplain, this preliminary alternative would convert frequently flooded agricultural lands (within the five-year flood frequency) to switchgrass production by means of a program similar to the USDA's Commodity Credit Corporation (CCC) Biomass Crop Assistance Program (Sections 9001 and 9011, Food, Conservation, and Energy Act of 2008).

2.1.2.5 St. Johns Bayou Basin - Nutrient Trading

This preliminary alternative would establish a nutrient trading program to provide additional incentives to landowners to convert from agriculture to silviculture. Nutrient trading is essentially the transfer of pollution reduction credits from one source to another (Greenhalgh and Faeth 200, Latane and Stephenson 2011). If a source has reduced its effluent for a given variable (for example, phosphorus) below what it is otherwise required, additional reductions may be available to sell in the form of credits. Alternatively, a source that cannot reduce its effluent to the level required has the option of buying credits made available by another source. When done properly, trading can be a very effective way to balance resources within a watershed.

The preliminary alternative would obtain a conservation easement on all agricultural lands within the 5-year flood frequency (14,327 acres) and provide additional income as a result of a nutrient trading program. Thus, the flood damage would be removed by the conversion to trees and additional income would be provided to the landowner as a result of nutrient trading credits.

2.1.2.6 East Prairie, Missouri - Relocations

This preliminary alternative would relocate 646 structures (homes, buildings, government buildings, etc.) in East Prairie that are subject to flooding and relocate them to an area that has less risk of floods.

2.1.2.7 St. Johns Bayou Basin - Raise Road Surface Elevations

This preliminary alternative would raise the surface elevation of 17 miles of roads in the SJBB, including Interstate 55. Community isolation as a result of flooding of streets and roads was a major concern conveyed during the public scoping meeting. Therefore, this preliminary alternative would involve raising the surface elevation of roads to allow for travel during periods of floods. Raising roads is considered a non-structural solution because it does not involve a structure to prevent the flood. Floods would still occur.

2.1.3 New Madrid Floodway Structural Preliminary Alternatives

2.1.3.1 Construct a Levee Completing the New Madrid Floodway

As authorized by the Flood Control Act of 1954 and stated in the 1957 Phase 1 General Design Memorandum, a closure levee would be constructed at the 1,500-foot gap in the NMF and four 10-foot by 10-foot gated box culverts would be constructed in the levee as a gravity outlet structure for Mud Ditch. The gates would be managed in a fashion similar to the SJBB outlet structure; they would be closed when the level of the Mississippi River is higher than the elevation of the interior sump, and would be re-opened when the river level fell below that elevation.

2.1.3.2 Alternative New Madrid Floodway Closure

Figure 2.1 shows other locations where a levee might be built to close the NMF gap. The lengths of these levees would be 6,500 feet and 18,500 feet, respectively. The levees would have a gravity outlet structure in Mud Ditch consisting of four 10-foot by 10-foot gated box culverts. Alternate levee closures would result in maintaining a greater area of connectivity between the New Madrid Floodway and the Mississippi River.

2.1.3.3 New Madrid Floodway Pumping Station

Due to the risks and effects of internal flooding that would occur if a levee were constructed to close the NMF gap (i.e., when the Mud Ditch outlet structure gates had to be closed to prevent backwater flooding), the Water Resources Development Act of 1986 authorized the construction of a pumping station. A Limited Reevaluation Review was completed in 1997 and did not modify its design. Previous studies and modeling are valid. Therefore, no modifications were made for the purpose of this EIS.

2.1.4 New Madrid Floodway Non-Structural Preliminary Alternatives

2.1.4.1 New Madrid Floodway Fish and Wildlife Refuge

This preliminary alternative involves the purchase in fee of low-lying portions of the NMF for use as a wildlife refuge or conservation area. The previous USFWS plan for a refuge in the SJBB also included the purchase of approximately 5,175 acres of land in the NMF. The local community did not support the proposal, and consequently, the proposal was considered unachievable by the USFWS and was eliminated from further consideration.

Although the previous USFWS proposal was non-implementable, USACE was requested to re-analyze the proposal as a flood control preliminary alternative. Flood damages occur to agricultural areas. A refuge would remove the agricultural area. Thus, the flood damage would be removed and a flood control benefit could be quantified according to the project's purpose.

2.1.4.2 Expanded New Madrid Floodway Fish and Wildlife Refuge

Similar to the expanded SJBB expanded refuge preliminary alternative, the size of the NMF refuge would be expanded to the 5-year flood frequency elevation. The 5-year flood frequency corresponds to an elevation of 296.6 feet in the NMF. This corresponds to approximately 58,990 acres (approximately 48,130 agricultural acres). Therefore, the flood damage would be removed from 48,130 acres of agricultural lands and a flood control benefit could be quantified according to the project's purpose.

2.1.4.3 New Madrid Floodway - Agriculture to Silviculture

This preliminary alternative would convert frequently flooded agricultural land (within the 5-year flood frequency) to silviculture by means of a program similar to the WRP administered by the NRCS. As previously stated, converting agriculture to silviculture would remove the flood damage since trees can tolerate flooding. Although this preliminary alternative is similar to the refuge feature, it does not purchase land in fee. Instead, an easement would be obtained and lands would remain in private ownership with the opportunity to harvest timber. USACE, or the program agency, would obtain a conservation easement on 48,130 acres of agricultural lands located within the New Madrid Floodway's 5-year flood frequency elevation.

2.1.4.4 New Madrid Floodway - Convert Non-Flood Tolerant Crops to Flood Tolerant Crops

Similar to the preliminary alternative proposed in the SJBB, this preliminary alternative would convert agricultural commodities within the 5-year flood frequency elevation from mostly soybeans to switchgrass by means of a restrictive easement.

2.1.4.5 New Madrid Floodway - Nutrient Trading

Nutrient trading was previously discussed in 2.3.1.2.5. The same type of program would be established within the 5-year flood frequency elevation of NMF.

2.1.4.6 New Madrid Floodway - Relocations

As previously discussed, the current population of the NMF is not known following the 2011 activation. Although some residents have moved back and there will likely be more, there is currently no reliable information regarding the present number of structures within the NMF. Likewise, the Floodway will continue to be operated in the future. Therefore, any repopulation of the Floodway would be subject to future evacuations.

2.1.4.7 New Madrid Floodway – Raise Road Surface Elevations

This preliminary alternative would raise the surface elevation of 19 miles of roads in the New Madrid Floodway. Although any repopulation of the Floodway would still be subject to future evacuation in the event of Floodway activation, isolation would still occur at more frequent, less destructive floods. Therefore, this preliminary alternative would involve raising the surface elevation of roads to allow for travel during periods of floods. Raising roads is considered a non-structural solution because it does not involve a structure to prevent the flood. Floods would still occur.

2.2 Screening process

To demonstrate consideration of a reasonable range of feasible alternatives, preliminary alternatives underwent an iterative screening process to determine alternatives that would be carried into detailed analysis. Reasonable alternatives include those that are economically and technically feasible, focusing on the accomplishment of the underlying project objectives and constraints. The following screening process was used to assess the overall characteristics of each preliminary alternative resulting in the selection of the reasonable range of alternatives that were considered in-detail.

Screening Process Step 1 evaluated preliminary alternatives to see if they met any of the project objectives. Preliminary alternatives that did not meet any project objective were eliminated from further analysis.

Screening Process Step 2 combined preliminary alternatives that were subsequently reviewed against project objectives. Combined preliminary alternatives that were inconsistent with one another were rejected in this step.

Screening Process 3 developed preliminary costs to look at the cost-effectiveness of each preliminary alternative/combination of preliminary alternatives. Since USACE policy requires a positive benefit to cost for implementation, preliminary alternatives and or combinations that did not have a positive benefit to cost were rejected in this step.

Screening Process Step 4 looked at avoid and minimize measures that could reduce the environmental impacts of the preliminary alternatives/combination of preliminary alternatives, in consideration of social and cost effectiveness.

Screening Process Step 5 selected a final range of alternatives for detailed review by validating that the remaining alternatives satisfy the project criteria (*i.e.*, objectives and constraints).

2.2.1 Iterative Screening Process Step 1

The first iterative screening process evaluated the ability of the individual preliminary alternatives to achieve the project objectives (see Section 1.3.1). Tables 2.1 and 2.2 show the proposed preliminary alternatives and associated objective that each preliminary alternative addresses for the SJBB and the NMF, respectively.

Table 2.1. St. Johns Bayou Basin preliminary alternatives and project objectives.

Preliminary alternative	Reduce Community Isolation	Reduce Agricultural Flood Damages	Reduce Street and Road Flood Damages	Retain for Screening
St. Johns Bayou Basin Pumping Station	X	X	X	Y
St. Johns Bayou Basin Ditch Modifications	X	X	X	Y
East Prairie Ring Levee			X	Y
St. Johns Bayou Basin Fish and Wildlife Refuge		X		N
St. Johns Bayou Basin Expanded Fish and Wildlife Refuge		X		Y
St. Johns Bayou Basin Agriculture to Silviculture		X		Y
St. Johns Bayou Basin Crop Conversion		X		Y
St. Johns Bayou Basin Nutrient Trading				N
St. Johns Bayou Basin Relocations	X			Y
St. Johns Bayou Basin Raise Roads	X			Y

Table 2.2. New Madrid Floodway preliminary alternatives and project objectives.

Preliminary alternative	Reduce Community Isolation	Reduce Agricultural Flood Damages	Reduce Street and Road Flood Damages	Retain for Screening
New Madrid Floodway Authorized Closure Levee	X	X	X	Y
New Madrid Floodway Alternate Levee Locations	X	X	X	Y
New Madrid Floodway Pumping Station	X	X	X	Y
New Madrid Floodway Fish and Wildlife Refuge		X		N
New Madrid Floodway Expanded Fish and Wildlife Refuge		X		Y
New Madrid Floodway Agriculture to Silviculture		X		Y
New Madrid Floodway Crop Conversion		X		Y
New Madrid Floodway Nutrient Trading				N
New Madrid Floodway Relocations	X			Y
New Madrid Floodway Raise Roads	X			Y

With the exception of nutrient trading, all preliminary alternatives achieve at least one project objective. Therefore, nutrient trading was not retained for further analysis. However, since the project area is mostly agricultural, implementation of other preliminary alternatives would not preclude future implementation of a nutrient trading program in the area.

Wildlife refuges previously analyzed by the USFWS were not retained for additional screening. Although these preliminary alternatives could reduce agricultural flood damages, they would only reduce the damages in the confines of the refuge itself. Therefore, there will be remaining damages outside the refuge boundary on lands that are found at a similar elevation. Because there would be remaining agricultural damages outside the refuge boundary, the Corps deemed the expanded refuge preferable to the smaller refuge size to be analyzed in additional screening.

2.2.2 Iterative Screening Process Step 2

The next step in the iterative screening process was to combine individual preliminary alternatives to achieve multiple project objectives. For example, non-structural preliminary alternatives such as wildlife refuges and crop conversions reduce agricultural damages but they do not prevent community isolation. Likewise, raising the surface elevation of roads prevent community isolation but does not reduce agricultural flood damages. Therefore, single preliminary alternatives were combined to achieve multiple objectives.

<u>St. Johns Bayou Basin</u>

Table 2.3 suggests how various preliminary alternatives could be combined and indicates whether or not they were retained for further screening.

Table 2.3. St. Johns Bayou Basin combined preliminary alternatives.

Preliminary Alternative	SJB Pumping Station	SJB Ditch Modifications	East Prairie Ring Levee	SJB Expanded Fish and Wildlife Refuge	SJB Agriculture to Silviculture	SJB Crop Conversion	SJB Relocations	SJB Raise Roads
SJB Pumping Station	-	Y	N	N	N	N	N	N
SJB Ditch Modifications	Y	-	N	N	N	N	N	N
East Prairie Ring Levee	N	N	-	Y	Y	Y	N	Y
SJB Expanded Fish and Wildlife Refuge	N	N	Y	-	N	N	Y	Y
SJB Agriculture to Silviculture	N	N	Y	N	-	N	Y	Y
SJB Crop Conversion	N	N	Y	N	N	-	Y	Y
SJB Relocations	N	N	N	Y	Y	Y	-	Y
SJB Raise Roads	N	N	Y	Y	Y	Y	Y	-

The bullets below explain the reasoning used to determine if the preliminary alternatives were retained or not retained for further screening.

- St. Johns Bayou Basin Pumping Station – The only other preliminary alternative combined with the SJBB Pumping station was ditch modifications. Construction of a pumping station achieves all of project objectives for SJBB. Thus, there would be no need to combine this preliminary alternative with other preliminary alternatives such as raising roads, relocations, etc. The pumping station and ditch modifications can be combined because both of these preliminary alternatives complement one another. For example, ditches can be modified to quickly remove flood waters in the vicinity of East Prairie and the pumping station can pump the floodwaters over the levee during period of Mississippi River floods when the gates are closed.

- St. Johns Bayou Ditch Modifications - Ditch modifications cannot be combined with any other measures with the exception of the pumping station. Any channel modifications without a pumping station would compound the impounded interior runoff problem at the structure because of the increase in drainage (timing). For example, a combination of ditch modifications and raising road elevations would reduce flood damages on agricultural lands due to headwater flooding as well as prevent community isolation. However, this would compound the impounded interior runoff problem when the SJBB outlet structure is closed. Therefore, ditch modifications were only combined with a pumping station and not retained as a stand-alone alternative.

- East Prairie Ring Levee – There is no need to construct a ring levee around East Prairie if a pumping station were constructed. Likewise, there is no need to relocate East Prairie if a ring levee is constructed. Therefore, the East Prairie ring levee was combined with non-structural preliminary alternatives for further screening.

- St. Johns Bayou Basin Expanded Refuge – Since the refuge would be located within the 5-year flood frequency elevation, there is no need for other flood control features on agricultural areas. Therefore, the refuge feature was combined with the ring levee, relocations, and raising roads.

- St. Johns Bayou Agriculture to Silviculture - Since all agricultural lands in the 5-year flood frequency would be converted to silviculture; there is no need for other flood control features (e.g., pump station) for agricultural areas at higher elevations (consequently less annual damages) because the benefits would likely not justify the additional costs. Therefore, the preliminary alternative was combined with the ring levee, relocations, and raising roads.

- St. Johns Bayou Crop Conversion - Since all agricultural lands in the 5-year flood frequency would be converted to a flood tolerant crop, there is no need for other flood control features on agricultural areas. Therefore, the preliminary alternative was combined with the ring levee, relocations, and raising roads.

- St. Johns Bayou Relocations – Relocations were combinable with all other preliminary alternatives except the pumping station (no longer necessary if a pumping station is constructed), ditch modifications, or a ring levee.

- St. Johns Bayou Road – Raising roads was combinable with all other preliminary alternatives except the pumping station, ditch modifications, and the ring levee.

New Madrid Floodway

Table 2.4 suggests how various preliminary alternatives could be combined and indicates whether or not they were retained for further screening.

Table 2.4. New Madrid Floodway combined preliminary alternatives.

Preliminary Alternative	NMF Authorized Closure Levee	NMF Alternate Levee Locations	NMF Pumping Station	NMF Expanded Fish and Wildlife Refuge	NMF Agriculture to Silviculture	NMF Crop Conversion	NMF Relocations	NMF Raise Roads
NMF Authorized Closure Levee	-	N	Y	N	N	N	N	N
NMF Alternate Levee Locations	N	-	Y	N	N	N	N	N
NMF Pumping Station	Y	Y	-	N	N	N	N	N
NMF Expanded Fish and Wildlife Refuge	N	N	N	-	N	N	N	Y
NMF Agriculture to Silviculture	N	N	N	N	-	N	N	Y
NMF Crop Conversion	N	N	N	N	N	-	N	Y
NMF Relocations	N	N	N	N	N	N	-	N
NMF Raise Roads	N	N	N	Y	Y	Y	N	-

The bullets below explain the reasoning used to determine if the features were retained or not retained for further screening.

- New Madrid Floodway Authorized Closure Levee – Due to the problem associated with impounded interior runoff, the closure levee has to be combined with a pumping station. Constructing the closure levee and pumping station make all other preliminary alternatives unnecessary. Therefore, no other preliminary alternatives were combined.

- New Madrid Floodway Alternate Levee Locations – Similar to the authorized location, the closure levee has to be combined with a pumping station. All other preliminary alternatives are unnecessary.

- New Madrid Floodway Pumping Station – There is no benefit to the project area by a pumping station without the attendant closure levee as backwater would continue to flood the area. Therefore, a pumping station was only combined with a closure levee.

- New Madrid Floodway Expanded Refuge – Since the refuge would be located within the 5-year flood frequency elevation, there is no need for other preliminary alternatives on agricultural areas. Therefore, the refuge preliminary alternative was combined with raising roads.

- New Madrid Floodway Agriculture to Silviculture - Since all agricultural lands in the 5-year flood frequency would be converted to silviculture; there is no need for other flood control features (e.g., pump station) for agricultural areas at higher elevations (consequently less annual damages) because the benefits would likely not justify the additional costs. Therefore, the preliminary alternative was combined with raising roads.

- New Madrid Floodway Crop Conversion - Since all agricultural lands in the 5-year flood frequency would be converted to a flood tolerant crop, there is no need for other flood control features on agricultural areas. Therefore, the preliminary alternative was combined with raising roads.

- New Madrid Floodway Relocations – Although relocations are combinable with other preliminary alternatives, they were not retained because the current amount of structures is unknown following the activation of the Floodway, and any population that moves back into the Floodway would still be subject to evacuation in the event of the Floodway has to be activated. Thus, relocations in the New Madrid Floodway were not considered.

- New Madrid Floodway Roads – Raising roads was combinable with all other preliminary alternatives except the closure levee and pumping station.

2.2.3 Iterative Screening Process Step 3

The next step in the screening process was to develop preliminary costs and benefits. Only those preliminary alternatives or a combination of preliminary alternatives that had a positive benefit to cost ratio were carried forward for additional screening.

<u>St. Johns Bayou Basin</u>

Tables 2.5 and 2.6 provide the preliminary costs and benefits for the St. Johns Bayou Basin preliminary alternatives and combined preliminary alternatives, respectively. A discussion follows.

Table 2.5. Preliminary costs and benefits, St. Johns Bayou Basin preliminary alternatives.

Preliminary Alternative	St. Johns Bayou Basin ($000's)		
	Annual Cost	Annual Benefit	Benefit/Cost
SJB Pump Station and Channel Modification	2,895	6,911	2.4
East Prairie Ring Levee	325	238	0.7
SJB Refuge	3,516	1,622	0.5
SJB Conversion to Silviculture	2,816	1,209	0.4
SJB Conversion to Flood Tolerant Crops	3,165	1,002	0.3
SJB Relocations	1,954	236	0.12
SJB Roads (Excludes I-55)	4,986	149	0.03

The only preliminary alternative that had a positive benefit to cost ratio was the St. Johns Bayou pumping station and the channel modifications. Relocation and roads annual costs provided in Table 2.5 are conservative estimates. It is very likely that due to site-specific considerations like bridges, culverts, relocation of businesses and governmental buildings, the actual costs could be substantially greater. The resulting economic analysis does not indicate that these preliminary alternatives have any potential to be recommended.

Table 2.6. Preliminary costs and benefits, St. Johns Bayou Basin combined preliminary alternatives.

Combined Preliminary Alternatives	Annual Cost	Annual Benefit	Benefit/Cost
SJ Pump Station and Channel Modification	2,895	6,911	2.4
Ring Levee, Refuge	3,841	1,860	0.5
Ring Levee, Silviculture	3,141	1,447	0.5
Ring Levee, Flood Tolerant Crops	3,490	1,240	0.4
Ring Levee, Roads	5,311	387	0.1
Ring Levee with Interior Ditches, Refuge	4,432	2,313	0.5
Ring Levee with Interior Ditches, Silviculture	3,732	1,900	0.5
Ring Levee with Interior Ditches, Flood Tolerant Crops	4,081	1,693	0.4
Ring Levee with Interior Ditches, Roads	5,902	840	0.1
Relocations, Refuge	5,470	1,858	0.3
Relocations, Silviculture	4,770	1,445	0.3
Relocations, Flood Tolerant Crops	5,119	1,238	0.2
Relocations, Roads	6,940	385	0.1
Roads, Refuge	8,502	1,771	0.2
Roads, Silviculture	7,802	1,358	0.2
Roads, Flood Tolerant Crops	8,151	1,151	0.1
Relocations, Refuge, Roads	10,456	2,007	0.2
Relocations, Silviculture, Roads	9,756	1,594	0.2
Relocations, Flood Tolerant Crops, Roads	10,105	1,387	0.1

The only combination of preliminary alternatives that had a positive benefit to cost ratio was the St. Johns Bayou pumping station and the channel modifications. Constructing the pumping station and channel modifications would achieve the objectives of reducing the number of days communities are isolated, reduces agricultural damages, and reduce street and road flood damages. Although other preliminary alternatives or a combination of preliminary alternatives would achieve the objectives, they are not cost effective. Thus, USACE cannot implement them and they were dropped from further analysis.

- **Ring Levee** - Constructing a ring levee would limit benefits to the City of East Prairie and would not provide any benefits to the vast surrounding areas subject to flooding outside of East Prairie. Therefore, a ring levee does not reduce agricultural flood damages. Additionally, the ring levee would not benefit the agriculturally-based area economy. In other words, the East Prairie residential community may be spared from flooding by a ring levee, but local business and commerce would not, with adverse impacts to local income. A ring levee would also isolate the community without raising roads, because transportation corridors would not be protected for people that travel to and from East Prairie. Therefore, a ring levee alone would not reduce the number of days communities are isolated. For example, during the Floods of 2011 and 2008, roads were closed leading in and out of the city. A ring levee is not cost effective as a standalone preliminary alternative, or in combination with other preliminary alternatives. Thus, it was not retained as a standalone preliminary alternative or in combination with other preliminary alternatives.

- **Refuge –** Since flooding would continue, a standalone refuge feature does not reduce the number of days communities are isolated or reduce street and road flooding. Although it reduces agricultural damages, it is not cost effective. Likewise, combining a refuge feature with other measures that provide benefits to streets and roads and reduces the number of days of community isolation is not cost effective. Thus, it was not retained.

- **Agriculture to Silviculture –** Converting from agriculture commodities (soybeans, corn, etc.) to silviculture is not economically justified. The purchase of conservation easements in the project area is currently estimated at $2,800 per acre for WRP enrollment (Debra Burgess, NRCS, personal communication). Converting from agriculture to silviculture does not reduce the number of days communities are isolated or reduce street and road flooding. Although it reduces agricultural damages, it is not cost effective. Likewise, combining this preliminary alternative with other preliminary alternatives that provide benefits to streets and roads and reduces the number of days of community isolation is not cost effective. Thus, it was not retained.

- **Conversion to Flood Tolerant Crops -** Similar to agriculture conversion to silviculture, this preliminary alternative would convert frequently flooded agricultural lands (within the five-year flood frequency) to switchgrass production by means of a program similar to the USDA's CCC Biomass Crop Assistance Program (Sections 9001 and 9011, Food, Conservation, and Energy Act of 2008).

  The USDA's program does not purchase easements in perpetuity. Consequently, flood control benefits would be considered temporary for such a program. Therefore, restrictive easements were considered for the preliminary costs similar to those obtained for the WRP program (*i.e.*, $2,800 per acre). All these factors combined indicated that converting to flood tolerant crops is not cost effective. In addition, converting from agriculture to flood tolerant crops does not reduce the number of days communities are isolated or reduce street and road flooding. Although it reduces agricultural damages, it is not cost effective. Likewise, combining this preliminary alternative with other preliminary alternatives that provide benefits to streets and roads and reduces the number of days of community isolation is not cost effective. Thus, it was not retained.

- **Relocations –** Relocations are not cost effective as a standalone preliminary alternative or in a combination with other preliminary alternatives. Thus, it was not retained.

- **Raising Roads –** Raising the surface elevation of roads is not cost effective as a standalone preliminary alternative or in a combination with other preliminary alternatives. Thus, it was not retained.

New Madrid Floodway

Tables 2.7 and 2.8 provide the preliminary costs and benefits for the NMF preliminary alternatives and combined preliminary alternatives, respectively. A discussion follows.

Table 2.7. Preliminary costs and benefits, New Madrid Floodway preliminary alternatives.

Preliminary Alternative	New Madrid Floodway ($000's)		
	Annual Cost	Annual Benefit	Benefit/Cost
NMF Closure and Pump Station	6,120	9,205	1.5
Alt Closure 1 (6,500 foot) and Pump Station	4,673	5,923	1.3
Alt Closure 2 (18,500 foot) and Pump Station	4,662	5,971	1.3
NMF Refuge - Expanded	14,891	6,842	0.5
NMF Silviculture	2,690	1,150	0.4
NMF Tolerant Crops	13,402	4,226	0.3
NMF Roads	5,572	205	0.0

The only preliminary alternative that had a positive benefit to cost ratio was the New Madrid Floodway closure and pumping station, including the alternate levee alignments. Annual road costs provided in Table 2.7 are conservative estimates. It is very likely that due to site-specific considerations like bridges, culverts, and rights-of-ways, the actual costs could be substantially greater. The resulting economic analysis does not indicate that these preliminary alternatives have any potential to be recommended.

Table 2.8. Preliminary costs and benefits, New Madrid Floodway combined preliminary alternatives.

Combined Preliminary Alternatives	Annual Cost	Annual Benefit	Benefit/Cost
NMF Closure and Pump Station	6,120	9,205	1.5
Alt Closure 1 (6,500 foot) and Pump Station	4,673	5,923	1.3
Alt Closure 2 (18,500 foot) and Pump Station	4,662	5,971	1.3
Refuge, Roads	20,463	7,047	0.3
Silviculture, Roads	8,262	1,355	0.2
Flood Tolerant Crops, Roads	18,974	4,431	0.2

The only combination of preliminary alternatives that had a positive benefit to cost ratio was the New Madrid Floodway closure and pumping station, including the alternate levee alignments. Constructing the closure levee and pumping station achieves the objectives of reducing the number days communities are isolated, reduces agricultural damages, and reduces street and road flood damages. Although other preliminary alternatives or a combination of preliminary alternatives achieve the objectives, they are not cost effective to implement. The following preliminary alternatives and or combination of preliminary alternatives were not retained for further analysis.

- **Refuge –** A stand alone refuge does not reduce the number of days communities are isolated or reduce street and road flooding. Although it reduces agricultural damages, it is not cost effective. Likewise, combining a refuge preliminary alternative with raising roads is not cost effective.

- **Agriculture to Silviculture –** Converting from agriculture commodities (soybeans, corn, etc.) to silviculture is not economically justified. The purchase of conservation easements in the project area is currently estimated at $2,800 per acre for WRP enrollment (Debra Burgess, NRCS, personal communication). Converting from agriculture to silviculture does not reduce the number of days communities are isolated or reduce street and road flooding. Although it reduces agricultural damages, it is not cost effective. Likewise, combining this preliminary alternative with raising roads is not cost effective. Thus, it was not retained.

- **Conversion to Flood Tolerant Crops -** Similar to agriculture conversion to silviculture, this preliminary alternative would convert frequently flooded agricultural lands (within the 5-year flood frequency) to switchgrass production by means of a program similar to the USDA's CCC Biomass Crop Assistance Program (Sections 9001 and 9011, Food, Conservation, and Energy Act of 2008).

The USDA's program does not purchase easements in perpetuity. Consequently, flood control benefits would be considered temporary for such a program. Therefore, restrictive easements were considered for the preliminary costs similar to those obtained for the WRP program (*i.e.*, \$2,800 per acre). This being the case, converting to flood tolerant crops is not cost effective. In addition converting from agriculture to flood tolerant crops does not reduce the number of days communities are isolated or reduce street and road flooding. Although it reduces agricultural damages, it is not cost effective. Likewise, combining this preliminary alternative with other preliminary alternatives that provide benefits to streets and roads and reduces the number of days of community isolation is not cost effective. Thus, it was not retained.

- **Raising Roads –** Raising the surface elevation of roads is not cost effective as a standalone preliminary alternative or in a combination with other preliminary alternatives.

2.2.4 Iterative Screening Process Step 4

The next step in the screening process was to refine preliminary alternatives that were retained in steps 1-3 with practical avoid and minimize measures to reduce environmental impacts. Avoid and minimize measures serve two primary functions. First, the avoidance and minimization, to the extent practicable, of environmental impacts is a requirement of the Clean Water Act Section 404(b)(1) Guidelines. Second, reducing environmental impacts also reduces the amount of required compensatory mitigation and overall project costs.

St. Johns Bayou Basin

The authorized project in the SJBB consists of construction of a 1,000 cfs pumping station and channel modifications. Channel modifications entail clearing of overbank areas and channel enlargement along both banks. Excavated material would be placed along both banks. Thus, any ecological resources, including wetlands, would be impacted along the channels.

Previous NEPA documents analyzed methods to reduce direct impacts in the SJBB by reducing channel enlargement dimensions. Instead of impacting both banks, construction would only occur on one side. Likewise, channel dimension can be reduced to decrease the total amount of excavated material placed along the bank.

No changes in the operation of the existing flood control structure or the operation of the proposed pumping station in SJBB are warranted due to the potential to increase flood risk in an area that is currently protected from Mississippi River backwater flooding.

New Madrid Floodway

Based on screening Steps 1 – 3, flood control preliminary alternatives in the NMF consist of the authorized closure levee, alternate closure levee locations, and the 1,500 cfs pumping station. Since the pumping station is required regardless of levee location, the three different levee alignments underwent additional screening. Preliminary costs of the different closure levee locations are presented in Table 2.9.

Table 2.9. Alternative closure levee location preliminary costs.

	1,500-foot	**6,500-foot**	**18,500-foot**
Real Estate (acres)	9	36	100
Real Estate Cost[1]	$28,800	$115,200	$320,000
Fill material (cubic yards)	233,000	537,000	1,316,000
Fill material cost[2]	$2,064,380	$4,757,820	$11,659,760
Preliminary Total Cost	$2,093,180	$4,873,020	$11,979,760

[1]Based on a cost of $3,200 per acre used for calculating mitigation costs.
[2]Based on an average cost of $8.86 per cubic yard ($10.00 and $7.72) based on costs for repairing crevassed sections of levee.

Flooding contributes ecological functions. Therefore, maintaining flooding (*i.e.*, the flood pulse) on portions of the floodplain would avoid and minimize environmental impacts. The "amount" of impacts depends on underlying land use (*e.g.*, agriculture, forest, etc.), flood frequency (*e.g.*, 2-year, 5-year, 10-year, etc.), flood duration (*e.g.*, 15 days, 10 days, 5 days, etc.), season (*e.g.*, spring, summer, etc.), and specific ecological resource (*i.e.*., wetlands, fish, waterfowl, and shorebirds). The 6,500-foot levee and 18,500-foot levee would maintain flooding on 981 and 4,276 acres, respectively (Figure 2.1), whereas, no backwater flooding would continue under the authorized location. Therefore, alternate levee locations would reduce the environmental impact but construction costs would be greater. Likewise, economic damages would continue in these areas.

Within the NMF, out of bank flooding (flooding >280 feet) first occurs in the Eagle's Nest area that is located approximately 8 miles upstream of the 1,500-foot gap, followed by remaining bottomland hardwoods in the vicinity of the Ten Mile Pond Conservation Area[9] that is located approximately 20 miles upstream of the 1,500-foot gap. Both areas are at lower elevations than at the gap itself (Figure 2.2) and provide valuable ecological resources. Both alternate levee alignments (6,500-foot and 18,500-foot) would not maintain connection to these areas. Thus, they were not carried forward into detailed analysis.

[9] The Missouri Department of Conservation manages the conservation area with levees. Although these levees provide waterfowl habitat, they also prevent backwater flooding in the lowest portions of the conservation area. The area is not subject to Mississippi River flooding until the river elevation is approximately 290 feet, approximately 6-8 feet higher than natural ground elevation. However, remaining areas not behind MDC levees are subject to backwater flooding, the most notable being the Bogle Woods tract that has been previously purchased for mitigation.

To maintain a connection to these areas as well as reduce agricultural flood damages, an alternate levee could be many miles in length because it would have to follow specific elevation contours. Such a levee would be impractical. As opposed to constructing a levee many miles in length, practical avoid and minimize measures were formulated that constructs the levee at the 1,500-foot gap location (least construction costs) but changes the operation of the gravity outlet structure and pump. For example, gates can remain open allowing the flood pulse to continue to inundate ecologically sensitive areas at lower elevation areas in the New Madrid Floodway such as the Eagles Nest Area and the bottomland hardwoods in the vicinity of Ten Mile Pond Conservation Areas. Gates could then be closed and or pumps turned on to provide flood control benefits to agricultural areas at higher elevations.

2.2.5 Iterative Screening Process Step 5

Continued operation of the Birds Point -New Madrid Floodway is required regardless of any feature. Constructing flood control features in the St. Johns Bayou Basin would not impact the continued operation of the Birds Point to New Madrid Floodway. Based on hydraulic and hydrologic modeling, closure of the 1,500-foot gap in the levee would reduce the conveyance for flood water passage within the Floodway when the Floodway is activated. Therefore, an increase in water elevation along portions of the Birds Point-New Madrid Setback Levee would occur during periods of operation. To maintain the authorized 3-foot freeboard above the project design flood, a 14.1-mile section of the Setback Levee would require a grade raise to ensure flood protection in the St. Johns Bayou Basin at the authorized level of protection.

2.3 Alternatives Retained for Detailed Analysis

The following alternatives were formulated based on the preliminary alternatives that underwent the iterative screening process

2.3.1 Alternative 1 (No Action)

As required by NEPA, a no action alternative—Alternative 1—is considered for comparative purposes. This alternative, by looking at existing and reasonably foreseeable future conditions, contemplates how the environment in the project area will be affected if no action is taken. This alternative describes what USACE refers to as “the without-project condition.”

No flood reduction improvements would be constructed under Alternative 1. Under Alternative 1, the existing St. Johns Bayou Basin (SJBB) gravity outlet structure in the New Madrid Floodway (NMF) setback levee would continue to be operated to prevent Mississippi River backwater flooding in the SJBB which would continue to cause and to contribute to flooding from the impounding of water in the basin. The gates would be closed whenever the level of the Mississippi River (*i.e.*, the elevation of the river in relation to the land around it) is higher than the elevation of the basin’s interior sump, meaning that water would not be able to flow by gravity through the outlet structure and into the river. Damages, disruptions, and dislocations described in Section 1 would continue, varying in severity seasonally and from year-to-year.

The gap at the lower end of NMF would remain open, thus allowing Mississippi River backwater flooding in a large area of the floodway. Damages, disruptions, and dislocations described in Section 1 would continue, varying in severity seasonally and from year-to-year.

Over the next 50 years, conditions in the Lower Mississippi River Valley are projected to remain substantially as they are at present. This is based on observed river conditions and the results of hydraulic modeling using data from the hydrologic period of record[10] (See Appendix C, Part 1 - Hydraulics and Hydrology). The model assumes stationarity, meaning future conditions are based upon the observed conditions over the past 67-years. Therefore, the model assumes future extreme floods and droughts, normal floods and droughts, and wet and dry precipitation years at roughly the same frequency, duration, and seasonality as that observed from the period of record analysis.

Further over the next 50 years, conversion of currently forested areas to additional agricultural land is not expected. This projection assumes that all potential farmland in the project area has been cleared. The remaining tracts of forested land are currently publicly owned (*e.g.,* Big Oak Tree State Park, portions of Ten Mile Pond Conservation Area, and Donaldson Point Conservation Area), in silvicultural production, or are too wet to farm because they are located in depressions that remain saturated for prolonged periods due to precipitation. Based on current silvicultural practices in the project area, forested areas not in public ownership would likely be cut for timber production (once in the next 50 years) and then be allowed to re-generate naturally.

Little or no conversion from agriculture to other land uses would be expected under Alternative 1. This is attributed to the projected increases in agricultural commodity prices. Agricultural prices are expected to significantly increase in the project area due to increasing scarcity of agricultural land and water in other parts of the country (Battelle, 2010).[11] Some producers may take land out of production due to environmental incentives such as the WRP administered by the NRCS. Based on existing WRP lands in the project area and input from the NRCS, USACE has forecasted that there would be annual increases of 119 acres and 36 acres in SJBB and NMF, respectively. Additional information regarding this no action assumption can be found in Appendix M, Part 1. Under Alternative 1, it is possible that some small on-farm drainages may not be maintained or may be intentionally plugged due to WRP. However, it is more likely that existing ditches and drainage infrastructure would be maintained in substantially the

[10] The hydrologic period of record is being used to determine the project's benefits, costs, environmental impacts, and compensatory mitigation requirements.

[11] During Phase 2, the IEPR panel stated that "Agricultural land has declined in the United States because of conversion to other uses. In addition, water scarcity may be a future issue due to climate change. Energy prices may also rise as society converts to alternatives to fossil fuels. Thus, real price and cost change may be a reality for agricultural producers in this and other regions of the United States."

same condition. Ditch maintenance consists of periodic vegetation and sediment removal to ensure drainage is maintained. Ditch maintenance is conducted by local levee and drainage districts. Similarly, the existing gravity outlet structure for SJB would likely undergo periodic maintenance, repair, or replacement; however, no appreciable change in its operation and management would occur.

No plans with funding mechanisms have been identified to restore hydrology to Big Oak Tree State Park with Mississippi River surface water. Although the Missouri Department of Natural Resources (MDNR) had a previous plan for the park that relied on groundwater pumps, this plan has been abandoned and no plans exist to restore the park independent of the St. Johns Bayou - New Madrid Floodway Project (R. Stout, MDNR, personal communication). Therefore, the observed progression from hydric vegetation to drier species would continue (McCarty, 2005), and Big Oak Tree State Park would continue to decline in ecological significance. See McCarty (2005) for additional information regarding the parks progression from hydric vegetation to drier species

Under Alternative 1, the NMF would be activated to receive Mississippi River flood waters when and as needed, according to federal law (i.e., approximately once every 80 years, based on historic conditions). Following these major events, levees would be rebuilt to provide the level of protection as authorized by legislation. Local governments, communities, and homeowners would repair damages to structures, roads, and other infrastructure. Although there may be temporary impacts on agricultural production and short- or long-term dislocation of local populations, life in the NMF should return to pre-flood conditions. Subsequent to the activation of the Floodway in May 2011 (see Appendix L), levees have been rebuilt, large scour holes filled with sand, ditches cleaned out, roads re-surfaced, and agricultural areas re-planted.

Residential areas are expected to remain relatively unchanged under Alternative 1. Although the activation of the floodway in 2011 resulted in immediate displacement of residents, some have already moved back and others are making plans to return, suggesting that infrequent opening of the floodway (on average once in 80 years) does not cause permanent population shifts. Although the Village of Pinhook (population 30) has applied for a buy-out, no funds have been provided to date (Connie Duke, personal communication). Even if a buy-out occurs, residents have returned to other areas in the New Madrid Floodway.

Climate change was considered as a basis for changes in land use and in hydraulics and hydrology. Predicting the effects of climate change on discrete areas, however, is extremely difficult. The capabilities of global circulation models to predict future climate change are generally recognized as approximate, strongest in predicting temperature changes and weak in predicting precipitation changes. Climate change models are strongest in predicting changes over large regions and weak in downscaling to watersheds (Battelle, 2010). Although changes as a result of future global climate change were not quantified, potential global climate scenarios and associated ramifications to this project are discussed in Section 4.

Additional information on Alternative 1 is presented throughout Section 4.

2.3.2 Alternative 2 – Construct and Operate Flood Control Improvements

The alternative was split into three sub-alternatives consisting of flood control features in the SJBB only, flood control features in the NMF only, and a combination of both. These sub-alternatives were developed to respond to issues and specific alternatives identified by the interagency team expressing a preference for a detailed study of the SJBB only alternative. Although Alternative 2 does not contain avoid and minimize measures, it was carried forward for detailed analysis for comparative purposes. In other words, Alternative 2 served as a baseline to measure the effectiveness of avoid and minimize measures developed for other alternatives.

2.3.2.1 Alternative 2.1 - Construct and Operate Flood Control Improvements in the St. Johns Bayou Basin

Alternative 2.1 concerns the management of flood risks in the SJBB only (Figure 1.1). The alternative consists of channel enlargement and drainage improvements along the lower 4.5 miles of St. Johns Bayou, beginning at New Madrid, Missouri, continuing along the Birds Point-New Madrid Setback Levee Ditch, and ending with 10.8 miles along St. James Ditch. In addition, a 1,000-cfs pumping station would be constructed a few hundred feet east of the existing gravity outlet at the lower end of St. Johns Bayou.

The lower 4.3 miles[12] of St. Johns Bayou would be cleared and enlarged on both sides; bottom widths would be increased from approximately 80 feet to 200 feet. Approximately 2,485,000 cubic yards of material would be deposited along both banks, creating a 220-foot wide embankment on each side**.** Embankment dimensions would vary but would generally have side slopes of 1 vertical to 2.5 feet horizontal and a crown slope no steeper than 1 vertical on 20 feet horizontal to minimize erosion. Maximum embankment height would vary by construction reach. However, embankments would be no greater than 20 feet above natural ground elevation.

The lower 8.1 miles of the Birds Point-New Madrid Setback Levee Ditch would be enlarged from approximately 40 feet to 50 feet. The work would take place along the left descending bank and approximately 675,000 cubic yards of material would be placed in a 120-foot wide embankment located along the left descending bank. The area would be allowed to revegetate naturally as part of a conservation easement, however no mitigation credit would be provided as this action is implemented as a best management practice.

St. James Ditch would be enlarged along the left descending bank. Bottom width along the lower 3.5 miles would be enlarged from 35 feet to 45 feet. No changes to bottom width would be anticipated along the remaining 7.8 miles of channel. However, top width along the left descending bank would be widened to an 80-foot average.

[12] Total construction limits are the lower 4.5 miles of St. Johns Bayou. However, the first 0.2 miles would only consist of a construction access road placed along the right descending bank in farmland. Channel modifications would only take place on the remaining 4.3 miles.

Approximately 630,000 cubic yards of excavated material would be placed on a 100-foot wide embankment along the left descending bank. The area would be allowed to revegetate naturally as part of a conservation easement, however no mitigation credit would be provided as this action is implemented as a best management practice.

A 1,000 cfs pumping station would be constructed several hundred feet to the east of the existing gravity outlet structure on St. Johns Bayou. Pumping would commence when water in the sump area reached an elevation of 279.0 feet and would continue until the sump elevation dropped to 277.0 feet. Gates would remain closed when river stages were greater than the interior sump elevation. Gates would remain open when the interior sump elevation exceeded the Mississippi River elevation, thus allowing for gravity drainage through the St. Johns Bayou gravity outlet structure.

During waterfowl season (1 December to 31 January), gates would be closed to impound interior runoff in the lower SJBB for the benefit of waterfowl. Impounded interior runoff would be managed to maintain an interior sump elevation of 285.0 feet.

2.3.2.2 Alternative 2.2 – Construct and Operate Flood Control Improvements in New Madrid Floodway

Alternative 2.2 concerns the management of flood risks only in the NMF. This alternative consists of the closure of the 1,500-foot levee gap at the lower end of the NMF between setback levee mile 35 and 37 (Figure 2.1). The levee would be constructed of approximately 233,000 cubic yards of material. Cross sectional dimensions would be a crown elevation of 317.0 feet, a top width of 16 feet, a base width of approximately 302 feet, and side slopes of 1:4.5. In addition, the lower section of the Frontline Levee would be raised to a height equivalent to the rest of the Frontline Levee. The levee raise would require an additional 127,000 cubic yards of material. Fill material (totaling 360,000 cubic yards) would be obtained from approximately 60 acres of borrow pits that would be ecologically designed to benefit floodplain fisheries.

Four 10-foot by 10-foot gated box culverts would be constructed in Mud Ditch to maintain drainage in the NMF.

This alternative would also include a grade raise in a 14.1-mile section of the Setback Levee to ensure flood protection in the SJBB at the authorized level of protection. Setback Levee grade raises would range from 0.1 feet to 3 feet (average 1.28 feet) and would require 2.4 million cubic yards of material. Material would be obtained from 387 acres of borrow pits. The grade raise would be limited to the crown only. No increases to the levee width and right of way are contemplated.

A 1,500 cfs pump station would be constructed in the NMF. Pumping would normally commence when the water in the sump reached 278.0 feet and would continue until the interior sump elevation dropped to 275.0 feet. Should Mississippi River stages drop during pumping to levels below the interior sump elevation, pumping operations would cease and the floodgates would be opened to allow for gravity drainage.

During waterfowl season (1 December to 31 January) gates would be closed to impound interior runoff in the lower NMF for the benefit of waterfowl. Impounded interior runoff would be managed to maintain an elevation of 284.4 feet.

2.3.2.3 Alternative 2.3 – Construct and Operate Flood Control Improvements in both St. Johns Bayou Basin and New Madrid Floodway

Alternative 2.3 combines Alternatives 2.1 and 2.2.

2.3.2.4 Alternative 3 – Combined Authorized Project with Avoid and Minimize Measures

2.3.2.4.1 Alternative 3.1 – Manage Connectivity Scenario 1

St. Johns Bayou Basin Channel Modifications

In contrast to the authorized project (Alternative 2) that calls for a two-sided channel enlargement from an existing bottom width of 80 feet to 200 feet, the avoid and minimize measures would enlarge the lower 3.7 miles of St. Johns Bayou from the right descending bank only and the proposed bottom width would increase from 80 feet to 120 feet.

Setback Levee Ditch would be enlarged from one side (left descending bank). The Setback Levee runs parallel to Setback Levee Ditch along the left descending bank. This alternative was refined to avoid the relatively high concentration of freshwater mussels discovered in 2002 and 2006 along the right descending bank in this reach. A recent 2010 survey indicated that these populations have decreased due to recent basin wide ditch maintenance efforts, however, the avoid and minimize measure was retained in the final array of alternatives.

Rights of way along St. James Ditch would be obtained along alternate sides to protect areas of riparian vegetation (*i.e.*, spoil material would be placed into areas that are likely prior converted cropland as opposed to vegetated areas, where practical).

New Madrid Floodway

The proposed NMF gravity outlet structure and pumps would be used to strategically manage socioeconomic flood risks while minimizing environmental damages. For example, backwater flooding would be allowed to occur at elevations that would still provide connectivity to the majority of remaining forested habitat during portions of the year in which flooding is beneficial (approximate elevation of 290 feet). Likewise, flooding would be managed at different elevations during periods of the year that coincide with agriculture (approximate elevation of 285 feet). Furthermore, floods could be managed to reduce the risk of flooding to project area roads and infrastructure (approximate elevation of 290 feet). Table 2.10 provides alternative 3.1 gate and pump management scenarios.

Winter Period (Figure 2.3)

For the winter period (*i.e.*, 15 November to 28/29 February), flood waters would naturally inundate the New Madrid Floodway to a maximum flood elevation objective[13] of 289.5 feet (MS 115[14] = 34 feet). This elevation is approximately 0.5 feet below flood stage, which corresponds to the elevation of area roads. Therefore, roads would remain open. During this period, the proposed gravity outlet structure would be closed at an elevation of 288 feet (MS 115 = 32.5 feet). Pumps would be turned on when the interior sump elevation reached 289.5 feet. Pumps would be turned off at an interior sump elevation of 288.5 feet. In the event that the Mississippi River elevation fell below the interior sump elevation, pumps would be turned off and gates would be opened to allow for gravity drainage.

During waterfowl season (*i.e.*, 1 December – 31 January), gates would be closed to impound interior runoff. However, dependent on river stages, flood waters would still be allowed to inundate the Floodway up to an elevation of 289.5 feet (MS-115 = 34 feet).

Early Spring (Figure 2.3)

For the early spring period (*i.e.*, 1 March – 15 April), flood waters would naturally inundate the Floodway to an elevation of 288 feet (MS-115 = 32.5 feet). During this period, the proposed gravity outlet structure would be closed at an elevation of 286 feet. Pumps would be turned on when the interior sump elevation reached 288 feet. Pumps would be turned off at an interior sump elevation of 287 feet. In the event that the Mississippi River elevation fell below the interior sump elevation, pumps would be turned off and gates would be opened to allow for gravity drainage.

Late Spring (Figure 2.3)

For the late spring period (*i.e.*, 16 April – 31 May), flooding would be allowed in the Floodway to an elevation of 284 feet (MS-115 = 28.5). This would be accomplished by closing gates and turning on pumps at an elevation of 284 feet. Pumps would be turned off at an elevation of 282 feet. In the event that the river elevation fell below the interior sump elevation, pumps would be turned off and gates would be opened to allow for gravity drainage.

Remainder of the Year (Figure 2.3)

For the remainder of the year (1 June to 14 November), flood elevations would be limited to an elevation of 280 feet. This would be accomplished by closing gates at an elevation of 278.5 feet, starting pumps at an elevation of 280 feet, and turning pumps off at an elevation of 278.5 feet. In the event that the Mississippi River elevation fell below the

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[13] The maximum flood elevation is a management objective; floods can and will still occur above this elevation in the event of significant interior rainfall that occurs during high Mississippi River elevations.
[14] MS 115 is the Mississippi River gage located at New Madrid.

interior sump elevation, pumps would be turned off and gates would be opened to allow for gravity drainage.

2.3.2.4.2 Alternative 3.2 – Manage Connectivity Scenario 2

In the SJBB, actions discussed under alternative 3.1 would remain unchanged for alternative 3.2. In the NMF, overall management of alternative 3.2 is the same as alternative 3.1 except that additional flood protection in the NMF is provided in the spring (Table 2.10).

Table 2.10. Alternative 3.1 and 3.2 gate and pump management scenarios, New Madrid Floodway.

Date	Close Gate		Start Pump		Stop Pump	
	Alt 3.1	Alt 3.2	Alt 3.1	Alt 3.2	Alt 3.1	Alt 3.2
15 Nov – 28 Feb[1]	288	288	289.5	289.5	288.5	288.5
1 March – 15 April	286	284	288	286	287	285
16 April – 31 May	284	282	284	282	282	280
1 June – 14 November	278.5	278.5	280	280	278.5	278.5

[1] Elevations do not depict winter waterfowl management pool.

2.3.2.5 Alternative 4 – Maintain Connectivity

Alternative 4 is similar to alternative 3 in that all project features are constructed, including the 1,000 cfs St. Johns Bayou pumping station, 24 miles of reduced width channel enlargement in the SJBB, 1,500-foot closure levee, 1,500 cfs pump in the NMF, and waterfowl management in both basins. However, with the exception of waterfowl season, alternative 4 would not close the NMF structure or utilize pumps until floods reach an elevation in which roads are threatened (approximate elevation of 289.5 feet). This would be accomplished by closing the gates at an elevation 287.5 feet, starting pumps at an elevation 289.5, and stopping pumps at an elevation of 288 feet.[15] Gates would be opened to allow for gravity drainage during periods in which the Mississippi River elevation is less than the interior sump elevation.

During the Phase 3 IEPR review, the panel recommended that other potential benefits be investigated that would provide benefits to agricultural areas below an elevation 289.5 feet. Since some of these measures may be problematic for USACE to implement, the alternative was divided into two different sub-alternatives.

2.3.2.5.1 Alternative 4.1 – Maintain Connectivity Scenario 1

St. Johns Bayou Basin

In the SJBB, actions discussed under alternative 3.1 would remain unchanged for alternative 4.1.

[15] Note that these are the same elevations as the period 15 Nov – 28 Feb for Alternatives 3.1 and 3.2.

New Madrid Floodway

Alternative 4.1 calls for construction of the flood control features only with no additional measures to areas below an elevation of 289.5 feet.

2.3.2.5.2 Alternative 4.2 – Maintain Connectivity Scenario 2

St. Johns Bayou Basin

In the SJBB, actions discussed under alternative 3.1 would remain unchanged for alternative 4.2.

New Madrid Floodway

Alternative 4.2 calls for reforestation of agricultural lands below an elevation of 289.5 feet in conjunction with the structural flood control features previously stated. There are 13,340 acres of agricultural lands below an elevation of 289.5 feet. In addition to the benefit from the conversion of agriculture to silviculture, this alternative would augment that benefit with additional economic incentives from carbon sequestration and nutrient trading. Areas above an elevation of 289.5 feet would receive the same project benefits as previous alternatives.

Additional benefits to carbon sequestration and nutrient trading were computed in a similar method as was utilized by Shabman and Zepp (2000). As previously mentioned there is currently no nutrient trading program in the State of Missouri to base project benefits. Although carbon credits were previously traded on the market, they no longer are. Therefore, there is currently no existing available program to base carbon credits on.

Measures that take productive agricultural land out of production and reforest it are not supported by local landowners (St. John Levee and Drainage District, personal communication). Therefore, it is highly unlikely that a volunteer type of easement could be established to implement such a plan. Therefore, the alternative estimated that real estate would be purchased fee title (current estimate is $3,200 per acre). Estimates did not include any costs associated with tree planting, earthmoving, forest maintenance etc. Therefore, costs are likely under estimated.

2.4 Comparison of Alternatives

Benefits and impacts of each alternative are summarized in Table 2.11. The relationship of each alternative to environmental protection statutes or other environmental requirements is summarized in Table 2.12. Alternative 3.1 is the NED plan. Thus, it was identified as the tentatively selected plan. Detailed information regarding project benefits, impacts, mitigation, monitoring, and adaptive management can be found in Sections 3-7.

Table 2.11. Impacts and benefits of alternative plans, St. Johns Bayou Basin and New Madrid Floodway.

	Alt. 2.1	Alt. 2.2	Alt. 2.3	Alt. 3.1	Alt. 3.2	Alt 4.1	Alt. 4.2
Reduced Flooding (total acres)[1]	3,085	52,108	55,193	46,248	48,145	41,883	41,883
Reduced Flooding (agricultural acres)[1]	2,646	44,372	47,018	40,597	42,105	37,030	23,690
Roads/Infrastructure (Risk Managed Y/N)	Y	Y	Y	Y	Y	Y	Y
Social Impacts (Risk Managed Y/N)	Y	Y	Y	Y	Y	Y	Y
Average days per year roads are inundated (SJB/NMF)	11.9/20.4	17.4/0	11.9/0	11.9/0	11.9/0	11.9/0.2	11.0/0.2
Wetland Impacts (LGRB Detain Floodwater FCU)	-116	-6449	-6,565	-3,598	-4,156	3,024	-75
Wetland Impacts (LGRO Detain Floodwater FCU)	-653	-186	-839	-432	-432	-583	-583
Wetland Impacts (CD Maintain Plant Communities FCU)	0	-179	-179	-124	-138	-108	-196
Terrestrial Wildlife (AAHU)	-1263	-13	-1,276	-779	-779	-779	+11,262
Waterfowl Impacts (Feb-March DUD)	-3,133,296	-6,241,577	-9,374,873	-6,424,082	-6,872,547	-5,861,012	-1,728,785
Shorebird Impacts (spring opt. equiv. acres)	-116	-852	-968	-731	-858	-439	-439
Fish Spawning and Rearing (mid-season AAHU)	-441	-2,794	-3,225	-2,502	-2,781	-1,934	-351
Total First Costs[2] ($000)	$57,942	$143,902	$200,616	$164,779	$178,429	$151,357	$179,619
Net Annual Costs[3] ($000)	$2,895	$6,120	$9,015	$7,249	$7,563	$6,872	$8,919
Net Annual Benefits[3] ($000)	$6,911	$9,205	$16,116	$15,501	$15,688	$15,100	$15,286
Excess Benefits[3] ($000)	$4,016	$3,085	$7,101	$8,252	$8,125	$8,228	$6,367
Benefit:Cost Ratio[3]	2.4	1.5	1.8	2.1	2.1	2.2	1.7

[1]Calculated as the difference between the pre and post project five year flood frequency.
[2]Based on original construction cost estimates inflated to reflect 2011 costs and revised mitigation costs.
[3]Based on the current interest rate of 4.00%
LGRB – Low Gradient Riverine Backwater (see Section 3.8.1)
LGRO – Low Gradient Riverine Overbank (see Section 3.8.1)
CD – Connected Depression (see Section 3.8.1)
AAHU – Average Annual Habitat Units (see Section 4.8.2 and Section 4.8.5)
DUD – Duck Use Days (see Section 4.8.3)

Table 2.12. Relationship of plans to environmental protection statutes or other environmental requirements, St. Johns Bayou Basin and New Madrid Floodway.

FEDERAL STATUTES	*Alt. 2.1*	*Alt. 2.2*	*Alt. 3.1*	*Alt 3.2*	*Alt. 4.1*	*Alt 4.2*
1. Archaeological and Historic Preservation Act of 1974. Compliance requires Corps to undertake recovery, protection, and preservation of significant cultural resources whenever its activities may cause irreparable loss or destruction of such resources.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
2. Clean Air Act, as Amended. Compliance requires coordination with the U.S. Environmental Protection Agency and analysis of potential impacts on air quality.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
3. Clean Water Act of 1977. Compliance requires preparation of 404(b)(1) Evaluation and submission of such to Congress with the draft EIS or procurement of state water quality certification(WQC). See, Appendix E, Part 5, for the 404(b)(1) evaluation. Pending State WQC.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
4. Endangered Species Act of 1973, as Amended. Compliance requires coordination with the U.S. Fish and Wildlife Service (USFWS) to determine if any endangered or threatened species or their critical habitat would be impacted by the project.	*NC*	*NC*	*NC*	*NC*	*NC*	*NC*
5. Federal Water Project Recreation Act. Compliance requires review by the Department of the Interior. Coordination of the draft EIS will bring the project into full compliance.	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
6. Fish and Wildlife Coordination Act. Compliance requires coordination with the USFWS and recommendations are discussed in, Appendix Q, which includes the Fish and Wildlife Coordination Act Report(CAR). Pending CAR from USFWS.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
FEDERAL STATUTES	*Alt. 2.1*	*Alt. 2.2*	*Alt. 3.1*	*Alt. 3.2*	*Alt. 4.1*	*Alt. 4.2*
7. Land and Water Conservation Fund Act. Compliance requires Secretary of the Interior approval of replacement property that would be acquired to mitigate converted property purchased with LWCFA funds.	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
8. National Historic Preservation Act. Compliance requires Corps to take into account the impacts of project on any property included in or eligible for inclusion in the National Register of Historic Places.	*FC*	*FC*	*FC*	*FC*	*FC*	*PC*

9. <u>National Environmental Policy Act.</u> Compliance requires preparation of this draft EIS, consideration of public comments, and preparation and public review of the final EIS. Signing of the Record of Decision would bring this project into full compliance.	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
10. <u>River and Harbor Act.</u>	*PC*	*PC*	*PC*	*PC*	*PC*	*PC*
11. <u>Farmland Protection Policy Act.</u> Compliance requires coordination with the Natural Resources Conservation Service to determine if any designated prime or unique farmlands are affected by the project.	*FC*	*FC*	*FC*	*FC*	*PC*	*PC*
12. <u>Watershed Protection and Flood Prevention Act.</u> No requirements for Corps projects.	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
13. <u>Wild and Scenic River Act.</u> Compliance requires coordination with Department of the Interior to determine if any designated or potential wild, scenic, or recreational rivers are affected by the project. Coordination has been accomplished and there are no such rivers in the project area.	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
<u>EXECUTIVE ORDER/MEMORANDA</u>	*Alt. 2.1*	*Alt. 2.2*	*Alt. 3.1*	*Alt. 3.2*	*Alt. 4.1*	*Alt. 4.2*
1. <u>Executive Order 11988, Floodplain Management.</u> Compliance requires an assessment and evaluation together with the other general implementation procedures to be incorporated into EIS.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
2. <u>Executive Order 11990, Protection of Wetlands.</u> Compliance requires results of analysis and findings related to wetlands be incorporated into the EIS.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
3. <u>Executive Memorandum, Analysis of Impacts on Prime and Unique Farmlands in EIS.</u> Compliance requires inclusion of effects of proposed action on prime and unique farmlands in EIS.	*FC*	*FC*	*FC*	*FC*	*PC*	*PC*
4. <u>Executive Order 11593, Protection and Enhancement of the Cultural Environment.</u> Compliance requires Corps to administer cultural properties under their control in stewardship for future generations; preserve, restore or maintain such for benefit of the people; and assure that its plans contribute to preservation and enhancement of non-federally owned sites.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*
5. <u>Executive Order 13112, Invasive Species.</u> Compliance requires assessment of potential for the project to introduce invasive species to the project	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*

area.						
6. Executive Order 12898, Environmental Justice in Minority and Low-income Populations. Compliance requires assessment of project effects on minority and low-income populations.	*FC*	*FC*	*FC*	*FC*	*FC*	*FC*

FC - In Full Compliance
PC - In Partial Compliance
NA - Not Applicable
NC – Not in Compliance, to date

3.0 AFFECTED ENVIRONMENT

The affected environment is the area and resources that might be affected by the alternatives discussed in this report. This chapter also served to describe the existing and future without-project conditions.

The St. Johns Bayou Basin and the New Madrid Floodway Project area is located in Mississippi and New Madrid counties in southeastern Missouri along the right descending bank of the Mississippi River. Although the project area was historically one drainage basin due to extensive ditching and levee construction (both public and private), the project area currently encompasses portions of two drainage basins separated by the Birds Point-New Madrid Setback Levee (Figure 1.1).

The St. Johns Bayou Basin is approximately 324,170 acres (507 square miles) in size, extending north to Commerce, Missouri, east to East Prairie, Missouri, and south to New Madrid, Missouri. Major streams and ditches include St. Johns Bayou, Setback Levee Ditch, St. James Ditch, St. Johns Ditch, Lee Rowe Ditch, and Maple Slough Ditch (Figure 3.1). All of these ditches flow into St. Johns Bayou, and, via the St. Johns Bayou outlet structure, empty into the Mississippi River. All ditches undergo periodic vegetation and sediment removal.

The remaining area drains through the Drinkwater area, where runoff flows through a gravity outlet structure or is pumped over the levee during periods of high Mississippi River stages. Select photographs of ditches in the St. Johns Bayou Basin are included as Figure 3.2.

The New Madrid Floodway is approximately 132,600 acres (207 square miles) in size, beginning just south of Cairo, Illinois, and extending south to New Madrid (Figure 1.1). Major streams and ditches include Mud Ditch, Wilkerson Ditch, St. Johns Diversion Ditch, Tenmile Pond, and St. James Bayou (Figure 3.3). St. James Bayou and the other ditches flow into Mud Ditch, which passes through the 1,500-foot gap, converges with St. Johns Bayou, and empties into the Mississippi River about one-half mile east of New Madrid (Figure 3.4).

The remaining Peafield area drains through a gravity outlet structure or is pumped over the frontline levee during periods of high Mississippi River stages. Similar to the St. Johns Bayou Basin, all major watercourses have been channelized and new drainage ways constructed throughout the area. For example, Mud Ditch was intentionally dug to drain the Eagle’s Nest area of the New Madrid Floodway. Select photographs of ditches in the New Madrid Floodway are included as Figure 3.5. Aquatic habitat is limited to species that can withstand the periodic maintenance.

The Primary Impact Area (PIA) of the project was determined by evaluating the area that was reasonably affected by interior runoff in the St. Johns Bayou Basin and Mississippi River backwater flooding in the New Madrid Floodway. Junk *et al.* (1989) defined the floodplain as “areas that are periodically inundated by the lateral overflow of rivers or lakes, and/or by direct precipitation or groundwater;….”[16] An elevation of 300 feet was used as the upper limit of the PIA (Figure 3.6).

The PIA can be further refined based upon the resource being analyzed due to the response threshold that results in an adaptation or produces a community structure. For example, the 5-year flood frequency elevation was used to differentiate between riverine wetlands and flats (Klimas *et al*, 2009). Therefore, the 5-year floodplain served as the primary impact area for wetland analysis because floods greater than the 5-year frequency do not play a major ecological role for wetlands at elevations greater than the corresponding 5-year flood frequency. Additionally, the 5-year frequency elevation was used as the upper limit of suitable spawning and rearing fish habitat (J. Jackson, personal communication) for Mississippi River fishes. However, seasonally inundated habitat is exploited by waterfowl and shorebirds regardless of flood frequency as long as it occurs during the appropriate migration windows and is of appropriate depths (Battelle, 2010). The upper limit for shorebirds was the maximum observed stage, and the corresponding limit for waterfowl was the 100-year flood frequency elevation. Further information regarding the primary impact area for each significant resource can be found in the section of the draft EIS devoted to that specific resource.

3.1 Elevations

To determine the economic benefits of the project and environmental impacts, an analysis was required that compared existing conditions with project alternatives. Stage-area and daily elevation data of the extent of flooding was generated to determine benefits and impacts of the project. The stage area was determined from two separate data sets. Light Detection and Ranging (LIDAR) data was available for the New Madrid Floodway. Since LIDAR was not available for the entire St. Johns Bayou Basin, elevations established by the U.S. Geological Survey (USGS) were utilized. Further GIS analysis was then conducted from the newly established one-foot contours to support the resource analyses conducted for the draft EIS. Specific GIS applications utilized to generate the 1-foot contours are found in Appendix M, Part 3. As the shorebird analysis required a finer resolution, 0.10-foot contours were interpolated between the previously established one-foot contours. A sensitivity analysis was conducted to validate the dataset (Appendix M, Part 4).[17]

3.2 Historic Conditions

Major natural communities/habitat types that historically were present in the St. Johns Bayou Basin and New Madrid Floodway project area included: 1) the main channel and islands of the Mississippi River and its major tributaries; 2) river chutes and side channels; 3) bottomland lakes, often referred to as oxbows; 4) riverfront forest that was

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[16] Note that Junk *et al's* (1989) definition includes references to direct precipitation and groundwater; the Hydraulics and Hydrology model used for alternative analysis includes estimates of groundwater seepage, precipitation, and the Mississippi River elevation to determine flood elevations.

[17] The results of the sensitivity analysis indicated there was no substantive difference between USGS and LIDAR data.

dominated by early succession tree species such as willow, silver maple, cottonwood, and sycamore; 5) bottomland hardwood forest (BLH) that contained diverse hardwood tree species including green ash, American elm, box elder, sugarberry, and several oak species; 6) terrace hardwood forest dominated by relatively water intolerant hardwood trees such as post oak and cherrybark oak; 7) slope forest on alluvial fans with mixed upland and floodplain tree species; 8) sand prairie; and 9) sand savanna. (Heitmeyer, 2010). A complete assessment of the historic landscape is found in Appendix D.

Figure 3.7 provides a land use map of presettlement conditions (*e.g.*, circa 1790). Soil type, geomorphic surface, and hydrology were highly correlated with, and predictive of, the historic community distribution in the project area. Forest covered 93 percent of the project area. Riverfront forest historically covered 9.3 percent and was distributed primarily in a band parallel to the active Mississippi River channel on fine sandy loam soils. Low bottomland hardwoods including bottomland lakes covered about 115,000 acres of the project area and were present mostly in the Holocene meander belt of the Mississippi River and had Sharkey and Alligator clay soils. Intermediate bottomland hardwoods were widely distributed over 23.8 percent of the project area in the Holocene meander belt and some valley train relict channels where average flooding occurrence was 1-2 years during the growing season and soils were silty-clay-loam Mollisols and Inceptisols. High bottomland hardwoods were present on about 65,000 acres of the project area in several floodplain geomorphic surfaces where average growing season flood frequency was 2-5 years and soils were silt loams. Terrace hardwood covered about 109,000 acres of higher elevation terrace and valley train surfaces with >50 year flood occurrence and sandy-loam Entisol soils. Slope forest was limited to a few small alluvial fan sites adjacent to the Commerce Hills. Prairie and savanna historically were distributed on the highest elevations of project area where fine loamy sand soils were present on braided stream terraces and the Sikeston Ridge. These two communities may have compromised nearly 33,000 acres in the Presettlement period.

3.3 Land Use

The project area has undergone major alterations that have converted the project area from 93 percent forested to over 80 percent agriculture today (Tables 3.1 and 3.2). What once was an expansive bottomland hardwood forest (BLH) ecosystem (Figure 3.7) has been converted into a homogenous landscape of agricultural fields (Figure 3.8). The development and conversion of much of the project area to agricultural usage coincided with flood control and drainage projects in the late 1800s and early 1900s (Heitmeyer, 2009)[18]. All natural drainages have undergone past channelization activities,[19] a vast network of new ditches and drainage structures have been constructed to drain low lying

[18] An evaluation of existing land use came from data from the 2007USDA Natural Resources Conservation Service National Cartography & Geospatial Center 2001 National Land Cover Database (NLCD) as verified by aerial imagery obtained from the National Agricultural Imagery Program. Land use was further verified by conducting site visits on 20 percent of the project area.

[19] Manmade manipulation of natural watercourses is evidenced by the fact that many maps now contain the phrase “Ditch” after natural water course names such as St. Johns Bayou Ditch and St. James Bayou Ditch.

areas,[20] levees have been constructed,[21] and the land has been cleared and leveled to accommodate agricultural production.

At the present time, the largest tracts of woods remaining in the New Madrid Floodway include Big Oak Tree State Park, Bogle Woods, and a privately owned wooded tract north of Ten Mile Pond Conservation Area. (Figure 3.9) All of these tracts are situated in clay-type soils located on silted-in ancient oxbow lake beds, also identified as Halocene Meander Belts. Another wooded tract located at the lower end of the New Madrid Floodway is owned by the Westvaco Timber Company. In the lower end of the St. Johns Bayou Basin, three larger wooded tracts have not been cleared due to topography and persistent saturated soil conditions. Overall, the remaining larger forested tracts have retained their wooded cover because they are in public or timber company ownership, because of owner preference, and/or because appropriate hydrologic conditions do not exist for conversion to agricultural use. Mean area of remnant forest tracts in the project area is < 50 acres, and when the larger tracts that are in public ownership are excluded, the mean area of forested tracts is < 12 acres (Heitmeyer, 2010; Twedt and Loesch, 1999).

Historically, a continuum of riverfront forest, BLH and Terrace Hardwood communities was found from the edges of Mississippi River channels to the Sikeston Ridge. Riverfront forest communities can currently be found in the batture lands adjacent to the project area and in remnant river chutes of the Floodway. These communities are dominated by early successional tree species, ranging from water tolerant species such as black willow and silver maple along river channels and lower elevations to intermediate water tolerant species such as green ash, cottonwood, box elder, sycamore, and sugarberry on ridges. Oaks, such as swamp white and pin, are occasionally found in higher elevations of riverfront forests, but suffer high mortality rates during periods of extended flooding. Herbaceous vegetation among riverfront forests is sparse near the river edge, but increases with elevation. Typical shrub and vine species include poison ivy, Virginia creeper, grape, and dogwood. Common soils under riverfront forests are Caruthersville sandy loam and Commerce silt loam.

The makeup of BLH communities in the project area varies according to elevation gradients and flooding regimes. Low BLH communities exist where flooding occurs for extended periods, sometimes 4-6 months of the year and occasionally year round. Since the Mississippi River does not flood for 4-6 months of the year, hydrology in these areas is based on local drainage patterns. Although these areas may be inundated during high Mississippi River stages, flooding persists due to local precipitation and lack of drainage. Remnant examples of low BLH can be found in the Ten Mile Pond Conservation Area, Eagle's Nest WRP site, Big Oak Tree State Park and depressional areas on private lands. Low BLH communities consist of bald cypress, water locust, water elm and water tupelo at the lower elevations and shift to overcup oak, green ash, red maple, and pecan as elevation increases. Herbaceous vegetation in low BLH is sparse due to flooding, but

[20] For example, Mud Ditch was constructed to drain the Eagle's Nest Area of the New Madrid Floodway
[21] For example, the Mississippi Frontline Levee, the Setback Levee, and numerous private levees have been constructed throughout the area.

sedges, smartweed, and rice cutgrass can be found in abundance during dry periods. Woody shrubs and vines found in low BLH consist of swamp privet, buttonbush, water elm, crossvine, and greenbrier. Soils in low BLH are comprised of Sharkey, Jackport and Alligator clays.

Intermediate BLH communities are located in areas that typically flood from 2 to 4 months a year. Remnant examples of intermediate BLH include Big Oak Tree State Park, forested areas northwest of Ten Mile Pond Conservation Area and slough banks and natural levees along the Mississippi River Levee. Likewise, the Mississippi River does not flood 2-4 months of the year. Hydrology is maintained through localized drainage patterns and precipitation. Tree species include pin oak, Nuttal oak, bur oak, green ash, sweetgum, sugarberry, and American elm. Understory plants consist of common privet, honeysuckle, grape, trumpet creeper, and poison ivy. Soils of intermediate BLH are dominated by silty clay loams.

High BLH communities in the project area flood up to several weeks annually during wet years and may be dry for several consecutive years during dry periods. Very few high BLH sites remain in the project area because these were likely the first sites to be cleared and the easiest to be drained for agricultural production. Remnant high BLH sites mostly occur on private lands and ridges on the northern Charleston Fan and inside older point bar meander scrolls and natural levees. Dominant tree species include willow oak, pin oak, cherrybark oak, shagbark hickory, shellbark hickory, sweetgum, American elm, and to a minor extent, sycamore, cottonwood, and winged elm. Herbaceous cover in high BLH is dominated by dense stands of poison ivy, crossvine, trumpet creeper, cane, and Virginia creeper. Soils found under high BLH communities are mainly silt loams, while sandy loams can be found on terraces, relict Valley Train channels and natural levees.

Terrace hardwood forest, often called “flats,” historically occurred where overbank and backwater flooding from the Mississippi River was rare. Like the high BLH, Terrace Hardwoods have nearly been eliminated in the project area and only a few small patches remain near the town of East Prairie and on private land. Dominant tree species include pin oak, cherrybark oak, post oak, willow oak, hickory, and winged elm. Understory plants include trumpet creeper, goldenrod, bedstraw, and wood sorrel. Soils found under Terrace Hardwoods consist of Clana, Bosket, Broseley, Farrenburg, and Lilbourne types.

3.3.1 Prime and Unique Farmland

The Farmland Protection Policy Act (FPPA), 7 U.S.C. § 4201 et seq. (2012) was enacted in 1981 to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses, and to assure that Federal programs are administered in a manner that, to the extent practicable, would be compatible with State, unit of local government, and private programs and policies to protect farmland.

The policy of the Natural Resources Conservation Service (NRCS) is to protect agricultural lands from conversions that are irreversible and result in the loss of an essential food and environmental resource. Prime farmland has been identified by NRCS as important agricultural resource that warrants protection. The FPPA defines prime farmland as land that has the physical and chemical characteristics for producing food, feed, fiber, forage and oilseed crops, and is available for these uses. Prime farmland has the soil quality, growing season and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods.

Most of the project area is dedicated to agricultural production. According to NRCS, there are 390,466 acres of farmland within both the entire St. Johns Bayou Basin and New Madrid Floodway. Of these acres, 351,419.4 (90 percent) are considered to be prime farmland (Figure 3.10). Outside of mitigation, farmland should not be removed from production and prime and unique farmland will only be utilized for mitigation if no other farmland is made available.

3.4 Hydraulics and Hydrology

The detailed Hydraulics and Hydrologic (H+H) analysis is contained in Appendix C, Part 1.

In summary, the H+H analysis included the following:

a. Daily Mississippi River gage data was obtained from the New Madrid, Missouri, gage for the period 1943-2009.
b. Rainfall records were obtained from the Cairo, Illinois; New Madrid, Missouri; and Sikeston, Missouri stations from 1943-2009. Accuracy of data was assessed, and missing data was estimated from other rainfall stations to produce a record sufficient for continuous simulation.
c. Daily flows for the St. Johns Bayou Basin and the New Madrid Floodway were calculated utilizing the HUXRAIN model.
d. Elevation-storage relationships were updated.

Table 3.1. Existing stage area curve (acres), St. Johns Bayou Basin.

Elevation	Agriculture	Developed	Fallow	Forest	Herbaceous	Open Water	Pasture	Scrub/Shrub	Total
281 and below	250.3	13.1	0.0	335.9	10.6	100.2	0.0	0.0	710.1
282 and below	267.0	15.4	0.1	387.2	12.0	100.2	0.0	0.0	782.0
283 and below	287.3	17.0	0.9	442.5	12.8	100.2	0.1	0.0	860.9
284 and below	1,581.8	31.7	5.6	867.6	40.6	157.3	0.5	0.0	2,685.1
285 and below	1,653.5	34.0	11.1	986.9	41.7	158.4	0.6	0.0	2,886.2
286 and below	1,855.2	41.8	38.9	1,454.0	64.6	187.4	0.8	0.0	3,642.8
287 and below	2,482.3	56.8	88.7	2,131.6	96.2	244.5	1.1	0.0	5,101.2
288 and below	2,844.4	65.4	152.2	2,508.4	111.6	259.7	1.2	0.0	5,942.9
289 and below	3,276.2	84.7	195.5	2,819.4	126.0	270.3	1.4	0.0	6,773.6
290 and below	4,355.9	126.2	233.2	3,336.4	136.6	291.1	2.9	0.0	8,482.2
291 and below	7,110.9	211.9	287.1	3,822.1	166.5	298.3	7.4	0.0	11,904.3
292 and below	10,494.1	330.1	305.0	4,280.1	183.6	307.0	12.9	0.0	15,912.8
293 and below	12,472.6	417.2	313.5	4,526.2	199.4	309.8	23.5	0.0	18,262.2
294 and below	14,126.5	479.2	316.7	4,692.7	205.8	310.0	44.6	0.0	20,175.5
295 and below	16,124.6	548.3	319.2	4,865.7	209.0	310.4	111.3	0.0	22,488.5
296 and below	22,465.9	840.4	321.4	5,314.7	224.9	310.8	483.2	0.0	29,961.4
297 and below	30,399.0	1,336.6	325.0	5,804.5	258.3	312.1	938.9	0.0	39,374.3
298 and below	32,912.6	1,515.9	327.7	6,077.3	262.9	312.3	1,073.8	0.0	42,482.5
299 and below	34,931.4	1,676.2	329.6	6,274.1	264.2	312.5	1,194.4	0.3	44,982.8
300 and below	37,010.4	1,852.1	333.3	6,441.0	264.7	313.1	1,273.9	0.8	47,489.4

Table 3.2. Existing stage area curve (acres), New Madrid Floodway.

Elevation	Agriculture	Developed	Fallow	Forest	Herbaceous	Open Water	Pasture	Scrub/Shrub	Total
280 and below	87.4	0.7	5.7	280.5	84.5	60.1	0.1	0.0	518.9
281 and below	146.5	1.6	6.0	384.1	234.2	67.3	0.3	0.0	840.1
282 and below	305.1	2.5	6.4	466.5	443.4	76.4	0.4	0.0	1,300.8
283 and below	602.4	5.6	7.2	529.5	534.1	85.1	0.5	0.0	1,764.5
284 and below	1,060.9	10.1	10.5	636.4	548.8	151.5	0.6	0.0	2,418.8
285 and below	1,632.2	22.9	30.1	883.0	558.1	222.4	0.7	0.2	3,349.7
286 and below	2,801.5	42.0	91.4	1,452.1	580.5	317.1	0.9	0.6	5,286.2
287 and below	4,714.2	71.6	154.6	2,484.8	617.2	432.7	1.0	1.0	8,477.1
288 and below	7,539.0	117.1	183.8	3,473.7	662.8	527.3	1.3	1.5	12,506.5
289 and below	11,310.6	170.2	192.1	4,325.2	678.9	569.7	1.7	1.5	17,250.0
290 and below	15,368.7	214.6	197.1	5,075.4	690.0	603.5	2.2	1.5	22,153.0
291 and below	19,737.9	280.2	200.3	5,499.3	700.3	614.1	3.7	1.6	27,037.4
292 and below	24,950.5	392.0	202.5	5,898.6	709.3	625.7	6.0	1.6	32,786.3
293 and below	30,302.5	552.3	203.9	6,413.0	722.9	632.5	8.9	1.6	38,837.6
294 and below	35,654.4	730.4	205.6	6,907.0	736.8	640.0	13.1	1.7	44,889.0
295 and below	40,604.9	946.6	207.1	7,299.9	742.5	654.8	20.2	1.7	50,477.7
296 and below	45,184.7	1,177.9	208.0	7,620.5	747.0	681.4	28.0	1.8	55,649.5
297 and below	50,094.4	1,432.3	209.0	7,994.7	751.2	689.1	40.7	5.9	61,217.1
298 and below	54,679.8	1,718.9	209.4	8,309.3	763.5	695.7	63.0	9.1	66,448.6
299 and below	60,175.2	2,046.1	211.0	8,594.9	768.2	703.7	83.1	9.2	72,591.4
300 and below	65,637.6	2,410.9	211.7	8,859.7	772.2	709.6	104.6	9.2	78,715.4

3.5 The Flood Pulse

The flood pulse is regarded as the principal driving force responsible for the existence, productivity, and interactions of the major biota in river-floodplain systems (Junk et al. 1989). The flood pulse concept (FPC) explains many of the processes that occur in unaltered floodplain, but its role in manipulated systems is complicated.

Sparks (2005) stated that large river-floodplain ecosystems are often species rich for multiple reasons. Water and sediment quality in the floodplains as well as patterns of water and sediment flows in the river channel strongly influence the floodplain habitat structure, the trophic base, and biotic interactions. Furthermore, Sparks (1995) stated that river floodplain ecosystems, unlike most lakes, are characterized by seasonal floods that promote the exchange of nutrients and organisms among a mosaic of habitats and thus enhance biological productivity. Although the FPC states that the flood pulse is the principle driving force in unaltered ecosystems, its role is greatly diminished or is no longer the principle driving force in broadly manipulated environments such as the project area. For example, natural geomorphic processes cause a river to meander and constantly change its course. This constant change creates a mosaic of habitats within the floodplain (see Appendix D). Depending on their locations within the floodplain, the mosaics of habitats flood at different levels, or perhaps more important to biotic interactions, retain water as flood waters recede or pool precipitation at different rates. The Mississippi River no longer changes course as it previously did. Likewise, the mosaic of habitat that previously occupied the project area have been cleared, leveled, and drained to convert a forested landscape to agriculture. The floodwaters and sediment flows that the project area experiences are not the kind that Sparks (1995) describes that shape the floodplain and drive biotic interactions; they result from backwater or impounded interior runoff. Due to little or no flow velocity, this type of flooding does not shape the floodplain and sediment loads quickly settle out. Any shaping of the floodplain due to floods or sedimentation is quickly remedied with the farmer's plow after the flood waters recede.

Junk *et al* (1989) stated that anthropogenic influences on the flood pulse or floodplain frequently limit production. The annual disturbance as a result of agricultural practices (disking, land leveling, plowing, seeding, applying pesticide/herbicide, fertilizing, harvesting, and burning) is presently the principle driving force responsible for the existence, productivity, and interactions of major biota found in the St. Johns Bayou Basin and New Madrid Floodway. Moreover, the hydrologic manipulations to the floodplain further limit the value of the flood pulse. A vast drainage network that consists of hundreds of miles of constructed drainage ditches, hundreds of miles of once natural stream converted to channelized canals, countless drainage structures, and miles of levees make up the floodplain today. Although a heterogeneous ecosystem (*e.g.*, topography, flood frequencies, flood durations, habitat, species) was found in the past, a more homogenous ecosystem (leveled, drained, agricultural fields) is found today. Nevertheless, flooding still contributes value to this homogenous ecosystem, although the habitat of farmland is considered sub-optimal. For example, an acre of farmland that is flooded periodically by the flood pulse provides more ecological value (*e.g.*, shorebird, waterfowl, fish habitat) than an acre that is not subject to the pulse. However, it is clearly no longer the principle driving force since the project area has been converted. For example, if the flood pulse was still the driving force, there would be little to no differences in habitat value/function between a functioning bottomland hardwood and a cleared/leveled agricultural field if both experienced the same flood frequency, depth, and duration.

Large floods can reset the successional clock (Junk et al. 1989). However, ecological succession is reset on over 80 percent of the project area every year as a result of farm plows. Flooding only ecologically resets a very small portion of the project area that is not farmland or resets species richness to tolerant-type species capable of withstanding the extreme conditions found in the Mississippi River.[22]

While extreme floods temporarily reset conditions on farmland by destroying crops, blocking drains, and preventing ongoing farming operations, local interests will correct these issues in a very short period. As evidenced by the flooding of the New Madrid Floodway in 2011, the vast majority (80-85 percent) of the Floodway had been replanted by fall 2011 (Gerald Hrdina, FSA, personal communication). Therefore, large floods do not "reset ecological conditions" in the project area; they simply result in economic impacts and intensive manipulation to return the land to pre-flood condition.

3.6 Social Resources

3.6.1 Past Social Profile

The Mississippi River's flood pulse has influenced social activities within the project area since the first humans occupied the project area around 15,000 BC. Many occurrences of pre-historic occupation are found on higher ridges formed from natural geomorphic processes. The major factor governing the lives of local residents is water (Lafferty *et al.,* 1996).

Many early settlements in the project area occurred along the river. These included areas such as Belmont, Rush Ridge, and Wolf Island. These early developments provided fule and supplies to steamboats. The population in 1810 was estimated to be less than 100 (Lafferty *et al,* 1996). The first cleared areas were on higher lands, and settlers grew crops (including cotton), kept hogs and cattle, and hunted (Lafferty *et al,* 1996). By 1856, the population of Mississippi County, Missouri increased to approximately 4,200 individuals. The Swamp Land Acts of 1849 and 1850 gave the states possession of unsold swamp and overflow lands bordering the Mississippi River and provided for the construction of levees and drainage diteches from the sale of those lands. Congress designated 3,346,936 acres of unsold land in Missouri as Swamp Land and gave it to the State. By 1959, early settlers were beginning those early flood control works.

Levee and drainage construction resumed following the Civil War. Minor floods were typical and mostly occurred in low-lying unsettled areas. Major floods occurred in 1897,

[22] High velocities, high sediment loads, turbidity.

1912, and 1913. Many residents were isolated during times of flood. Thousands of newcomers relocated to the area following the Floods of 1912 and 1913. Land values increased 164.6 percent during the period from 1911 to 1921 (Lafferty *et al*. 1996).

Remaining lands were quickly cleared and drained to make way for agriculture. Tenant farming was widely practiced. Lafferty *et al.* (1996) provided the following account regarding tenant farming in the project area:

> "The first problem was migrancy. A 1936 study of the Bootheel found that 34 percent of the sharecroppers and 44 percent of the day laborers had moved twice or more within the last five years. Relocation adversely affected children, hurt schooling and diminished church attendance (White et al. 1938:4). Moving was prompted by the quest for something better, but this was rarely achieved. In 1936, white sharecropper income was $415 per annum while African Americans averaged only $251 (Cantor 1969:13). Although sharecroppers lived in rural areas, 'Gardens are lacking or inadequate and are usually discouraged by the landlord' (White et al. 1938:6). Half of sharecroppers and four-fifths of the day laborers did not own cows, and two-fifths of the day laborers had no chickens (White et al. 1938:6). Actual income was even lower than reported since the 10 percent interest charged on advances was taken out at settlement time (White et al. 1938:6). The 1936 study concluded, 'At least one-half of the families do not have sufficient cash income to maintain a decent standard of living' (White et al. 1938:6).
>
> Housing was 'a picture of squalor, filth, and poverty,' a government report observed (Cantor 1969:14). Most tenant houses were of box construction which planter Thad Snow described as 'thrown up of rough lumber without studding or bracing' (Snow 1954:96). The 1936 report divided housing into two categories: strip houses, with vertical siding and stripping over the cracks, and weatherboard houses of frame construction with drop siding. Renters and owners were more likely to occupy the latter. Houses sat on blocks, with those in the flood plain on cypress blocks some three or four foot high (White et al. 1938:40-41). Both exterior paint and interior wallpaper were lacking (White et al. 1938:42). Sewing machines, telephones, and radios were rare, 'The one thing owned by every sharecropper is [a] hoe'" (White et al. 1938:43).
>
> Health problems abounded. Only two percent of the homes had indoor toilets, and outside unscreened outhouses, often located near shallow wells, invited disease. Pellagra, colitis, malaria, typhoid fever, pulmonary tuberculosis, pneumonia, diarrhea, and enteritis figures for the Bootheel were sometimes 20 times higher than the state average (White et al. 1938:47). The poor were unaware of the need for screening, casual in their sanitation measures, and greatly at risk of their inadequate diet (White et al. 1938:6, 48).
>
> Institutional support was lacking. Many attended poor rural churches outside the religious mainstream. Faith healing often substituted for medicine (White et al. 1938:58). Education was much neglected, being marked by inadequate buildings,

> poorly trained and paid teachers, and students who attended only intermittently. African-American education was especially bad, with black teachers making an average salary of only $370 per year compared to $500 for whites (White et al. 1938:59-60). Social clubs, Home Demonstration clubs, and 4-H groups generally did not involve cropper families. Many social activities revolved around the schools, especially the high schools, so that high dropout rate effectively eliminated the poor from those activities (White et al. 1938:61). Many of the rural poor took solace in alcohol, and the night clubs or roadhouses were identified as 'perhaps the most significant development in recreation' (White 1938:62). These places were the scenes of violence, as when in 1934 two white men, both overseers, were shot while watching an African-American dance near Wolf Island (Charleston *Spokesman*, August 31, 1934).
>
> African-Americans in the Bootheel suffered the most under the system. Some landowners, when moving into the area, had brought their laborers with them and took great pains to keep them; two had stockades for housing and used guns and bull whips to enforce obedience. Snow spoke of the 'servile cotton croppers' as being 'amazingly submissive… chisling croppers out of their cotton money was embedded deeply into the tradition of cotton growing' (Snow 1954:139; 154-155; 199)."

The Flood of 1927 changed the social profile of the project area and the region. Lafferty *et al.* (1996) reported that total damage in Levee District No. 3 amounted to $515,500. Approximately 40 percent of the damages were attributed to growing crops. One hundred houses were destroyed and 300 damaged. Thirty horses and mules, 50 cattle, and 200 hogs were lost; and 200 miles of fencing were destroyed. Damage to school buildings and equipment was estimated at $50,000. The St. John Levee and Drainage District had losses of $802,078, including 1,200 homes damaged and 26 houses destroyed. One store was destroyed, 12 were damaged, 2 cotton gins were damaged, and extensive losses were reported to water-damaged merchandise, baled cotton, seed, household goods, automobiles, and farm implements. In addition to direct losses, there was also loss of $375,000 due to the loss of rent on lands that could not be cultivated. The Flood Control Act of 1928 was passed in response to those large-scale losses and authorized the the Mississippi River and Tributaries Project. That authorization contained the early plans for the construction of the New Madrid Floodway.

New Deal policies impacted the social profile of the area. Due to cotton surpluses, lack of foreign sales, and no other practical crop, farmers were paid to plow under their cotton (Lafferty *et al*, 1996). Tenants were supposed to receive a percentage of the payment equal to their intended share. However, in many circumstances, the payments were not made and planters found ways to get the tenants shares (Lafferty *et al.*, 1996). To avoid payments many landowners evicted sharecroppers and replaced them with day laborers because they had no claim to payments (Mitchell, 2009; Roll, 2010). Many organizations including the Southern Tenant Farmers Union (STFU) and the National Association for the Advancement of Colored People (NAACP) protested the government's response to the agricultural crisis during the Depression as well as the way sharecroppers were treated (Roll, 2010).

The New Madrid Floodway was operated on 25 January 1937 causing evacuation of many sharecropper and tenant homes that were found within the boundaries of the Floodway. Among local landless farmers gathered in relief camps for displaced evacuees, union organizers demanded that if the federal government offered relief in response to a disaster it created with dynamite, it should address the disaster caused by legislation (Roll, 2010). In response to the protests, the Farm Security Administration (FSA) funded a number of communities in the Delta. La Forge (located just outside the St. Johns Bayou Basin between the Farrenburg Levee and I-55 on Highway P) was established in New Madrid County and housed 100 sharecropper families on 6,700 acres (Lafferty *et al,* 1996). News of the government's response attracted more people to join the STFU and NAACP. The STFU affiliated with the United Cannery, Agricultural, Packing, and Allied Workers of America to create a new umbrella union organization (Roll, 2010).

Despite the establishment of the La Forge community, tenant farmers were still being replaced with day laborers. In 1938, many planters stepped up plans to employ wage laborers so they could claim all of the subsidies themselves and invest it in labor-saving machinery, such as tractors (Roll 2010). A large number of evictions were planned at the beginning of 1939. Local activists protested and the 1939 Roadside Demonstration ensued.

On the night of 9 January 1939, between 251 and 450 evicted sharecropper families (1,161 to 1,700 individuals) relocated to the side of U.S. Highway 61 and 62 (MDNR, 2008). The demonstration was widely publicized. The State of Missouri declared the camps a health hazard and called for the forced removal (MDNR, 2008). Some protesters returned to their local homes while others were taken away to a variety of camps. The largest camp was a 40-acre tract located in the Birds Point-New Madrid Floodway (referred to as Homeless Junction), another near Dorena (located in the Floodway), and a third at the Sweet Home Baptist Church near Wyatt, Missouri (Lafferty *et al.,* 1996).

Many demonstrators remained together, squatting in the Floodway, in churches, and old dance halls (MDNR, 2008). In response, the FSA administered the Delmo Group Labor Homes, which established ten communities throughout the Missouri Bootheel including groups at North Lilbourn, South Lilbourn, and Morehouse in New Madrid County and groups at North Wyatt and East Prairie in Mississippi County (MDNR, 2008).

Land within the Floodway was also made available to the Christian Liberty Association. Through the Association, African Americans could obtain 40-acre plots within the Floodway (Harper, 2011). The area they settled was Pinhook. The following is a statement provided by Mr. Jim Robinson, Jr. that describes the living conditions and hardships of those who reside in Pinhook:

> "In 1943 the Jim Robinson, Sr. family moved to the Pinhook area at which time I was nine years old. I was introduced to backwater the following spring. It was devastating where we were concerned, because we had to paddle a boat for two miles to take my oldest sister to dry land to walk two miles to catch a bus to go to school. This happened twice a day for at least a month if not more. All supplies

had to be brought in by mules and wagons or boats. This is a considerable inconvenience for anyone. This continued for about five years.

Then the flood water became a little less severe. We pulled up roads, ditches were dug and some of the land was cleared by hand. For about fifteen years we had virtually no backwater in Pinhook. When we moved out in 1946 and 1949, we lived in tents. There were no homes available for us. We were referred to as "river rats" which was distasteful, needless to say. After this, the community began to flourish. Homes were built, the population grew by leaps and bounds and people were back home in Pinhook!

Then in 1973, it started all over again. I had personally, myself and my family, built a new home and was very proud and happy. Before completion in February 1973, the floods came and partially destroyed our home. We moved three times in one year because the flood waters kept coming back. We had to repair the house at night and work in the fields during the day. In 1975, the same thing occurred again. Each time during the flood threats were made to blow the levee. No flood insurance was available to us at that time. All of the home repairs were done out of pocket or not done at all. We had to make additional loans, but the people were nice and let us have the funds. In 1977, flood insurance became available to us and we bought up to the limit.

In 1979, here comes the flood again. Which brings me to discussing the inconvenience of the gap in the levee. Naturally, we moved out that year and our homes were destroyed. Two miles of existing homes were either destroyed or rendered condemned and there are houses there today. The inconvenience that it caused was that we had to pile together in one house. There were 26 people living in a six room house. We managed with God's help. However, we elected to stay in Pinhook because this was our home and still is.

Another inconvenience was that we were surrounded by water. Pinhook literally becomes an island. The only ways in and out is with big, tall diesel tractors and a trailer connected or a boat. All the residents that worked outside of Pinhook, which is everyone, had to be ferried out to Haney's hill. My brother and I ran tractors like taxi cabs. All of the neighbors band together to aid each other during these times. One of the main reasons for the people not leaving their homes is due to not having lodging elsewhere. Crops were always delayed or destroyed. Hundreds of acres of corn and wheat were destroyed.

All of this is due to the hole in the levee." (Jim Robinson, Jr., Public Meeting statement, 20 May 1999).

3.6.2 Present Social Profile

Flooding, regardless of its source, results in social impacts to the residents of the project area. However, the significance of the impact depends on the flood elevation, frequency, and duration. Social impacts begin to accrue when roads are overtopped and community isolation occurs. Based on the 2010 census, the population of the St. Johns Bayou Basin and the New Madrid Floodway was 33,478[23] and 307 people, respectively. The current population of the New Madrid Floodway is not known following the 2011 activation of the Birds Point-New Madrid Floodway. The Village of Pinhook has requested to be federally purchased and relocated as a single community at federal expense. Three potential areas are being investigated, all within the St. Johns Bayou Basin in the vicinity of East Prairie, itself a community impacted by flooding. However, no plans or funding have been finalized or approved. Although the current population is not known, some residents have rebuilt within the Floodway following its activation. Likewise, some residents have moved back into Pinhook. It is anticipated that with time and the infrequency of Floodway operation, more residents will return although population levels are expected to remain relatively low.

Statistics regarding the social make up of New Madrid and Mississippi Counties is provided in Table 3.3. The current social profile is considered rural in nature, primarily due to its agrarian landscape.

[23] This figure includes population areas outside of the PIA.

Table 3.3. Social data for New Madrid and Mississippi Counties, Missouri.

People QuickFacts	New Madrid County	Mississippi County	Missouri
Population, 2011 estimate	18,783	14,306	6,010,688
Population, 2010 (April 1) estimates base	18,960	14,358	5,988,927
Population, percent change, April 1, 2010 to July 1, 2011	-0.90%	-0.40%	0.40%
Population, 2010	18,956	14,358	5,988,927
Persons under 5 years, percent, 2011	6.50%	6.30%	6.40%
Persons under 18 years, percent, 2011	23.60%	22.10%	23.50%
Persons 65 years and over, percent, 2011	16.30%	15.30%	14.20%
Female persons, percent, 2011	52.20%	46.30%	51.00%
White persons, percent, 2011 (a)	81.90%	74.30%	84.00%
Black persons, percent, 2011 (a)	15.90%	24.30%	11.70%
American Indian and Alaska Native persons, percent, 2011 (a)	0.30%	0.20%	0.50%
Asian persons, percent, 2011 (a)	0.50%	0.20%	1.70%
Native Hawaiian and Other Pacific Islander persons, percent, 2011 (a)	Z	Z	0.10%
Persons reporting two or more races, percent, 2011	1.40%	0.90%	1.90%
Persons of Hispanic or Latino Origin, percent, 2011 (b)	1.30%	1.70%	3.70%
White persons not Hispanic, percent, 2011	80.90%	72.90%	80.80%
Living in same house 1 year & over, 2006-2010	82.50%	82.00%	83.20%
Foreign born persons, percent, 2006-2010	0.70%	2.50%	3.70%
Language other than English spoken at home, pct age 5+, 2006-2010	1.80%	3.50%	5.90%
High school graduates, percent of persons age 25+, 2006-2010	73.20%	66.20%	86.20%
Bachelor's degree or higher, pct of persons age 25+, 2006-2010	12.20%	10.50%	25.00%
Veterans, 2006-2010	1,599	1,071	511,253
Mean travel time to work (minutes), workers age 16+, 2006-2010	18.4	19.4	23.2
Housing units, 2010	8,531	5,711	2,712,729
Homeownership rate, 2006-2010	64.30%	62.80%	70.00%
Housing units in multi-unit structures, percent, 2006-2010	15.20%	11.50%	19.60%
Median value of owner-occupied housing units, 2006-2010	$67,100	$67,400	$137,700
Households, 2006-2010	7,719	5,287	2,349,955
Persons per household, 2006-2010	2.43	2.61	2.45
Per capita money income in past 12 months (2010 dollars) 2006-2010	$18,811	$15,927	$24,724
Median household income 2006-2010	$32,895	$29,586	$46,262
Persons below poverty level, percent, 2006-2010	21.10%	27.60%	14.00%
Business QuickFacts	**New Madrid County**	**Mississippi County**	**Missouri**
Private nonfarm establishments, 2009	398	270	150,892
Private nonfarm employment, 2009	5,678	2,596	2,358,706
Private nonfarm employment, percent change 2000-2009	-10.70%	-5.30%	-1.70%

Nonemployer establishments, 2009	794	576	375,075
Total number of firms, 2007	1,068	715	501,064
Black-owned firms, percent, 2007	S	S	4.90%
American Indian- and Alaska Native-owned firms, percent, 2007	F	F	0.60%
Asian-owned firms, percent, 2007	S	F	1.90%
Native Hawaiian and Other Pacific Islander-owned firms, percent, 2007	F	F	0.10%
Hispanic-owned firms, percent, 2007	F	F	1.20%
Women-owned firms, percent, 2007	19.10%	28.00%	26.10%
Manufacturers shipments, 2007 ($1000)	D	0	110,907,604
Merchant wholesaler sales, 2007 ($1000)	288,016	235,151	81,032,913
Retail sales, 2007 ($1000)	509,771	161,504	76,575,216
Retail sales per capita, 2007	$28,850	$11,946	$12,957
Accommodation and food services sales, 2007 ($1000)	14,988	10,000	11,070,634
Building permits, 2011	17	9	9,242
Federal spending, 2010	278,398	187,131	70,348,063
Geography QuickFacts	**New Madrid County**	**Mississippi County**	**Missouri**
Land area in square miles, 2010	674.84	411.58	68,741.52
Persons per square mile, 2010	28.1	34.9	87.1
FIPS Code	143	133	29
Metropolitan or Micropolitan Statistical Area	None	None	X

(a) Includes persons reporting only one race.
(b) Hispanics may be of any race, so also are included in applicable race categories.
FN: Footnote on this item for this area in place of data
NA: Not available
D: Suppressed to avoid disclosure of confidential information
X: Not applicable
S: Suppressed; does not meet publication standards
Z: Value greater than zero but less than half unit of measure shown
F: Fewer than 100 firms
Source: US Census Bureau State & County QuickFacts

3.6.3 Flooding and Social Impacts

Comments from local residents regarding social impacts from flooding are included in Volume 2, Part 2. While the hardship imposed by floodwaters cannot be properly accounted for in monetary terms, they are qualitatively described below.

3.6.3.1 Community Isolation

Community isolation is a major concern that was conveyed from residents within both basins during the public scoping meeting. Flooding inundates roads[24] causing area residents to take sometimes extraordinary measures to perform basic tasks such as going to work, attending school, purchasing groceries and gaining access to basic medical care.

[24] Economic impacts associated with flooding roads are assessed in Section 3.7 and were quantified in Appendix B.

As relayed by local residents, students have had to ride trailers to school in order to traverse floods. To overcome transportation issues, residents either have to find alternative transportation routes that are many miles longer or have to utilize boats or heavy equipment to move through flood waters. Roads are overtopped on average 17.4 days and 20.4 days in the St. Johns Bayou Basin and New Madrid Floodway, respectively.

Flooding also disrupts emergency vehicles from being able to service communities. Ambulances will not traverse floodwaters. In addition to emergency vehicles, flooding also disrupts routine services such as U.S. Mail delivery, sanitation pickup, and sewage treatment.

One resident of Pinhook shared a story about a death that occurred during a period of flooding that isolated the community. Residents were required to place the deceased in the back of a cattle trailer to be pulled through flood waters by a tractor to a waiting ambulance.

A resident of St. Johns Bayou Basin provided information describing how he and his family had to live upstairs during periods of floods and that they had a stove pipe running out one of the upper windows. Sandbags are routinely used around homes to keep floodwaters out.

3.6.3.2 Health

Another major concern conveyed during the public scoping meeting was health impacts as a result of flooding, particularly diseases such as Blastomycosis. Blastomycosis is a fungal infection caused by the organism *Blastomyces dermatitidis* and is endemic in the Mississippi and Ohio River basins (Chapman 2000). Infection occurs by inhalation of the fungus that is found in moist soil, particularly where there is rotting vegetation. Once inhaled in the lungs, the fungus multiplies and may disseminate through the blood and lymphatic system to other organs, including the skin, bone, genitourinary tract, and brain. The incubation period is 30 to 100 days, although infection can be asymptomatic.

The average annual incidence of blastomycosis is 0.2/100,000. However, Mississippi County, Missouri has the highest incidence (12/100,000) with a much higher rate among blacks than whites (43.2/100,000) [Cano *et al.* 2003]. Cano *et al.* (2003) observed 36 cases of blastomycosis reported in the State of Missouri from 1992 to 1999. Twenty of the cases occurred in five counties in the southeastern part of the state and of those 12 (60 percent) were in Mississippi County, resulting in four deaths. Furthermore Cano *et al.* (2003) stated:

> "Although the number of blastomycosis infections in humans documented during 1993 was not significantly greater compared with other years, the increase during that year may be related to environmental changes that occurred in the southeastern part of the state. Yearly floods are common in the areas bordering the Mississippi River, but in 1993, the Southeastern Missouri counties along the

Mississippi River had a drought and then late flooding that lasted for several months. In particular, the amount of rainfall reported during 1993 in Mississippi County was the higher than in other years. During that year, river stages for the Ohio and Mississippi River were also the highest. Higher incidence rates of endemic blastomycosis, as well as outbreaks, had been previously associated with regions of low elevation containing acidic soil and bodies of water".

3.6.3.3 Drinking Water Wells

A total of 1,178 drinking water wells are found within the project area, of which 132 wells are located within the New Madrid Floodway; and 1,046 wells are located within the St. Johns Bayou Basin.[25] Wells are the predominant source of water for rural residents in both basins as well as the primary irrigation supply in the project area. Flooding impacts drinking water wells by providing suspended sediments that form a clogging layer on the soil surface. Following floods, increased levels of contaminants can be expected, causing residents to purge their drinking water wells. Although the cost associated with decontamination was not quantified for the economic analysis, a definite social risk exists from drinking water wells as a result of flooding.

3.6.3.4 Waste Water Treatment

The majority of wastewater treatment in the project area is provided by individual septic tanks. During periods of flooding, tile fields do not function, which results in surfacing of waste water (Chittenden, 2011). Although difficult to detect due to the large volume of floodwater, surfacing of wastewater results in contamination, including contamination of nearby drinking water wells.

There are 17 waste-water outfalls in the St. Johns Bayou Basin and none in the New Madrid Floodway. Prolonged flooding results in high ground water tables causing water to infiltrate sewer pipes and leaking manholes. This results in excessive flows to wastewater treatments plants and engorged sand within the sewer pipes and wastewater facilities (Chittenden, 2011). Although difficult to quantify, these issues result in a need for costly repairs and the potential to release untreated wastewater.

All flow (including sewage discharge) in the St. Johns Basin travels through the structure located at the lower end of the Basin. During times of floods, the St. Johns Bayou gate is closed preventing interior runoff as well as treated sewage from flowing into the Mississippi River. Although pollution levels are difficult to detect due to the volume of impounded interior runoff, pollution is not discharged to the Mississippi River and remains in a stagnant state until gates are opened.

3.7 Flooding and Economic Impacts

Flooding, regardless of its source, results in economic damages. However, the amount of damages depends on the flood elevation, frequency, and duration. Quantifiable economic

[25] This data also includes wells outside the PIA.

damages as a result of flooding, are divided into two broad categories: non-agricultural and agricultural.

3.7.1 Non-Agricultural

The Missouri Department of Transportation works to keep Interstate 55 open during periods of flooding. Depending on the severity of flooding, Missouri Department of Transportation may use pumps in the median to pump floodwaters off of the road, place sandbags, or close lanes. In addition to Interstate 55, numerous state and county roads located in the St. Johns Bayou Basin and New Madrid Floodway are damaged by floodwaters. The associated savings of a flood risk management project versus the cost to raise flood-damaged roads above the 100-year floodplain was considered.

In addition to streets and roads, flooding can directly damage residential areas. As the majority of residential areas are located at higher elevations, damages were not quantified for the purpose of developing benefits and costs for the project due to the infrequency of the event and the limited amount of property impacted.

3.7.2 Agricultural

As previously stated, over 80 percent of the project area is devoted to agricultural production. The primary crops grown in the project area are soybeans (71 percent), corn (9.5 percent), grain, (13.1 percent), sorghum (2.6 percent), and rice (3.3 percent). State and county profiles (New Madrid and Mississippi counties) are available in Volume 2, Part 2. In summary, there are 350 and 228 farms with an average size of 1,088 acres and 1,134 acres in New Madrid County and Mississippi County, respectively. Market value of products sold totaled $141,262,000 (average per farm of $403,606) and $108,420,000 (average per farm of $475,525) for New Madrid County and Mississippi County, respectively. Total government payments were $13,667,000 (average per farm of $42,845) and $4,459,000 (average per farm of $22,294) for New Madrid County and Mississippi County, respectively.

Flooding plays an important role in the agricultural sector's decision-making process regarding crop selection and planting date. More profitable crops such as corn must be planted in late April or early May to obtain profitable yields (Wiebold, 2010). Corn yield decreases as the planting date is delayed (Table 3.4). Less profitable soybeans can be planted later in the growing season with favorable planting dates running through 1 June. Delaying planting until after 1 June results in a loss of 1 bushel per acre per week, and delaying planting until July results in a loss of three bushels per acre per week (Helsel and Minor, 1993). Therefore, area farmers must make a decision to plant more profitable crops early in the growing season with a higher risk of flooding, or choose to delay planting and limit selection to less profitable crops and poorer yields. Regardless of which scenario an area farmer chooses, a risk that flooding would destroy recently planted crops always exists.

Table 3.4. State of Missouri estimates regarding corn planting dates (Wiebold, 2010).

Planting Date	Yield Estimate
1 May	94%
6 May	92%
11 May	89%
16 May	86%
21 May	83%
26 May	80%
31 May	77%
5 June	75%
10 June	71%
15 June	65%

Following discussions with the IEPR panel, the 5-year flood frequency was used to delineate the level in the project area in which flooding causes inefficient crop management in the project area. Farmland located at elevations greater than the 5-year flood elevation were considered the area where more intensive and profitable crops are grown due to the infrequency of flooding and less risk to area producers. Slightly lower value crops are grown at elevations below the five-year frequency elevation because they are subject to more frequent floods and there is a greater risk to planting more profitable crops earlier in the growing period.

Less profitable crops are still grown above the 5-year frequency elevation. However, they are cultivated at the farmer's choice. As with all legumes, the ability of soybeans to place nitrogen back in the soil is an effective management technique. Therefore, many area farmers rotate crops to increase yields for multiple years. The major difference between soybean production in the two zones is that soybeans are planted by choice in the higher elevated areas and are usually planted in sufficient time to provide optimal yields. Soybeans are planted by necessity and usually at a less than optimal date at lower elevations because of the risk associated with floods.

3.8 Flood Pulse and Environmental Resources

Although anthropogenic influences made to the floodplain limit the productivity of the flood pulse, the flood pulse still provides limited floodplain functions. Environmental resources were identified through required compliance with Federal and State laws, Executive Orders, independent external peer review (IEPR), interagency input and public comments. Significant environmental resources identified include: wetlands, waterfowl, terrestrial wildlife, shorebirds, fish (spawning and rearing habitat), water quality, freshwater mussels, ecosystem services, ditch habitat, and cultural resources.

3.8.1 Wetlands

The conversion to cropland is widely documented as one of the leading causes of wetland losses in the United States (Dahl and Allord, 1997). The State of Missouri has lost an estimated 87 percents of its original wetlands due to rapidly expanding agriculture (Dahl, 1990; Mitsch and Gosselink, 1993, as cited by EPA, 2012). USACE estimates that 86 percent of the wetlands historically found in the project area have been lost due to conversion to cropland (See Section 4.20 – Cumulative Impacts). Figure 3.11 provides a map of the remaining forested areas found in the project area. These forested areas represent the remaining natural habitat found in the project area.

The term "wetlands" is not consistently defined, and numerous, confusing and even contradictory scientific and colloquial definitions are used (Mitsch and Gosselink, 2000). For the purposes of the DEIS, USACE utilized the wetland definition found in 33 CFR 328.3(b) and CFR 230.3(t), which define wetlands as follows:

> "The term "wetlands" means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

3.8.1.1 Wetland Extent

USACE relies on the 1987 Corps of Engineers Wetlands Delineation Manual (and the appropriate regional supplement) in identifying and delineating wetlands for regulatory purposes pursuant to Section 404 of the Clean Water Act. The approach described in the manual requires positive evidence of hydrophytic vegetation, hydric soils, and wetland hydrology.

- Soils - Soils in the project area include a mix of Alfisols, Entisols, Inceptisols, Mollisols, and Vertisols. Nearly 60 individual soil types occur in the project area, and reflect their age and affiliation with the geomorphic history of individual locations. The USDA considers a vast majority of the project area as having soils that are classified hydric or partially hydric. Hydric soils are defined by the National Technical Committee for Hydric Soils as "soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions near the surface. Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation."

- Hydrology - Four primary factors influence wetland hydrology in the project area. The first is flooding from either the Mississippi River in the New Madrid Floodway or impounded interior runoff in the St. Johns Bayou Basin. The second factor is groundwater. During high Mississippi River stages the groundwater table is high in both basins. Depending on the severity of flooding, groundwater can seep under existing levees to the surface. The third factor is rainfall and local drainage patterns. Direct precipitation can inundate areas and inundation can occur for prolonged periods in the absence of drainage coupled with the high clay soils in the project area. The last factor is active management. Ten Mile Pond Conservation Area and numerous WRP sites rely on groundwater/surface water pumps to inundate specific "cells" for the purpose of wildlife management.

- Vegetation – A fundamental assumption in this EIS is that areas that could have been cleared for agricultural production have been cleared. Remaining vegetated areas were either placed in public ownership or were too wet to farm. Normally, agricultural areas do not have a prevalence of wetland vegetation.

For purposes of calculating wetland impacts, USACE assumed that all vegetated areas located at and below the pre-project 5-year flood frequency elevation were wetlands (5,233 acres in the St. Johns Bayou Basin and 8,807 acres in the New Madrid Floodway). The 5-year flood return interval supports major wetland functions that involve periodic connection to stream systems (Klimas *et al*,2009), thus, the 5-year flood frequency elevation was also used to differentiate between riverine wetlands and flats (flats have little or no gradient, and the principal water source is precipitation). Mitsch and Gosselink (1993) stated that hydroperiod (magnitude, duration, and frequency of inundation) is known to be one of the most important physical factors controlling the distribution of riparian and other wetland plant species. In a study examining the relationship between flood frequencies and riparian plant communities, Chapin et al. (2002) concluded that, on average, a flood return frequency of 4.6 years was needed to sustain riparian plant communities. According to the HGM model, functions associated with flats, which are primarily precipitation driven, would not be reduced through project implementation, as there will be no direct impacts. However, hydrologic changes in lands located above the 5-year flood return frequency were accounted for in other ecological models, shorebirds and waterfowl, as it was determined that these resources would utilize any inundated habitat.

The NRCS routinely conducts wetland estimates on agricultural areas and categorizes these lands as either upland (i.e., non-wetland), prior converted cropland (wetland converted to cropland), or farmed wetland (farmland that still retains wetland characteristics and provides functions). The NRCS wetland definitions are defined by regulation in the Food Security Act. The NRCS wetland methodology and accompanying report is located in Appendix E, Part 1.

USACE relied on the NRCS estimate to distinguish those areas that are classified as farmed wetlands (wetlands) from those areas that are prior converted cropland (non-wetlands). The Food Security Act regulations at 7 CFR 12.2 differentiates between farmed wetlands and prior converted cropland.

> <u>Converted wetland</u> is a wetland that had been drained, dredged, filled, leveled, or otherwise manipulated (including the removal of woody vegetation or any activity

that results in impairing or reducing the flow and circulation of water) for the purpose of or to have the effect of making possible the production of an agricultural commodity without further application of the manipulations described herein if:

(i) Such production would not have been possible for such action, and
(ii) Before such action such land was wetland, farmed wetland, or farmed –wetland pasture and was neither highly erodible land nor highly erodible cropland.

Farmed wetland is a wetland that prior to December 23, 1985, was manipulated and used to produce an agricultural commodity, and on December 23, 1985, did not support woody vegetation and met the following hydrologic criteria:

(i) Is inundated for 15 consecutive days or more during the growing season or 10 percent of the growing season, whichever is less, in most years (50 percent chance or more).

Prior converted cropland is a converted wetland where the conversion occurred prior to December 23, 1985, an agricultural commodity had been produced at least once before December 23, 1985, and as of December 23, 1985, the converted wetland did not support woody vegetation and met the following hydrologic criteria:

(i) Inundation was less than 15 consecutive days during the growing season or 10 percent of the growing season, whichever is less, in most years (50 percent chance or more).

NRCS land classification acreage estimates are provided in Table 3.5.

Table 3.5. Land classification estimates provided by NRCS.

	Vegetated Wetlands	Farmed Wetlands	Prior Converted Cropland	Total
St. Johns Bayou Basin	5,475	792	36,218	42,485
New Madrid Floodway	6,803	306	65,331	72,440

An overwhelming amount of scientific literature concludes that while vegetated wetlands provide numerous ecological beneficial goods and services, wet agricultural areas generally provide a disservice and are largely considered anathema to conservation (Power 2010, Blann et al 2009, Kenny et al 2009, Dale and Pulasky 2007, Zhang et al 2007, EPA 2006, MEA 2005, Zhang and Schilling 2005, Zedler 2003, Tilman et al 2002, Mitsch 2001, Zucker and Brown 1998, Dahl 1990). For example, vegetated wetlands provide a vital ecosystem service for treating and removing a variety of waste products; and some vegetated wetlands have been reported to reduce concentrations of nitrate by more than 80 percent (MEA, 2005). Excessive nutrient loading is a contributor to the Gulf of Mexico hypoxia problem. Based on Spatially Referenced Regression on Watershed attributes (SPARROW) data, the project area was ranked by Robertson et al (2009), with 95 percent certainty for Total Nitrogen and 90 percent certainty for Total Phosphorus, as being a top 15 watershed (out of 818) contributor of nutrients to the Mississippi Alluvial Valley. Farmland, whether considered farmed wetlands or prior converted cropland, in the project area provides an ecological disservice to nutrient removal, therefore, farmland no longer provides significant wetland function. Additional information regarding the ecological goods and services provided by vegetated wetlands and disservices provided by agricultural lands is included as Appendix E, Part 2.

Prior converted cropland was not considered wetlands because these areas have been so degraded that they no longer provide any significant wetland function. Scientific study supports the conclusion that drained agricultural lands no longer function as wetlands (Mitsch and Gosslink, 2000). However, lands identified by the NRCS as farmed wetlands (791.51 acres and 305.95 acres in St. Johns Bayou Basin and New Madrid Floodway, respectively) were considered wetlands for the EIS.

3.8.1.2 HGM Wetland Classification

Wetland areas were classified by utilizing a hydrogeomorphic (HGM) classification system (Klimas *et al.*, 2011) [See Appendix E, Part 3] into one of three HGM subclasses, as described below.

Low gradient riverine backwater (LGRB) wetlands occupy sites that flood frequently (1- to 5-year flood frequency), but flooding is primarily by slack water, rather than by the higher velocity flows that predominate in overbank flood zones. Backwater flooding usually occurs when mainstem streams are in high stages, impeding the discharge of tributaries and causing them to back up onto their floodplains. This flood regime results in sediment accumulation and ponding[26] that persists long after water levels have fallen in the stream channels. Sediments tend to be fine-grained, with considerable accumulation of organic material. Backwater sites that flood for long durations and are very poorly drained are usually dominated by overcup oak and water hickory. Sites with shorter inundation periods are often dominated by green ash, Nuttall oak or willow oak, and the driest backwater sites may have species such as water oak and cherrybark oak as important components in the overstory. As with flats, wetlands with little to no gradient, whose principal water source is precipitation, vernal pools may be an important component of the low-gradient backwater community type.

Low-gradient overbank wetlands (LGRO) occur on regularly flooded sites (1- to 5-year flood frequency zone) along or near streambanks and on bars and islands within channel

[26] The persistent ponding is a result of a lack of drainage. For example, water levels would fall at a rate consistent with the channel if a drainage ditch drains the site.

systems. These sites are usually point bar deposits, often with a natural levee veneer. This type of wetland differs from the low-gradient backwater community type because floodwater usually moves through the overbank zone at moderate to high velocities, parallel to the channel. Sediments, nutrients, and other materials are exported downstream or imported from upstream sites differently than they are in backwater wetlands. Backwater sites tend to accumulate fine sediments and organic material and to export dissolved materials in the water column. Overbank sites tend to be subject to scour or deep deposition of coarse sediments; litter and other detritus may be completely swept from a site or accumulated in large debris piles. In-channel sandbars and riverfront areas usually are dominated by willows, sycamore, cottonwood, and similar pioneer species, while older and less exposed substrates support more diverse communities. In most cases, however, plant communities in the overbank flood zone tend to be dominated by species with broad tolerances for inundation, sedimentation, and high-velocity flows. Overbank sites sometimes include vernal pools, usually in the form of long, arched swales between the depositional ridges of meander-scroll topography, rather than the irregularly shaped pools typically found in backwater areas.

Connected depressions (CD) occur within the 5-year floodplain of streams, and are integral components of the stream ecosystem with regard to materials exchange and storage. They often are used by fish and other aquatic organisms that move in and out of the wetland during floods. Floodplain depressional wetlands are most commonly found in remnants of abandoned stream channels, or in broad swales left behind by migrating channels. They are usually near the river and are flooded by the river during the more common (1- to 5-year) flood events. They typically support swamp forests or shrub swamps in deeper water zones that remain flooded most of the time, and overcup oak-water hickory forests in areas that dry out in summer. Floodplain depressional wetlands were once common in the Delta, but as flood-control measures have been developed along major rivers, many depressions have become disconnected from stream systems and now function as unconnected alluvial depressions.

Table 3.6 provides the acreage of each wetland subclass in the St Johns Bayou Basin and New Madrid Floodway.

Table 3.6. Wetland subclasses and acreages.

	St. Johns Bayou Basin		New Madrid Floodway	
	Vegetated Wetlands	Farmed Wetlands	Vegetated Wetlands	Farmed Wetlands
LGRB	3,848.0	791.5	7,344.0	306.0
LGRO	1,385.0	0.0	1,163.0	0.0
CD	0.0	0.0	300.0	0.0
Total	5,233.0	791.5	8,807.0	306.0

3.8.1.3 Wetland Function Assessed in HGM

Wetlands provide many ecological functions which are influenced by many factors. Likewise, different wetland subclasses assessed with HGM within the project area provide similar functions (Table 3.7). The difference between subclasses is that the connected depressional subclass does not detain precipitation. Detailed descriptions of different functions are described in Klimas *et al.* (2011), and a brief description is included in the following paragraphs.

Table 3.7. Wetland functions, St. Johns Bayou Basin and New Madrid Floodway.

Function	LGRB	LGRO	CD
Detain Floodwater	X	X	X
Detain Precipitation	X	X	
Cycle Nutrients	X	X	X
Export Organic Carbon	X	X	X
Maintain Plant Communities	X	X	X
Provide Habitat for Fish and Wildlife	X	X	X

Detain Floodwater - This function reflects the ability of wetlands to store, convey, and reduce the velocity of floodwater as it moves through a wetland. The potential effects of this reduction are damping of the downstream flood hydrograph, maintenance of post-flood base flow, and deposition of suspended sediments from the water column to the wetland.

Detain Precipitation - This function is accomplished chiefly by microdepressional storage, infiltration, and absorption by organic material and soils. Both flood-prone (riverine) wetlands and non-flooded wetlands (flats) are assessed for this function. Precipitation storage in flats and riverine wetlands is more often a local effect related to microdepressional storage and infiltration capacity.

Cycle Nutrients - This function refers to the ability of the wetland to convert nutrients from inorganic forms to organic forms and back through a variety of biogeochemical processes such as photosynthesis and microbial decomposition. The nutrient cycling function encompasses a complex web of chemical and biological activities that sustain the overall wetland ecosystem.

Export Organic Carbon - This function is defined as the capacity of the wetland to export dissolved and particulate organic carbon, which may be vitally important to downstream aquatic systems. Mechanisms involved in mobilizing and exporting nutrients include leaching of litter, flushing, displacement, and erosion. This assessment procedure employs indicators of organic production, the presence of organic materials that may be mobilized during floods, and the occurrence of periodic flooding to assess the organic export function of a wetland. An independent quantitative measure of this function is the mass of carbon exported per unit area per unit time (g/m2/year).

Maintain Plant Communities - This function is defined as the capacity of a wetland to provide the environment necessary for characteristic plant community development and maintenance. In assessing this function, one must consider both the extant plant community as an indication of current conditions and the physical factors that determine whether or not a characteristic plant community is likely to be maintained in the future. Various approaches have been developed to describe and assess plant community characteristics that might be appropriately applied in developing independent measures of this function. These include quantitative measures based on vegetative composition and abundance such as similarity indices (Ludwig and Reynolds 1988) and indirect multivariate techniques such as detrended correspondence analysis (Kent and Coker 1995). However, none of these approaches alone can supply a "direct independent measure" of plant community function, because they are tools that are employed in a more complex analysis that requires familiarity with the regional vegetation and collection of appropriate sample data.

Provide Habitat for Fish and Wildlife - This function is defined as the ability of a wetland to support the fish and wildlife species that utilize wetlands during some part of their life cycles. Potential independent, quantitative measures of this function are animal inventory approaches, with data analysis usually employing comparisons between sites using a similarity index calculated from species composition and abundance (Odum 1950, Sorenson 1948). In addition to the HGM, significant fish and wildlife habitat is discussed in greater detail in the following sections, including areas that were not designated as wetlands.

3.8.2 Terrestrial Wildlife

In southeastern Missouri, the conversion of woodlands and swamps to cropland has eliminated or severely reduced the abundance of species dependent upon extensive forested or swamp ecosystems. These severe habitat alterations coupled with other anthropogenic activities have resulted in the extinction, extirpation, or decline of many wildlife species (*e.g.*, red wolf, black bear, and ivory billed woodpecker). Remaining wildlife resources are constrained by to remaining patches of isolated habitat.

Game mammals in the project area include white-tailed deer, eastern gray and fox squirrels, swamp rabbit, and eastern cottontail rabbit. Other mammals found in these isolated areas include mink, beaver, raccoon, muskrat, flying squirrel, river otter, opossum, striped skunk, coyote, red fox, various rodents, and the big and little brown bats.

Although there are no known heron rookeries in the project area, wading birds such as the great blue heron, little blue heron, great egret, snowy egret, and yellow-crowned night heron are found in the project area. These species have adapted to the changed habitat conditions and are commonly observed in agricultural drainage ditches throughout the year.

Forested wetlands have been found to support significantly higher abundance and diversity of bird species compared to upland forests (Brinson *et al*. 1981). Raptors, woodpeckers, warblers, thrushes, and flycatchers use bottomland hardwood habitat as migration and breeding habitat. The Mississippi kite has been observed nesting within the project area. In December 2010, the Audubon's annual Christmas Bird Count at Big Oak Tree State Park recorded sightings of 87 species, with unusually high counts of 12 species (Audubon 2011).

Johnson (1997) noted that the native swamplands of southeast Missouri provide unmatched habitat for many species of amphibians and reptiles. Big Oak Tree State Park is arguably the only native swampland left in the project area and is on the decline. Amphibians found in ditches or lakes/borrow pits and the remaining forested wetlands in the project area include: the western lesser siren, marbled and small mouth salamanders, Fowler's toad, eastern narrow-mouthed toad, spring peeper, green treefrog, and bronze frog. State-listed species found in the project area include the three-toed amphiuma, Illinois chorus frog, and the eastern spadefoot toad. Lack of forested habitat is most likely the cause for their listing. Reptiles found in the project area include Mississippi mud turtle, stinkpot, southern painted turtle, western chicken turtle, red-eared slider, eastern spiny softshell, broadhead skink, black rat snake, dusky hognose snake, speckled king snake, water snakes, western ribbon snake, eastern garter snake, and rough green snake (USFWS 1998 Coordination Act Report).

3.8.3 Waterfowl

Like the entire Mississippi Flyway, the St. Johns Bayou Basin and New Madrid Floodway are valuable areas for migrating and overwintering dabbling ducks (e.g., mallard, gadwall, green and blue-winged teal, pintail, widgeon, shoveler, and black duck), coots, and geese. Waterfowl have adapted to and have exploited the habitat created by farming. Unharvested crops (or those missed by machinery) provide valuable food sources for migrating waterfowl. However, waste grain is substantially reduces from advances in farm technology. In addition, flooded agricultural fields provide invertebrate food resources for molting and pre-laying hens. There are limited numbers of residential waterfowl present in the project area, such as wood duck and, to a lesser extent, mallard, hooded merganser and blue-wing teal. The limited numbers are usually found in the patches of remaining bottomland hardwoods or artificially managed wetlands such as Ten Mile Pond Conservation Area. Diving ducks, such as lesser scaup, ring-necked duck and canvasback use deeper waters of the project area, primarily backwaters and the mainstem of the Mississippi River. Diving ducks tend to use the project area more during spring migration than during fall and winter. Ring-necked ducks are adapted to shallower depths than other diving ducks and are more likely to use flooded backwater areas and occasionally are seen with mallards and other dabbling ducks.

Fall migration of waterfowl begins in mid-August, when the first flocks of blue-wing teal arrive, and continues through late December and early January as more winter-hardy species continue south. Fall/winter migration has barely concluded before early migrants fly north. Wintering may occur at various latitudes and is dictated by habitat availability and freeze. Spring migration through the project area generally concludes by mid-March as the last of the shovelers and blue-wing teal depart.

A large part of the waterfowl use occurs in the Ten Mile Pond Wildlife Management Area. Management of Ten Mile Pond began in 1982 and has included the construction of interior levees, wells, pumps, and water control structures. Over 1,000 acres of this wetland habitat is managed through the manipulation of water levels to provide high quality foods, such as millets, smartweed, sprangletop, sedges, and invertebrates

The waterfowl season in the project area extends for 151 days from 1 November to 31 March. In most years, lands at the lower ends of both basins are not normally flooded during fall and early winter by Mississippi River backwater flooding or impounded interior runoff. However, a large amount of waterfowl habitat is provided by artificial means such as groundwater or surface water pumps that are used to intentionally flood areas for waterfowl, primarily for hunting. Although these artificially managed areas provide waterfowl habitat, the project will not impact this from occurring in the future.

Spring flood events create temporary feeding and resting areas for migrating and pre-migrating waterfowl. During this time, waterfowl seek important invertebrate protein particularly associated with flooded bottomland hardwoods for proper late winter molt, muscle mass, and pre-egg laying conditions.

Waterfowl populations depend on a variety of habitat types. Although limited, the remaining bottomland hardwood patches are important to wintering waterfowl because they provide nutritious food, secure roosting areas, cover during inclement weather, loafing sites, protection from predators, and isolation for pair formation. Because of the importance of wetlands to waterfowl, restoring wetlands, especially bottomland hardwoods, is a key objective of the Lower Mississippi Valley Joint Venture, a subset of the North American Waterfowl Management Plan. A primary focus of the Joint Venture is reforestation of croplands into bottomland hardwoods, an extremely valuable wetland complex for waterfowl.

3.8.4 Shorebirds

Seasonal inundation of non-forested land, predominately cropland, within these basins provides shallow-water flooding and mudflats that are suitable for foraging by shorebirds (Charadriiformes). These birds comprise a diverse group of small to medium-large birds that generally forage for invertebrates in shallow water (Recher 1996, Brown et al. 2001). Away from coastal shorelines, most shorebird species forage in areas of sparse vegetation, such as those associated with harvested agricultural lands (Helmers 1992, Rottenborn 1996, Twedt et al. 1998, Isola et al. 2000, Cole et al. 2002).

Because this area of southeastern Missouri was historically forested, large flocks of shorebirds were not attracted to the area (Twedt and Loesch 2002, Smith et al. 1996). Although bottomland hardwoods historically covered 93% of the project area (Appendix

D), shorebird habitat may have been present during low Mississippi River water levels in late summer and early fall. Receding Mississippi River water levels led some river chutes and side channels to become disconnected resulting in stagnant water capable of supporting sparse herbaceous plants that germinated on exposed mud flats. These areas were likely too deep for shorebird use during high water stages that frequently occur during the spring migration.

Exposed sandbars during summer and fall are prevalent throughout the Lower Mississippi River during low water conditions. These areas are likely used by a variety of shorebirds. Most notably the endangered interior least tern nests on sandbars throughout the Lower Mississippi River during the summer and fall if water elevations are favorable to expose sandbars. The interior least tern is discussed in greater detail in Section 3.9.2. Sandbar habitat is too deep to be of beneficial use to shorebirds during spring floods.

At present, most of the land within the New Madrid Floodway and St. Johns Bayou Basin has been converted to agriculture, and levees protect the area from river meandering. These basins now have potential for providing foraging habitat for shorebirds in far greater abundance than was historically present, including the spring migration. Even so, few shorebird species breed in this area, with only Killdeer (*Charadrius vociferus*) being common (Missouri Breeding Bird Atlas 1986 – 1992 <http://mdc.mo.gov/nathis/birds/birdatlas/index.htm>). The greatest abundance and species diversity of shorebirds within this region occur during spring and fall, as en route migrant shorebirds make “rest and refueling” stops during their northbound (spring) and southbound (fall) passages (Elliott and McKnight 2000; Skagen 1997, 2006).

Comprehensive, long-term monitoring data that document the temporal passage of shorebirds through southeastern Missouri during migration do not exist. Skagen et al. (1999) suggests that spring migrants are present between 15 March and 15 June, whereas fall migration may begin as early as 1 July and continue through 30 October (Skagen et al. 1999). These two time intervals encompass nearly the entirety of shorebird passage through southeastern Missouri. However, the numbers of shorebirds migrating through this region are not uniformly distributed within these intervals, but peak abundances are expected between late April and mid-May during spring and between mid-August and mid-September during fall.

Many factors contribute to habitat selection by shorebirds (Burger 1984, Jing et al. 2002). Most small and medium-sized shorebirds forage primarily in water depths <6 cm. Some of these shorebirds, and other less abundant shorebirds, also forage in exposed mudflat habitats and in floodwater depths from 6-15 cm, with a few, usually larger, species foraging at greater water depths. Despite this diversity in foraging habitats, more than 70 percent of shorebird species forage in water depths <10 cm and many species are restricted to water depths <5 cm (Helmers 1992, Skagen et al. 1999, Dinsmore et al. 1999). Shallow water depth was the most important predictor of shorebird abundance within the Rainwater Basin in Nebraska (Webb et al. 2010).

Shorebirds forage within a variety of substrates that range from bare ground to >75 percent vegetative cover, but most species preferentially use sites with sparse (<25 percent) vegetative cover (Davis and Smith 1998, Dinsmore et al. 1999). Moreover, abundance of some shorebird species is negatively correlated with vegetation height (Colwell and Dodd 1995) with most species found on sites where vegetation is less than half of their body height.

Terrestrial insects and other invertebrates found in cultivated fields in the Mississippi Alluvial Valley provide food for shorebirds when these fields are flooded. Thus, lands subjected to flooding that have sparse or short vegetation (e.g., agricultural fields or grazed grasslands) provide productive foraging sites for migrating shorebirds regardless of flood duration. Given current land use within southeastern Missouri, supplying the necessary mix of water depth and vegetative structure, within temporal windows that correspond with shorebird migration, is the most important issue for shorebird conservation in this region (Brown et al. 2001).

3.8.5 Fisheries

Drainage ditches, channelized bayous, and canals in St. Johns Bayou Basin and New Madrid Floodway are found throughout the alluvial floodplain of the Lower Mississippi River. Delta streams are most prevalent in the Mississippi Embayment, a 4,980 mi^2 area of the Lower Mississippi River valley, which is comprised of 62 percent agricultural land (Kleiss et al. 2000). Low water (from instream and groundwater withdrawals, drainage control), excessive sedimentation (from deforestation-induced erosion), and the accumulation of historically used organo-chlorine pesticides such as DDT have degraded these streams and bayous resulting in dominance of ubiquitous, tolerant fish species (Miranda and Lucas 2004, Sullivan et al. 2004, Wang et al. 1997).

Fishery data from the project area were obtained from Missouri Department of Conservation (Cape Girardeau Long-Term Resource Monitoring Station), Southern Illinois University (Sheehan et al. 1998), and ERDC-Environmental Laboratory. Ninety species of fish have been documented in the project area (see Appendix G). Fishes characteristic of the Lower Mississippi River and tributaries are dominated taxonomically by minnows (20 species), sunfishes (14 species), suckers (13 species), and darters (13 species).

Two groups or guilds of fish species that utilize the two basins for reproductive purposes are riverine (or transient) and permanent/residential (see Appendix G). Riverine species are those that occur primarily in the Mississippi River and will move onto flooded areas to spawn or rear during spring floods (e.g., buffalo). Collectively, the peak reproductive period of most Mississippi River fishes extends from March through June when water temperature ranges from 60-80 °F. Mississippi River fishes exhibit characteristic spawning chronologies: early-season spawners (March), mid-season spawners (April-15 May), and late-season spawners (16 May-June). Permanent species reside in the canals and bayous year-round (e.g., sunfishes). Although riverine species depend on Mississippi River flooding to complete critical life stages, permanent species are more dependent on habitat conditions in summer and fall (flow, sediments, and water quality). Therefore, Habitat Suitability Indices (HSI's) were selected specifically for the riverine species guild that spawn or rear in the two basins, since spring flooding would be directly affected by the project. Specific HSI values selected were coordinated with the interagency team (that further coordinated with independent experts), independent external peer review team, and the model certification review team.

The St. Johns Bayou Basin has a more diverse fishery compared to the New Madrid Floodway. Sheehan et al. (1998) documented 46 species in the floodway, while 71 species were found in St. Johns Bayou Basin using multiple types of collecting gears. In 2008, ERDC documented 42 species in St. Johns Bayou Basin compared to 33 species in the New Madrid Floodway using seines to collect fish. Of the 42 species collected in St. Johns Bayou Basin in 2008, 20 species were not found in New Madrid Floodway. The fish assemblages in both basins are numerically dominated by widespread, tolerant species (e.g., mosquitofish, certain sunfishes and shiners). Characteristics of tolerant fish assemblages include adaptations to low dissolved oxygen and high pulses of suspended solids; no direct requirements for clean, firm substrates for spawning; and ability to live in shallow, slackwater pools for extended periods (Hoover and Killgore 1998, Scott and Hall 1997, Jester et al. 1992). However, St. Johns Bayou Basin harbors more darters and minnows compared to the Floodway. Darters and minnows, as well as a few other taxonomic groups, typically occur in streams and bayous of higher habitat value, and differences in species richness between the two basins can be attributed to several factors:

1) St. Johns Bayou Basin is protected from unregulated Mississippi River flooding, which has resulted in reduced sedimentation in the streams. Typically, soft sediment depth in the streams is less than 1.0 ft in St. Johns Bayou Basin compared to greater than 1 ft in New Madrid Floodway. Turbidity is also higher in New Madrid Floodway, averaging 56 Nephelometric Turbidity Units (NTU) in summer 2008 but only 27 NTU in St. Johns Bayou Basin.

2) Mississippi River flooding restricts/reduces the stability and persistence of fish species residing in the streams year-round in New Madrid Floodway compared to St. Johns Bayou Basin that is protected from backwater flooding.
3) Channel degradation is accelerated in New Madrid Floodway due to fluctuating water levels from Mississippi River floods. The ditches and bayous become incised (channel bottom decreases in elevation to adjust to Mississippi River low water stages) and more homogeneous (lack of diverse stream morphology) compared to St. Johns Bayou Basin where the St. Johns structure serves as grade protection and ditches/bayous are more sinuous.

During non-flooding periods, the bayous and ditches are subjected to extreme perturbations consisting of little to no flow during most periods of the year, low dissolved oxygen, lack of deep pool habitat, high sediment loads, high water temperatures during the summer, little to no shade, limited in-stream structure, elevated levels of nutrients, and historic pesticide use. The residential fish assemblage that occurs in the network of drainage canals and bayous year round is tolerant of impaired aquatic habitat and does not depend on regular flooding for survival and growth. Therefore, only impacts to fish spawning and rearing habitat during the reproductive season of fishes were assessed.

3.9 Other Ecological Resources

3.9.1 Freshwater Mussels

Most of the over 300 North American species of unionid mussel populations have declined greatly in recent decades, and many species are in danger of extinction (Williams *et al*. 1992). Some of the manmade waterways that drain the agricultural lands in southeastern Missouri and northeastern Arkansas provide productive habitat for freshwater mussels. The presence of mussels in project area ditches depend on a combination of moderate depth and current speed, stable flows, sandy substrates, substantial groundwater flow, and presumably adequate numbers of fish hosts found in these ditches. Prior to recent non-USACE ditch cleanouts, several ditches in the St. Johns Bayou Basin provided the necessary conditions for mussels. In comparison, ditches in the St. Johns Bayou Basin supported higher abundances of mussels when compared to ditches in the New Madrid Floodway. Similarly, mussels are also not found in high numbers in area ditches within the lower portion of St. Johns Bayou Basin that are subject to impounded interior runoff.

Survey results from both 1997 (Barnhart 1998) and 2010 (USACE, Memphis District – Appendix N) indicate that the highest species diversity and greatest abundance of individuals occurs in the lower portion of Setback Levee Ditch. The presence of mature trees on the banks of project area ditches appears to correlate with the presence of relatively abundant and diverse unionids.

Two species of mussels that are considered rare by the State of Missouri were collected during the 2010 survey, the rock pocketbook (*Arcidens confragosus*) and the flat floater (*Anodonta suborbiculata*). Although these species are considered rare in Missouri, they are commonly found within ditch habitat in the Lower Mississippi Valley/Mississippi Delta, especially in the St. Francis River watershed of Arkansas and Missouri that is located immediately adjacent to the St. Johns Bayou Basin and New Madrid Floodway Project area. No Federally listed endangered mussels are recorded within the project area, and none were found in the survey.

3.9.2 Endangered Species

Two Federally-listed endangered species, the interior least tern (*Sterna antillarum athalassos*) and pallid sturgeon (*Scaphirhynchus albus*) are found in or near the project area.

The interior least tern is a small gray and white bird with a black cap, white forehead, and forked tail that nests on large, bare, isolated sandbars in the Mississippi River. Interior least terns are most abundant along the lower Mississippi River, and presently, more than

10,000 individuals are commonly observed there each year (USACE 1986-2010). Small boat surveys along the lower Mississippi River have documented between 28 colony locations in 1986 to as many as 107 in 2006 (USACE 1986-2010). Two large sandbars, each five miles upstream and downstream of New Madrid, Missouri, and one sandbar directly across from New Madrid contain least tern nesting colonies yearly. There is no permanent least tern-nesting habitat within the immediate project area.[27]

Pallid sturgeon are a main channel fish species avoiding backwaters and small tributaries. They inhabit deep thalwegs with hard-packed, sandy substrate, or channel border areas with steep shorelines near fast water, including dikes. Spawning occurs over gravel bars or possibly other hard substrates (*e.g.*, riprap stones) in fast-flowing waters. Recent studies by ERDC and USFWS have shown that pallid sturgeon populations exhibit low adult mortality, recruitment of recently spawned individuals is evident, and population levels are steady or increasing (Killgore et al 2007a b).

The project area is within the range of another species of note, the Federally endangered fat pocketbook mussel (*Potamilus capax*). This species was historically widespread and ranged from the Mississippi River in Minnesota, southeast to the Wabash and Ohio Rivers, and west to the St. Francis River Basin in Arkansas. Currently, fat pocketbook mussels are limited to the St. Francis River in Arkansas; the lower Wabash and Ohio rivers in Illinois, Indiana, and Kentucky; and possibly in stretches of the upper Mississippi River adjacent to Missouri (USFWS 1989, Cummings *et al*. 1990). The most comprehensive mussel survey of the St. Johns Bayou Basin and New Madrid Floodway did not find any evidence of this species (Barnhart 1998).

3.10 Water Quality

Water quality in the surface waters reflects current land use practices that are predominantly agricultural such as row crop production. The most detailed data for assessing existing conditions were collected in 1994-1998 as part of the National Water Quality Assessment Program (NAWQA) conducted by the USGS and summarized in Ashby et al., 2000. The existing data represent only waters that drain from the project area rather than standing water such as ponds and borrow pits. Water quality observations exhibited temporal trends associated with seasons and discharge patterns. In general, temperature and dissolved oxygen concentrations fluctuated by season with dissolved oxygen concentrations near 4-6 mg/L in mid-summer. Temperatures ranged from 2.6° C in winter to 37° C in summer with an annual mean of 16.8° C. Nitrate/nitrite concentrations were typically less that 2 mg/L in surface waters (Mississippi River concentrations average about 0.6 mg/L in this vicinity, but agricultural drainages often exceed the drinking water standard of 10 mg/L). Total phosphorus concentrations were quite variable with relatively high values often exceeding 0.1 mg/L, compared with average Mississippi River concentrations of ≈ 0.2 mg/L. Total organic carbon (TOC) values were mostly less than 2 mg/L with higher values on occasion. This is comparable

[27] As a result of Floodway operation in 2011, large amounts of sand were deposited in the vicinity of Inflow Outflow Crevasse #1. Least terns were observed nesting on this sand and levee repair activities were halted pending least tern migration to other areas of the river. Once the least terns left the area, the sand was removed.

to the Mississippi River (2 mg/L average) and exceeds the drinking water recommendation of 1 mg/L. Suspended sediments accounted for approximately 58 percent of the total residue and varied between less than 100 mg/L to values near 300 to 400 mg/l, comparable to the 140 mg/L average in the Mississippi River near New Madrid, Missouri (Ashby et al. 2000).

Robertson *et al.* (2009) ranked each of the 818 large watersheds in the Mississippi-Atchafalaya River Basin on the basis of SPARROW model estimates of nitrogen and phosphorus yields delivered to the Gulf of Mexico. These rankings indicate that some watersheds within the project area, or portions of it, rank second in nutrient yield (kg/km^2) among the basins considered (Figure 3.12, borrowed from Robertson et al). Overall, the project area serves primarily as a nutrient source even though it traps some nutrients and sediments (acts as a sink) during periods of inundation (the focus of this study). Export during extended and frequent periods without inundation (most of the year), far exceeds the retention that occurs during the less-frequent and briefer periods of inundation.

In 2006, two sites were identified on the 303(d) list in the project area. These sites were a site on the Mississippi River (Water Body IDs: 1707 & 3152) for chlordane and PCBs and Spillway Ditch (Water Body ID: 3134) for sediment (habitat loss). The 303(d) listings for 2006 and 2010 indicate that water quality in the project area is mostly within acceptable limits with low dissolved oxygen concentrations as the major impairment, but at only a few sites. A review of the proposed 2010 Missouri 303(d) list showed the following impaired waters in the project vicinity; Maple Slough Ditch for low dissolved oxygen in Mississippi and New Madrid Counties, St. John's Bayou for mercury from atmospheric deposition and bacteria in Scott and New Madrid Counties, and Stevenson Bayou for low dissolved oxygen in Mississippi County. Sites listed in the 2006 303(d) list (Mississippi River and Spillway Ditch) were not listed on the 2010 303(d) list.

The data that could be identified do not provide a thorough baseline of water quality for the few, relatively small, water bodies located within the project areas. But indications are these waters are influenced primarily by land use and runoff as typical of an agricultural landscape. Increased loading (terrestrial export) of sediments and nutrients in periods of high discharge were observed. It is likely that periods of inundation are accompanied by increased sediment accumulation, depressed oxygen levels (during warmer weather), and elevated inputs of plant nutrients to these water bodies. Such conditions are commonly experienced by natural water bodies within an unregulated floodplain.

3.11 Project Area Ditches

The St. Johns Bayou Basin and New Madrid Floodway are comprised of 773 and 407 miles of streams and ditches, respectively. Major ditches are shown in Figures 3.1 and 3.3. The typical agricultural ditch within the project area consists of a straight, trapezoidal channel with a relatively flat, uniform bed devoid of substantial bar structures. Smaller ditch sizes usually contain more bed vegetation and are usually located further from receiving streams. Larger ditches contain less bed vegetation and are often in closer proximity to receiving streams. As a customary practice in many agroecosystem watersheds in the MAV, the ditches in the project area are all maintained (removal of sediment and obstructions to facilitate drainage), therefore eliminating the possibility of any natural riffle/pool establishment. While some reaches of larger ditches and streams have areas of appropriate riparian buffer, a vast majority of the project area ditches have little to no buffer and are farmed to top bank. The intensive soybean and corn farming operations coupled with the lack of protective buffers along ditches capable of retaining sediments and nutrients results in the area being a top contributor to Gulf of Mexico hypoxia. Robertson et al. (2009) determined with ≥90 percent certainty that the area was ranked in the top 15 watersheds (out of 818) for nitrogen and phosphorous contributions to the Gulf of Mexico and concluded that the highest total nitrogen (TN) yields closely coincide with areas of intense agricultural production. Alexander et al. (2008) found that generally similar regions and watersheds in the Central Mississippi and Ohio River basins deliver the highest nutrient yields, nearly 60 percent of the nitrogen, and 54 percent of the phosphorous (both mostly from corn/soybeans) to the Gulf of Mexico while accounting for less than 30 percent of the area studied.

In response to the 2008 flooding, NRCS began an Emergency Watershed Protection (EWP) funded sediment removal program in 2009 that targeted over 1,290 miles of ditch cleanout in Southeast Missouri. The EWP funded cleanout identified 241 miles of ditches in the St. Johns Bayou Basin and 114 miles of ditches in the New Madrid Floodway that were scheduled to be returned to design grade by the end of 2011.

A portion of St. Johns Bayou that is not in the proposed work zone is currently on the State of Missouri's 303(d) list, citing bacteria and the presence of mercury in fish tissue samples.

3.12 Cultural Resources

The alluvial valley of the Mississippi River was one of the most densely populated areas of North America in prehistoric (pre-European contact) times. Consequently, there are thousands of archaeological sites in the valley ranging from post-glacial Paleo-Indian to late prehistoric Mississippian cultures. Next to the American Bottoms east of St. Louis, the Missouri Bootheel is one of the most significant archaeological regions in the central United States. It also has one of the densest concentrations of prehistoric archaeological sites.

A comprehensive literature search of previous archaeological investigations in the study area was conducted for the Memphis District in the late 1970s on 170 miles of St. Johns Bayou Basin and New Madrid Floodway ditches and 2,500 acres of mitigation land in Scott, New Madrid, and Mississippi counties, Missouri. The literature search concluded that all lands above the 290 feet elevation should be regarded as high sensitivity zones for the presence of significant prehistoric cultural resources.

In 1986, an intensive phase l archaeological survey of approximately 140 miles (5,000 acres) of drainage ditches in this same area was conducted for the Memphis District (Klinger *et al.*, 1988). The survey resulted in the discovery of 21 previously unrecorded archeological sites. Twelve of the sites were determined not significant; nine other sites were considered significant or potentially significant. Two sites (23MI599 and 23NM544) were tested and determined to be eligible for inclusion in the National Register of Historic Places. In 1997, the right bank of St. James Ditch in the St. Johns Bayou area was also intensively surveyed for cultural resources. Eleven non-significant prehistoric artifact loci and five low-density late nineteenth- and/or twentieth-century historic artifact scatters were discovered (Albertson and Buchner, 1997). All proposed construction sites within the St. Johns Bayou Basin portion of the project were surveyed for cultural resources. The results of all these surveys were coordinated with the Missouri State Historic Preservation Officer (MO SHPO) in compliance with 36 CFR800 and Section 106 of the National Historic Preservation Act. In response to the MO SHPO's recommendation, the St. Johns Bayou Basin project was re-designed to avoid all potentially significant archeological sites.

In early 1989, a large-scale cultural resources survey and testing program was begun in the Birds Point-New Madrid Floodway. The purpose of the program was to survey previously determined high probability areas and to test the discovered resources for National Register of Historic Places (NRHP) eligibility as required by Sections 106 and 110 of the National Historic Preservation Act, and the Archeological Resource Protection Act (Public Law 96-95). Approximately 11,000 acres were surveyed on four major landforms: Rush Ridge, O'Bryan Ridge, Barnes Ridge, and Sugar Tree Ridge. Two hundred and thirty-nine sites were discovered or relocated during the survey. Two hundred and twenty-three of these sites were tested for significance between July 1989 and April 1993 (Lafferty and Hess, 1996).

Seventy-four of the 223 sites tested had intact buried cultural deposits and were determined eligible for the National Register of Historic Places under criterion D (research potential). An additional 51 mainly small sites were considered to have partially intact features that were temporally clean (i.e., contained discreet components that could be dated) and could contribute to knowledge of the past in a way that the larger sites could not. It was determined that these sites were significant as a class. Of the seventy-four individual sites identified as historic properties eligible for listing in the National Register of Historic Places, twenty were mitigated through data recovery. Four sites identified in the 1996 programmatic agreement for data recovery could not be mitigated because landowners denied access.

3.13 Recreation

The project study area is located in southeast Missouri and includes all or portions of New Madrid, Mississippi and Scott counties (Figure 1.1). Major recreational attractions are located in the New Madrid Floodway, but there are opportunities for recreation in the St. Johns Bayou Basin. Recreational areas and facilities in the project area and vicinity include Donaldson Point and Ten Mile Pond Conservation Areas, both of which are owned and operated by the Missouri Department of Conservation (MDC), and the Big Oak Tree State Park, owned and managed by Missouri Department of Natural Resources.

Current land cover in the project area is dominated by agriculture. At the present time, the largest tracts of woods remaining in the New Madrid Floodway include Big Oak Tree State Park, Bogle Woods and a privately-owned wooded tract north of Ten Mile Pond Conservation Area. Seasonal recreational hunting and fishing occur on parts of these lands. Table 3.8 provides the number of fishing and hunting permits issued by the MDC within the three county study area. (http://mdc.mo.gov/sites/default/files/resources/2012/09/2011permitsales.pdf)

Table 3.8. Fishing and hunting permits sold in the vicinity of project area - permit year 2011*

County	Resident Fishing	Resident Hunting and Fishing	Migratory Bird	Resident Firearm Deer	All other Permit Types	Total Permits Issued
Mississippi	862	281	406	401	1,039	2,989
New Madrid	2,822	1,112	1,841	2,055	4,764	12,594
Scott	678	418	382	940	1,777	4,195

Source: Missouri Department of Conservation
*Permit Year is March 2011 through February 2012

Major recreational areas within New Madrid Basin include Big Oak Tree State Park and Ten Mile Pond and Donaldson Point Conservation Areas. Consumptive and non-consumptive recreation activities occur in the recreational areas, which are discussed in detail in the following paragraphs.

Located in New Madrid County, Big Oak Tree State Park includes an 80-acre tract of bottomland hardwood forest, which is a National Natural Landmark. Four trees in the park qualify as state champions with one ranking as a national champion. Ninety percent of the park is designated as a Missouri natural area because of its rarity and value in preserving Missouri's natural heritage. According to the State Park website the water-soaked soil attracts 12 species of rare plants and animals, 250 kinds of plants and 25 mammals, 31 reptile and seven amphibian species.

Wildlife-viewing is the predominate activity taking place in the park. A boardwalk through some of the park's largest trees gives visitors a chance to view many mammals such as deer, raccoons and the swamp rabbit. The trees in the park attract more than 150 species of birds, giving the park a national reputation among bird watchers. Several of the birds are considered rare in the state, including the prothonotory warbler, cerulean warbler, red-shouldered hawk, Mississippi kite and fish crow. An interpretive center along the boardwalk explains the forest and swamp ecosystem in the park and the history of the logging and drainage of Missouri's bootheel, changes in the Mississippi River floodplain, and the New Madrid earthquake. Big Oak Lake provides 22 acres of fishing. Picnic sites, a picnic shelter and a playground are also available at the park.

Big Oak Tree State Park was closed for four months as a result of the 2011 Mississippi River flood. The associated park closure from May through August 2011 resulted in a loss of about 8,000 visitors compared to the 2010 four month period and about 10,000 visitors during the last six months of the year. Visitation was also down 28 percent for the 2012 calendar year, compared to year 2010, as parts of the park remained in disrepair. According to Missouri State Parks, total damage recovery cost thus far for Big Oak Tree is just under $778,000. As of today, the day use area at Big Oak has not been fully restored although the park is open to the public. There are a few amenities open including the boardwalk, picnic pads and playground; but the picnic shelter and visitor center have not been rebuilt. With the infrastructure gone, it also has a major impact on the quality of recreation experience for those that are visiting the park as the interpretive elements are destroyed. Infrastructure was also destroyed at the Towosahgy State Historic Site located near Big Oak as a result of the 2011 but far less than that experienced at the Big Oak State Park.

The Ten Mile Pond Conservation Area, located east of East Prairie on Highway 80 in Mississippi County, is owned and operated by MDC. The Ten Mile Pond Area is predominately cropland and wetlands and is managed for dove, shorebirds, wading birds and waterfowl. The 3,755 acre area is also managed for re-establishing wetland habitat, which was lost when the land was drained and converted to agricultural use. Over 1,000 acres of this wetland habitat is managed through the manipulation of water levels to provide high quality natural foods, such as millets, smartweed and invertebrates. These food resources are highly sought after by migrating and wintering waterfowl, shorebirds, and other wetland wildlife species. Row crops are grown to provide food for geese and field-feeding species of ducks. Seasonal duck, goose, deer, dove, rabbit and waterfowl hunting and wildlife viewing are the most popular outdoor activities in the area. Bald eagles are common in the area from late fall through early spring. Ten boat ramps provide access to hunting pools during waterfowl season. There is also a handicap viewing deck/observation tower located in the area. There are no designated trails for hiking.

Donaldson Point Conservation Area is owned and operated by MDC. The Conservation Area, located about 6 miles southeast of New Madrid on Route WW, is predominately forest area with large stands of bottomland hardwoods. The 5,785-acre conservation area features improved camping sites with picnic tables and fire rings and 85 acres of fishable lakes and ponds created by construction of the Mississippi River levee. The Mississippi River forms part of the east and west boundaries of the conservation area and provides about 7 miles of river frontage. Common recreational fish species include catfish, crappie, bass and other sunfish. During seasonal flooding, large portions or all of the area may not be accessible.

Bird watching is a popular activity in the Donaldson Point Conservation Area which is designated an Important Bird Area by Audubon Missouri. Donaldson Point is home to several species not usually seen in the Mississippi lowlands, including the endangered Swainson's warbler that nests in giant cane, Mississippi kites, bald eagles, interior least terns and swamp rabbits. Seasonal hunting of deer, rabbit, squirrel, turkey and waterfowl is also allowed in the Area. One dirt boat ramp is available for use to Dawson Hole. No designated trails are in the conservation area.

3.14 Section 122 Items

The following paragraphs identify socioeconomic resources in the project area.

3.14.1 Noise

The Noise Control Act of 1972 established the EPA noise program, of which transportation was a major focus. The Act's goal was to promote an environment free from noise pollution and its adverse effects on public health and welfare. An outdoor noise level of 55 decibels (dB) has been identified as the noise level below which no interference or annoyance to human hearing occur. Additionally, EPA guidance is that a 24-hour exposure level of 70 dB or less is the environmental noise threshold below which no measurable hearing loss would occur over a lifetime. The EPA has found that the noisiest construction equipment typically ranges from 88 A-weighted decibels (dBA) to 91 dBA at a distance of 50 feet. Typical operating cycles may involve two minutes of full power, followed by three or four minutes at lower settings.

The project area is relatively noise free due to its rural setting. Exceptions to this are noises associated with outdoor recreation and agricultural activities.

3.14.2 Air Quality

EPA establishes primary and secondary National Ambient Air Quality Standards (NAAQS) under the provisions of the Clean Air Act (CAA). EPA classifies the air quality within an air quality control region according to whether the region meets or exceeds Federal primary and secondary NAAQS. Primary standards define levels of air quality necessary to protect public health with an adequate margin of safety. Secondary standards define levels of air quality necessary to protect public welfare (i.e., soils, vegetation, and wildlife) from any known or anticipated adverse effects of a pollutant. Federal NAAQS are currently established for seven pollutants (known as "criteria pollutants"); including carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), particulate matter equal to or less than 10 micrometers in aerodynamic diameter (PM_{10}), and very fine particulate matter ($PM_{2.5}$).

The project area is considered a NAAQS Attainment Area for all air quality parameters. MDNR is responsible for statewide measurement of ambient air concentrations and emissions levels for containinents. The nearest ambient air monitoring station is located in Iron County and has not recorded any violation of NAAQS in the last 13 years. (Steve Hall, MDNR, personal communication.)

3.14.3 Aesthetic Value

The project area's current visual landscape is dominated by flood risk reduction features, which include earthen levees, previous borrow areas used for levee-building material, and agricultural fields. The earthen levees consist of maintained turf grasses with very few trees. Linear, manmade drainage ditches are common throughout the area. The surrounding area exhibits a natural landscape that has been altered by agricultural and rural development.

3.14.4 Displacement of People

Alternative plan impacts as they relate to the displacement of people are concerned with the direct and indirect consequences of plan implementation on areas of existing habitation. An example of a direct plan would be those persons forced to relocate because they occupy lands required for project construction. An example of an indirect impact would be individuals compelled to move as a result of the decline in agricultural profitability and its accompanying loss of jobs. Within the project area, people are often displaced during periods of floods.

3.14.5 Community Cohesion

The cultural heritage of the project area is linked directly to a rural way of life based on agriculture. The preservation of this lifestyle is based on the continued existence of farm activities that support the agricultural based economy. Within the project area, communities are often isolated during periods of floods.

3.14.6 Local Government Finance, Tax Revenues, and Property Values

The collection of property, business, and sales taxes in support of community services and infrastructure is an important economic resource. Financial soundness is important because it often determines the level of quality of the necessary public services provided by local governments. Local government finances, tax revenues, and property values are impacted as a result of flooding.

3.14.7 Displacement of Businesses and Farms

Alternative plan impacts as they relate to the displacement of businesses and farms are concerned with the direct and indirect consequences of plan implementation. An example of a direct plan would be those businesses or farms forced to relocate because they occupy lands required for project construction. An example of an indirect impact would be business or farms compelled to move as a result of the decline in agricultural profitability.

3.14.8 Public Services and Facilities

The area of public services and facilities in concerned with ability of local government to provide the basic public services (education, police protection, and maintenance of roads, bridges, drainage systems and levees). Public services are impacted during periods of floods.

3.14.9 Community and Regional Growth

Growth in the project area and region is directly related to agriculture and agriculture related production. Agricultural production is expected to remain hindered in areas of high flood frequencies under the future without-project conditions. The reduced production capacity of flood-prone areas would be expected to limit local and regional community growth.

3.14.10 Employment

The area's employment is highly correlated with agriculture and agricultural production.

3.15 Hazardous, Toxic, and Radioactive Waste (HTRW)

There are presently no known HTRW concerns within the project area. A Phase I Environmental Site Assessment (ESA) [Appendix K] was prepared for the project area in December 2010 in accordance with U.S. Army Corps of Engineers Regulation ER 1165-2-132.

A land use history of the area was prepared pursuant to the investigation, and environmental database searches for potential sites of concern were conducted in consultation with the EPA, MDC, MDNR, NRC, and various local officials. No releases or spills are known to have occurred in the project area since 1990, and no Resource Conservation and Recovery Act (RCRA) database sites were located in the project area. The initial ESA concluded that no evidence of potential HTRW existed in the project area.

An ESA conducted by Gulf Engineers & Consultants (GEC) in July 2001 researched appropriate Federal, state, and local databases, historical sources, and interviewed pertinent personnel to characterize environmental conditions in the project area. Historical records were reviewed, including United States Geological Survey (USGS) historical topographic quadrangle maps, to ascertain previous uses and occupants of the project area and surrounding areas. Vista Information Solutions, Inc. (Vista) conducted a supplemental environmental database search for the project area.

In October 2010, USACE performed a subsequent ESA of the project area. Field inspection of the project area was conducted, including sections of Setback Levee Ditch, St. Johns Bayou, St. James Ditch, and Mud Ditch where work would be performed. Common household refuse was located sporadically throughout the project area at bridge crossings, though no evidence of any HTRW was found. Updated database searches for potential sites of concern were conducted in consultation with the EPA, MDC, MDNR, NRC, and various local officials. According to emergency response officials in East Prairie and New Madrid, there were no known hazardous waste incidents, releases, or contamination.

3.16 Environmental Justice

Approximately 19.2 percent of New Madrid, Mississippi and Scott counties, Missouri, described themselves as minority, compared to the approximately 16 percent throughout the State of Missouri (Table 3.9). Data from the U.S. Census Bureau were used for the Environmental Justice analyses. Approximately 23.5 percent of the population in project area was made up of children under the age of 18, which is consistent with state results. In addition, U.S. Census data is also provided for Alexander County, Illinois, and Fulton County, Kentucky, which are located in the vicinity of the project area (Table 3.10).

Table 3.9. US Census data for New Madrid, Mississippi, and Scott Counties, and the State of Missouri.

	New Madrid	Mississippi	Scott	Missouri
Population	18,783	14,306	39,136	6,010,688
Persons Under 5 Years (%)	6.5%	6.3%	7.0%	6.4%
Persons Under 18 Years (%)	23.6%	22.1%	24.7%	23.5%
Persons 65 Years and Older (%)	16.3%	15.3%	15.3%	14.2%
Female Persons (%)	52.2%	46.3%	51.8%	51.0%
White Persons (%)	81.9%	74.3%	86.3%	84.0%
African American Persons (%)	15.9%	24.3%	11.5%	11.7%
Other Non-White Persons* (%)	2.0%	1.3%	2.1%	4.2%

*Includes: American Indians, Alaska Natives, Asian Americans, and Persons of Hispanic or Latino Origins

Table 3.10. US Census data for Alexander County, Illinois and Fulton County, Kentucky.

	Alexander	Fulton
Population	7,748	6,525
Persons Under 5 Years (%)	6.70%	6.20%
Persons Under 18 Years (%)	22.60%	20.70%
Persons 65 Years and Older (%)	17.40%	18.60%
Female Persons (%)	49.20%	49.90%
White Persons (%)	61.60%	73.80%
African American Persons (%)	35.80%	23.20%
Other Non-White Persons* (%)	2.80%	2.00%

*Includes: American Indians, Alaska Natives, Asian Americans, and Persons of Hispanic or Latino Origins

3.17 Birds Point-New Madrid Floodway Operation

Details regarding Birds Point-New Madrid Floodway operation are found in Appendix L. In summary, the Birds Point-New Madrid Floodway has been operated twice (1937 and 2011).

4.0 ENVIRONMENTAL CONSEQUENCES

Although the project area has been highly modified and no longer provides the historical forested habitat found a century ago, a series of ecological models, as well as all applicable state and Federal required documentation, were used to assess the value of significant resources in the primary impact area (PIA) and determine impacts from the proposed project. Discussion regarding mitigation necessary to compensate for significant impacts to resources associated with the tentatively selected plan (TSP) can be found in Sections 5 and 7, and Appendix R.

4.1 Elevations

Although there would be continued earth moving activities related to agricultural practices, no significant changes in landscape-level elevations are expected under any alternative.[28]

4.2 Historic Conditions

From the natural/historic habitat, a determination can be made regarding the altered ecosystem's deviation from natural patterns. Using that information, performance standards and management objectives for the altered systems may be developed (Sparks, 1995). The project area was historically a bottomland hardwood ecosystem. Today it is farmland and the majority has been classified as prime farmland by the Department of Agriculture. The vast bottomland hardwood ecosystem that once existed (Figure 3.7) is relegated to small, isolated patches scattered throughout the project area (Figure 3.8). These areas represent the remaining natural ecosystem in the project area. Additional information regarding the value of the remaining historic habitat, impacts of the proposed project, and benefits of compensatory mitigation can be found in the following sections.

4.3 Land Use

With the exception of lands enrolled in the wetland reserve program (WRP), no changes to overall land use classification would be expected regardless of the chosen alternative, including the no action alternative (see Section 2). Although implementation of a flood risk management project would likely change the kinds of agricultural commodities grown, as well as the management strategy (with the exception of lands utilized for compensatory mitigation), all agricultural areas would retain their agricultural classification. No conversion of forested areas to agriculture would be expected, as the prevailing trend is for remaining forested areas to remain in public ownership, to be maintained by private owners for recreation, or to remain too wet to farm due to drainage/precipitation issues.

[28] Likewise, significant changes in elevations as a result of Floodway operation are either outside of the project area (Northern Inflow Crevasse and O'Bryan's Ridge) or are in the process of being repaired. For example, scour holes that formed in the vicinity of Big Oak Tree State Park were filled.

The WRP is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA NRCS provides technical and financial support to help landowners with wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

Analysis coordinated with the interagency team forecast that an additional 2,965 and 854 acres would be enrolled into the WRP program in the St. Johns Bayou Basin and New Madrid Floodway, respectively. Additional information regarding the WRP Program is found in Appendix M, Part 1.

To determine habitat value of future WRP enrolled lands, an estimate regarding their location in the floodplain was necessary. This was accomplished by first determining the current percent of area of WRP lands by elevation in the St. Johns Bayou Basin and New Madrid Floodway. An assumption was that future WRP enrollment would occur at the same percentage of area by elevation as for current conditions. An additional assumption was that future WRP enrollment would follow existing trends regarding the type of habitat restored, resulting in approximate restoration target ratios of 70 percent bottomland hardwood, 20 percent herbaceous wetlands, and 10 percent open water. Tables 4.1 and 4.2 provide stage-area data for future project conditions as it relates to WRP enrollment.

Table 4.1. Future stage area curve (acres) with projected WRP gains, St. Johns Bayou Basin.

Elevation	Agriculture	Developed	Fallow	Forest	Herbaceous	Open Water	Pasture	Scrub/Shrub	Total
281 and below	250.3	13.1	0.0	335.9	10.6	100.2	0.0	0.0	710.1
282 and below	266.2	15.4	0.1	387.8	12.2	100.3	0.0	0.0	782.0
283 and below	282.0	17.0	0.9	446.2	13.9	100.7	0.1	0.0	860.9
284 and below	1,568.2	31.7	5.6	877.1	43.3	158.6	0.5	0.0	2,685.1
285 and below	1,625.9	34.0	11.1	1,006.2	47.3	161.2	0.6	0.0	2,886.2
286 and below	1,686.7	41.8	38.9	1,572.0	98.3	204.3	0.8	0.0	3,642.8
287 and below	2,098.7	56.8	88.7	2,400.2	172.9	282.8	1.1	0.0	5,101.2
288 and below	2,290.2	65.4	152.2	2,896.4	222.4	315.1	1.2	0.0	5,942.9
289 and below	2,581.6	84.7	195.5	3,305.7	264.9	339.8	1.4	0.0	6,773.6
290 and below	3,506.0	126.2	233.2	3,931.3	306.6	376.1	2.9	0.0	8,482.2
291 and below	6,026.0	211.9	287.1	4,581.6	383.5	406.8	7.4	0.0	11,904.3
292 and below	9,162.7	330.1	305.0	5,212.1	449.9	440.1	12.9	0.0	15,912.8
293 and below	10,990.4	417.2	313.5	5,563.7	495.8	458.0	23.5	0.0	18,262.2
294 and below	12,530.1	479.2	316.7	5,810.2	525.0	469.6	44.6	0.0	20,175.5
295 and below	14,439.7	548.3	319.2	6,045.1	546.0	478.9	111.3	0.0	22,488.5
296 and below	20,623.5	840.4	321.4	6,604.4	593.4	495.0	483.2	0.0	29,961.4
297 and below	28,314.0	1,336.6	325.0	7,264.0	675.2	520.6	938.9	0.0	39,374.3
298 and below	30,684.6	1,515.9	327.7	7,636.8	708.4	535.1	1,073.8	0.0	42,482.5
299 and below	32,628.1	1,676.2	329.6	7,886.4	724.9	542.8	1,194.4	0.3	44,982.8
300 and below	34,680.1	1,852.1	333.3	8,072.3	730.8	546.2	1,273.9	0.8	47,489.4

Table 4.2. Future stage area curve (acres) with projected WRP gains, New Madrid Floodway.

Elevation	Agriculture	Fallow	Forest	Developed	Herbaceous	Open Water	Scrub/Shrub	Pasture	Total
280 & Below	0.0	5.7	341.6	0.7	102.0	68.8	0.0	0.1	518.9
281 & Below	0.0	6.0	486.7	1.6	263.5	82.0	0.0	0.3	840.1
282 & Below	0.0	6.4	680.1	2.5	504.4	106.9	0.0	0.4	1,300.8
283 & Below	136.7	7.2	855.5	5.6	627.3	131.7	0.0	0.5	1,764.5
284 & Below	555.6	10.5	990.1	10.1	649.9	202.0	0.0	0.6	2,418.8
285 & Below	1,112.9	30.1	1,246.6	22.9	661.9	274.3	0.2	0.7	3,349.7
286 & Below	2,264.7	91.4	1,827.9	42.0	687.9	370.8	0.6	0.9	5,286.2
287 & Below	4,150.2	154.6	2,879.6	71.6	730.0	489.1	1.0	1.0	8,477.1
288 & Below	6,922.6	183.8	3,905.2	117.1	786.1	588.9	1.5	1.3	12,506.5
289 & Below	10,674.4	192.1	4,770.5	170.2	806.2	633.4	1.5	1.7	17,250.0
290 & Below	14,719.9	197.1	5,529.5	214.6	819.8	668.3	1.5	2.2	22,153.0
291 & Below	19,040.1	200.3	5,987.7	280.2	839.9	683.8	1.6	3.7	27,037.4
292 & Below	24,219.6	202.5	6,410.3	392.0	855.5	698.8	1.6	6.0	32,786.3
293 & Below	29,537.4	203.9	6,948.6	552.3	875.9	709.0	1.6	8.9	38,837.6
294 & Below	34,832.5	205.6	7,482.3	730.4	901.2	722.2	1.7	13.1	44,889.0
295 & Below	39,771.8	207.1	7,883.1	946.6	909.1	738.1	1.7	20.2	50,477.7
296 & Below	44,341.4	208.0	8,210.8	1,177.9	915.7	765.8	1.8	28.0	55,649.5
297 & Below	49,241.4	209.0	8,591.8	1,432.3	921.8	774.4	5.9	40.7	61,217.1
298 & Below	53,826.6	209.4	8,906.5	1,718.9	934.1	781.0	9.1	63.0	66,448.6
299 & Below	59,321.9	211.0	9,192.2	2,046.1	938.8	789.1	9.2	83.1	72,591.4
300 & Below	64,784.2	211.7	9,457.1	2,410.9	942.8	794.9	9.2	104.6	78,715.4

4.3.1 Prime and Unique Farmland

NRCS was contacted regarding impacts to Prime and Unique Farmland. A Farmland Conversion Impact Rating Form AD-1006 (10-83) (Appendix M, Part 5) was completed comparing potential impacts of the authorized project to the avoid and minimize alternatives.

4.3.1.1 Alternative 1 – No Action

No changes to the overall amount of prime farmland would be anticipated under the no action alternative. Farmland designated as prime farmland would remain subject to impounded interior runoff and Mississippi River backwater flooding in the St. Johns Bayou Basin and New Madrid Floodway, respectively.

4.3.1.2 Alternatives 2.1, 2.2, 2.3, 3.1, 3.2 and 4.1

According to NRCS's response to the Farmland Conversion Impact Rating Form AD-1006 (10-83), only 8 acres of Prime and Unique Farmland would be impacted under the authorized project as well as the avoid and minimize alternatives, both of which include the levee closure as well as land associated with channel modifications in St. Johns Bayou Basin. Overall, all alternatives would reduce flood risk to the remaining farmland within the project area.

Compensatory mitigation measures required for other resources, including 447 acres of borrow pits, could potentially reduce the acreage of prime farmland. However, the flood management benefits provided to remaining farmland outweigh the impacts from compensatory mitigation activities. Therefore, the overall impact to prime and unique farmland is not considered significant. Thus, mitigation is not proposed for impacts to prime and unique farmland. Potential impacts to prime and unique farmland as a result of compensatory mitigation activities would be coordinated with NRCS during the development of each tract-specific mitigation plan.

4.3.1.3 Alternative 4.2

Alternative 4.2 would reforest 13,340 acres of agricultural lands below an elevation of 289.5 feet. Much of this land is designated as prime farmland as described under the Farmland Protection Policy Act (FPPA). Projects are subject to FPPA requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a Federal agency or with assistance from a Federal agency. Although the original intent of the FPPA was to protect farmland from urban sprawl and the waste of energy and resources associated with sprawling development, coordination with NRCS would be undertaken to ensure compliance should alternative 4.2 be recommended.

4.4 Hydraulics and Hydrology

Period of record data from 1943-2009 were used to compare without-project and alternative project conditions (with-project). The project area has experienced variable floods/droughts and wet/dry precipitation years during this period, and similar conditions are predicted for the future. A long period of record that accounts for numerous wet and dry years is highly desirable (Richter *et al.*, 2003). To evaluate possible environmental impacts due to the lowered water levels expected in some months, analysis was required. The approach taken was to perform a continuous simulation of interior water surface elevations for the period 1943-2009. The starting date of the simulation was 1 October 1942.

4.4.1 Alternatives 1, 2.1, 2.2, 3.1, 3.2, and 4

Table 4.3 provides a summary of flood return frequencies for project alternatives analyzed in the project area, graphic depictions are presented in Figures 1.4, 1.5 and 4.1 - 4.5. Table 4.4 provides the average acres flooded, by alternative, in the New Madrid Floodway. Table 4.5 provides the percentage of time, by month, that the floodgates would be open, by alternative, allowing backwater flooding into the New Madrid Floodway. Additional information regarding the Hydraulics and Hydrology (H+H) analysis including the overall methodology, hydrographs, and other statistics is found in Appendix C.

Table 4.3. Flood return frequencies for project alternatives, St. Johns Bayou Basin and New Madrid Floodway Project.

	St. Johns Bayou Basin		New Madrid Floodway				
Return Period (Years)	Alt. 1 (elevation)	Alt. 2.1 (elevation)	Alt. 1 (elevation)	Alt. 2.2 (elevation)	Alt 3.1 (elevation)	Alt 3.2 (elevation)	Alt. 4 (elevation)
1.01	281.6	284.1	279.3	283.0	283.6	283.0	284.8
2	291.0	290.4	292.1	285.7	287.6	287.2	288.5
3	292.5	291.5	294.5	286.1	288.2	287.8	289.1
4	293.4	292.2	295.8	286.3	288.5	288.1	289.4
5	294.1	292.6	296.6	286.5	288.7	288.3	289.6
10	295.6	293.8	298.7	286.9	289.3	289.0	290.3
20	296.9	294.7	300.5	287.1	289.7	289.4	290.8
50	298.4	295.7	302.5	287.4	290.3	290.0	291.4
100	299.4	296.3	303.9	287.6	290.7	290.4	291.8

Table 4.4. Average acres flooded by month in the New Madrid Floodway.

Month	Existing	Alternative 2.2	Alternative 3.1	Alternative 3.2	Alternative 4
January	3,344.1	3,253.0	4,370.2	4,370.2	4,370.6
February	4,345.1	381.3	2,742.1	2,742.1	2,742.4
March	9,128.5	237.0	3,427.1	2,220.6	4,412.7
April	10,033.3	165.5	2,812.8	1,470.7	5,199.1
May	7,351.6	118.6	754.5	440.4	3,710.8
June	1,975.4	101.2	138.8	126.4	1,530.4
July	403.5	47.2	61.4	61.4	379.2
August	254.4	23.2	27.4	27.4	222.7
September	26.2	20.8	22.8	22.8	26.1
October	59.2	22.8	24.7	24.7	60.3
November	188.5	47.0	155.0	155.0	155.9
December	1,180.7	2,427.4	3,047.2	3,047.2	3,047.6

Table 4.5. Percentage of time, by month[1] and alternative, flood control gates would remain open in the New Madrid Floodway.

Month	Authorized	Alternative 3.1	Alternative 3.2	Alternative 4
February	63.2	73.7	73.7	73.7
March	40.9	58.9	58.2	59.5
April	43.6	57.1	54.8	59.9
May	57.4	66.4	63	72.3
June	76.2	79.3	79.2	88.6
July	92.1	93.2	93.2	95.8
August	97.6	97.8	97.8	98.5
September	98.8	99.6	99.6	99.6
October	98.2	98.5	98.5	99.1
November	96.6	97.6	97.6	97.7

[1] December and January percentages were not calculated due to the winter waterfowl water holding plan.

Alternatives 2.2, 3.1, 3.2, 4.1 and 4.2 would result in lost flood storage due to the levee closure coupled with pumping operations. However, the loss of flood storage by project implementation would have no effect on communities outside of the floodway. This is due to the location of the surrounding river communities and the corresponding protective Mississippi River Levee system. Since, no increase in flood risk will result to adjacent areas and communities resulting from project implementation, the effects of lost New Madrid Floodway flood storage to the Mississippi River is not addressed by alternative in the draft EIS. However, extensive model tests[29] of the Mississippi River Levee system have been made to compare the current system response with that resulting from closing the existing gap at the lower end of the New Madrid Floodway. The only measured increases in stages with the closure were at Hickman, Kentucky and riverside of the mainline levee near Big Oak Tree State Park (H.W. 173), which were 0.1 feet and 0.3 feet higher, respectively. A 0.1 feet decrease in stage was measured at the New Madrid gage for the test with the closure. The maximum increase in water surface elevation at stations along the riverside of the frontline levee was 0.5 feet at levee mile 81.

Typically, the Mississippi River system response to flood events can be characterized by slow rising stages with prolonged crests. Under this condition, the difference in response of the Mississippi River system with the 1,500-foot closure compared to existing conditions would be negligible, both in terms of stage and duration. Therefore, no significant impacts would occur due to closure of the New Madrid Floodway for typical floods.

Hydrograph tests were also conducted for atypical flood conditions. Indications from the results of the PDF hydrograph tests are that flood events that have rapidly rising stages and short crests may increase stages along the Mississippi River from the vicinity of New Madrid downstream approximately 85 miles. No change in Mississippi River stages would occur upstream from New Madrid, including upstream communities along the Ohio River and the Upper Mississippi River. Although no measureable differences occur for atypical floods of lesser magnitude (less than 10-year flood), the maximum predicted stage increases for significant atypical flood events (rapid rise with short crest at the 10-, 25-, 50-year, etc. frequency) would be temporary with stages less than a 0.5 foot increase. This temporary increase in stage would be due to the loss in storage at the lower end of the New Madrid Floodway. The difference in duration of flooding with and without the closure would be insignificant. No communities would be affected by the loss of storage in the New Madrid Floodway due the 1500-foot closure.

Although slight increases in stage could result downstream from the closure of the New Madrid Floodway during certain conditions, including operation of pumping stations in St. Johns Basin and the New Madrid Floodway, no increases in stage would be

[29] "Transmittal of the Mississippi Basin Model Letter Report 89-1, Birds Point-New Madrid Floodway Reconnaissance Study," dated 27 July 1990. The report reflected results of steady-state Project Design Flood (PDF) tests and PDF hydrograph tests, considering the 1986 Plan of Operation for the New Madrid Floodway, which is the current plan of operation for the New Madrid Floodway. The results from the steady-state PDF tests comparing conditions with and without the 1,500-foot levee closure indicate very little difference in stages at Mississippi River gage locations.

experienced based on the modeling approach used to compute flood frequency estimates along the Lower Mississippi River. The flood frequency estimates are based on conditions (peak flows) that would maximize flood stages and would not be altered by the St. Johns-New Madrid project; these flowline estimates are closely related to slow rising rivers with prolonged crests. Also, it is important to note that the New Madrid Floodway has a drainage area that comprises only about 0.02 percent of the 919,200 square miles that contribute to flows on the Mississippi River at New Madrid. This fact can help put in perspective the negligible effect that the loss of storage from closing the 1,500-foot gap in the New Madrid Floodway would have on Lower Mississippi River stages.

4.5 Flood Pulse

4.5.1 St. Johns Bayou Basin

Impounded interior runoff would continue in the St. Johns Bayou Basin under both the no action alternative as well as the authorized project alternative. However, installing a 1,000 cfs pump as well as channel modifications would reduce the elevation and duration of the flood pulse (Table 4.3).

4.5.2 New Madrid Floodway

Closure of the New Madrid Floodway and installation of a 1,500 cfs pump would prevent Mississippi backwater flooding in the New Madrid Floodway under authorized project conditions. Similar to the St. Johns Bayou Basin, interior runoff would be impounded. However, impounded interior runoff would be pumped over the levee during periods of high Mississippi River elevations. Mississippi River backwater flooding is not severed under the avoid and minimize alternatives. All measures manage or maintain backwater flooding by allowing the Mississippi River to reach specific thresholds prior to closing the gates on the gravity outlet. Once gates are closed, avoid and minimize measures would restrict pumping operations until certain elevation thresholds are reached.[30] Although the avoid and minimize measures would reduce the elevation of frequency events of greater magnitude than the 1.01-year flood, they maintain both river connectivity and hydrologic variability.

4.6 Social Resources

Impacts to social resources begin when roads become overtopped by flood waters (290 feet), thus isolating communities.

4.6.1 Alternative 1 – No Action

Under the no action alternative, flooding would continue to isolate communities, requiring local residents to take extraordinary measures to complete otherwise simple

[30] The reason for this is to benefit environmental resources as well as to provide sufficient floodplain storage for pumping operations.

tasks (*e.g.,* traveling to work/school, buying groceries, obtaining medical care). Community resources would continue to be impacted during periods of flooding due to community isolation. Police and fire protection as well as access to healthcare would continue to be impacted. The overall socioeconomic structure of the area is not expected to change without the project, as the area would continue to be agriculturally-based.

Population changes are not expected under future without-project conditions. However, it is possible that Floodway operation would force residents to vacate property until conditions return to normal. History has shown some residents would be expected to return to the Floodway after operation. Repopulation occurred in the Floodway following operation in 1937, and limited numbers have already returned to the Floodway following the 2011 operation. However, not all residents return following Floodway operation. For example, the Village of Pinhook is considering relocating to potential areas found in the St. Johns Bayou Basin, although a plan has not been recommended to date. If residents choose to relocate to the St. Johns Bayou Basin, social impacts would increase in those areas, while decreasing in the New Madrid Floodway.

4.6.2 Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, and 4.2

Social resources would be expected to improve with all alternatives that minimize flood risks at levels that keep roads open (Table 4.6). These alternatives would reduce risks associated with flooding to a segment of the population that was subject to past racial segregation. Residents that are currently impacted as a result of flooding could, for the first time, receive the services and protection afforded to the majority of the country.

Flood risk would not be entirely eliminated for residents of the Floodway during periods of Floodway operation. The Floodway would be operated as authorized. Therefore, during periods of catastrophic floods (currently on average once in 80 years), temporary relocation of area residents would continue.

Table 4.6. Average days per year that roads are overtopped (elevation 290 feet) in the St. Johns Bayou Basin and New Madrid Floodway.

Alternative	St. Johns Bayou Basin (days/year)	New Madrid Floodway (days/year)
Alt 1 - No Action	17.4	20.4
Alt. 2.1	11.9	20.4
Alt. 2.2	17.4	0
Alt. 2.3	11.9	0
Alt. 3.1	11.9	0
Alt. 3.2	11.9	0
Alt. 4.1	11.9	0.2
Alt. 4.2	11.9	0.2

4.7 Economic Resources

The purpose of this section is to present information pertaining to the annual benefits, costs, and economic justification of the alternatives that have been developed. Alternatives presented in this section include a no-action plan, the authorized plan, and four additional environmentally sensitive alternatives.

4.7.1 Alternative 1 – No Action

Economic impacts would continue under the no-action alternative. Although there have been some recent changes in land use within the project areas resulting from the implementation of WRP, the project has accounted for likely future trends. Area producers would continue to attempt to minimize flood risks during the spring by delayed planting. Delayed planting limits the types of crops that could be grown as well as yields. However, there would always be a risk due to less frequent late season flooding. In addition to agricultural damages, streets and roads would continue to be damaged as a result of flooding.

4.7.2 Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1, and 4.2

Agricultural prices utilized in the analysis are based on current normalized crop prices developed by the Economic Research Service (ERS). The ERS is one of four agencies in the Research, Education, and Economic Mission Area of USDA. ER 1105-2-100 requires the use of current normalized crop prices. The normalized prices smooth out the effects of short-term price fluctuations. Therefore, alternatives can be evaluated on a more realistic basis rather than using current prices, which may be lower or higher than normal because of short-lived phenomena. ERS estimates are based on a 5-year moving average of actual market prices. Since the trend in market prices for agricultural commodities has been increasing in recent years, prices in this analysis are significantly higher than previous studies.

Tables 4.7, 4.8, 4.9, 4.10 and 4.11 present the project's economic conclusions. All alternatives analyzed had benefit-to-cost ratios that exceeded unity. Therefore, benefits of the project outweigh the costs of construction, operation, and maintenance, and all are within the interest of the government to construct. In addition, costs associated with the New Madrid Floodway closure (MRL project feature) are presented at an authorized interest rate of 2.5 percent as well as the current interest rate of 4.000 percent. The project is economically justified with either interest rate.

Table 4.7. Annual benefits, costs, excess benefits, and benefit-to-cost ratios, alternative 2, St. Johns Bayou Basin and New Madrid Floodway, October 2012 price levels.

	Alternative 2.1			Alternative 2.2				Alternative 2.3
	St Johns Basin			New Madrid Basin				Both Basins
Item	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,038,000	2,779,000	2,858,000	3,817,000	5,972,000
AG NonCrop	461,000	163,000	624,000	232,000	1,502,000	1,512,000	1,734,000	2,358,000
AG Intensification	486,000	105,000	591,000	512,000	2,825,000	2,919,000	3,337,000	3,928,000
Streets and Roads	102,000	3,439,000	3,541,000	106,000	211,000	214,000	317,000	3,858,000
Total	2,513,000	4,398,000	6,911,000	1,888,000	7,317,000	7,503,000	9,205,000	16,116,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,383,000	3,758,000	2,312,000	5,141,000	7,487,000
Sinking Fund	244,000	139,000	383,000	227,000	615,000	948,000	842,000	1,225,000
O&M	37,000	129,000	166,000	137,000	0	0	137,000	303,000
TOTAL	1,775,000	1,120,000	2,895,000	1,747,000	4,373,000	3,260,000	6,120,000	9,015,000
Excess Benefits	738,000	3,278,000	4,016,000	141,000	2,944,000	4,243,000	3,085,000	7,101,000
BCR	1.4	3.9	2.4	1.08	1.7	2.3	1.5	1.8

Table 4.8. Annual benefits, costs, excess benefits, and benefit-to-cost ratios, alternative 3.1, St. Johns Bayou Basin and New Madrid Floodway, October 2012 price levels.

	St Johns Basin			New Madrid Basin				Both Basins
Item	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,181,000	2,598,000	2,672,000	3,779,000	5,934,000
AG NonCrop	461,000	163,000	624,000	161,000	1,422,000	1,432,000	1,583,000	2,207,000
AG Intensification	486,000	105,000	591,000	326,000	2,697,000	2,787,000	3,023,000	3,614,000
Streets and Roads	102,000	3,439,000	3,541,000	36,000	169,000	171,000	205,000	3,746,000
Total	2,513,000	4,398,000	6,911,000	1,704,000	6,886,000	7,062,000	8,590,000	15,501,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,194,000	2,454,000	1,510,000	3,648,000	5,994,000
Sinking Fund	244,000	139,000	383,000	195,000	402,000	619,000	597,000	980,000
O&M	37,000	129,000	166,000	109,000	0	0	109,000	275,000
TOTAL	1,775,000	1,120,000	2,895,000	1,498,000	2,856,000	2,129,000	4,354,000	7,249,000
Excess Benefits	738,000	3,278,000	4,016,000	206,000	4,030,000	4,933,000	4,236,000	8,252,000
BCR	1.4	3.9	2.4	1.1	2.4	3.3	2.0	2.1

Table 4.9. Annual benefits, costs, excess benefits, and benefit-to-cost ratios, alternative 3.2, St. Johns Bayou Basin and New Madrid Floodway, October 2012 price levels.

	St Johns Basin			New Madrid Basin				Both Basins
Item	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,233,000	2,622,000	2,697,000	3,855,000	6,010,000
AG NonCrop	461,000	163,000	624,000	191,000	1,433,000	1,443,000	1,624,000	2,248,000
AG Intensification	486,000	105,000	591,000	378,000	2,697,000	2,787,000	3,075,000	3,666,000
Streets and Roads	102,000	3,439,000	3,541,000	49,000	174,000	176,000	223,000	3,764,000
Total	2,513,000	4,398,000	6,911,000	1,851,000	6,926,000	7,103,000	8,777,000	15,688,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,246,000	2,666,000	1,640,000	3,912,000	6,258,000
Sinking Fund	244,000	139,000	383,000	204,000	437,000	673,000	641,000	1,024,000
O&M	37,000	129,000	166,000	115,000	0	0	115,000	281,000
TOTAL	1,775,000	1,120,000	2,895,000	1,565,000	3,103,000	2,313,000	4,668,000	7,563,000
Excess Benefits	738,000	3,278,000	4,016,000	286,000	3,823,000	4,790,000	4,109,000	8,125,000
BCR	1.4	3.9	2.4	1.2	2.2	3.1	1.9	2.1

Table 4.10. Annual benefits, costs, excess benefits, and benefit-to-cost ratios, alternative 4.1, St. Johns Bayou Basin and New Madrid Floodway, October 2012 price levels.

	St Johns Basin			New Madrid Basin				Both Basins
Item	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	1,357,000	2,501,000	2,572,000	3,858,000	6,013,000
AG NonCrop	461,000	163,000	624,000	70,000	1,380,000	1,389,000	1,450,000	2,074,000
AG Intensification	486,000	105,000	591,000	157,000	2,564,000	2,649,000	2,721,000	3,312,000
Streets and Roads	102,000	3,439,000	3,541,000	7,000	153,000	156,000	160,000	3,701,000
Total	2,513,000	4,398,000	6,911,000	1,591,000	6,598,000	6,766,000	8,189,000	15,100,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,142,000	2,203,000	1,355,000	3,345,000	5,691,000
Sinking Fund	244,000	139,000	383,000	188,000	360,000	556,000	548,000	931,000
O&M	37,000	129,000	166,000	84,000	0	0	84,000	250,000
TOTAL	1,775,000	1,120,000	2,895,000	1,414,000	2,563,000	1,911,000	3,977,000	6,872,000
Excess Benefits	738,000	3,278,000	4,016,000	177,000	4,035,000	4,855,000	4,212,000	8,228,000
BCR	1.4	3.9	2.4	1.1	2.6	3.5	2.1	2.2

Table 4.11. Annual benefits, costs, excess benefits, and benefit-to-cost ratios, alternative 4.2, St. Johns Bayou Basin and New Madrid Floodway, October 2012 price levels.

	St Johns Basin			New Madrid Basin				Both Basins
Item	Headwater	Backwater	Total	Pump	Closure		Total	
Discount Rate	4.000%	4.000%	4.000%	4.000%	4.000%	2.500%	4.000%	4.000%
Benefits								
AG FDP	1,464,000	691,000	2,155,000	217,000	3,321,000	3,412,000	3,538,000	5,693,000
AG NonCrop	461,000	163,000	624,000	57,000	1,742,000	1,753,000	1,799,000	2,423,000
AG Intensification	486,000	105,000	591,000	157,000	2,564,000	2,649,000	2,721,000	3,312,000
Streets and Roads	102,000	3,439,000	3,541,000	106,000	211,000	214,000	317,000	3,858,000
Total	2,513,000	4,398,000	6,911,000	537,000	7,838,000	8,028,000	8,375,000	15,286,000
Costs								
Interest	1,494,000	852,000	2,346,000	1,370,000	3,735,000	2,297,000	5,105,000	7,451,000
Sinking Fund	244,000	139,000	383,000	224,000	611,000	943,000	835,000	1,218,000
O&M	37,000	129,000	166,000	84,000	0	0	84,000	250,000
TOTAL	1,775,000	1,120,000	2,895,000	1,678,000	4,346,000	3,240,000	6,024,000	8,919,000
Excess Benefits	738,000	3,278,000	4,016,000	-1,141,000	3,492,000	4,788,000	2,351,000	6,367,000
BCR	1.4	3.9	2.4	0.32	1.8	2.5	1.4	1.7

4.8 Flood Pulse and Environmental Resources

4.8.1 Wetlands

The Hydrogeomorphic (HGM) Approach is a method for developing functional indices and the protocols used to apply these indices to the assessment of wetland functions at a site-specific scale. The HGM model was developed by ERDC in cooperation with the Arkansas Multi-Agency Wetland Planning Team and EPA Region 6, which provided funding, and is certified by USACE for use in the project area. The HGM is considered the best tool available to quantify indirect impacts associated with the project (Battelle 2010) and was used in lieu of any less rigorous methods that are not intended to represent an exact or statistically proven scientific method. The complete HGM assessment for the project is located in Appendix E, Part 4.

A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley (Klimas et al. 2011) (Appendix E, Part 3) was utilized to determine impacts to wetlands associated with each project alternative. To take into account the time required to recover functions following impacts or restoration actions, an additional set of curves representing recovery trajectories were developed and published as part of the Delta Region Guidebook (Klimas et al. 2011). The HGM assessment was limited to all areas with direct impacts (e.g., clearing, widening of ditches, recontouring), and indirect impacts to all vegetated wetlands and farmed wetlands within the 5-year floodplain that are by definition river-connected and subject to changes in pumping and drainage regimes due to the project. Areas outside the 5-year floodplain (*e.g.,* flats) have hydrology that is primarily precipitation driven and were not included because they are not significantly influenced by impounded interior runoff or backwater flooding. Likewise, prior converted cropland does not provide significant wetland functions. Thus, no significant wetland impacts are anticipated to wetlands above the 5-year flood frequency or prior converted cropland according to the HGM Model.[31]

Field data were obtained from 61 plots (Figure 4.6), which were then compared to the calibration curve to derive a sub-index. The sub-index values were inserted into the model, which generated a functional capacity index (FCI) for the function being assessed. By multiplying the FCI by wetland acreage, a functional capacity unit (FCU) was generated. Pre- and post-project FCUs were then compared to determine impacts among project alternatives.

The Functional Capacity Index (FCI) value generated by the assessment model was between 0 and 1.0, where a value of 1.0 represented a fully functional condition. The HGM assessment analyzed the following wetland functions: Detain Floodwater, Detain

[31] Although there are no impacts to wetlands for areas above the five-year floodplain or prior converted cropland according to the HGM model, impacts to these areas were assessed by the utilization of the waterfowl and shorebird models.

Precipitation, Cycle Nutrients, Export Organic Carbon, Maintain Plant Communities, and Provide Habitat for Fish and Wildlife.

Alternatives were assessed over a 50-year project life, and existing land use patterns were assumed to remain and result in no change to the average condition of existing resources (other than WRP). Future WRP projections were assumed to be functioning wetlands. All impacts were assumed to be immediate upon project approval, all areas that would be cleared were assumed to remain cleared, and all changes to hydrology were assumed to remain constant. All farmed wetlands were assumed to be low gradient riverine backwater (LGRB), the majority subclass in both basins. Acreages utilized in the HGM assessment are provided in Table 4.12.

Table 4.12. Acres of wetlands considered for HGM analysis.

Basin	Condition/ Alternative	5-Year Flood Frequency Elevation	Farmed Wetlands*	Fallow	Forest	Herbaceous	Scrub/ Shrub	Total
St. Johns Bayou Basin	Existing	294.1	792.0	316.9	4,710.0	206.1	0.0	6,025.0
	Alternative 1 (No Action)	294.1	792.0	316.9	5,833.7	527.1	0.0	7,469.7
New Madrid Floodway	Existing	296.6	306.0	208.6	745.0	749.5	4.3	2,013.4
	Alternative 1 (No Action)	296.6	306.0	208.6	8,439.4	919.3	4.3	9,877.6

* Farmed Wetlands are not identified by elevation, results are for entire basin.

4.8.1.1 Alternative 1 – No Action

St. Johns Bayou Basin

There are 5,233 acres of vegetated wetlands estimated to exist within the 5-year floodplain of the St. Johns Bayou Basin. Of this total, 3,848 acres (74 percent) were classified as LGRB, and 1,385 acres (26 percent) were classified as LGRO. In addition to vegetated wetlands, NRCS identified 792 acres of agricultural lands as farmed wetlands, which were classified as LGRB. Additional lands are expected to be enrolled into WRP acreage over the life of the project. It is assumed that approximately 1,445 acres of WRP wetlands would be added to the St. Johns Bayou Basin. Anticipated WRP lands were divided into 1,127 acres of forested wetlands, assumed to be LGRB, and 318 acres of herbaceous wetlands, assumed to be CD wetlands. Alternative 1, the no action alternative, is not expected to impact wetlands.

Table 4.13 provides the FCU for each function by wetland subclass for alternative 1. Alternative 1 FCU were used to quantify impacts to wetlands within the St. Johns Bayou Basin.

Table 4.13. Alternative 1 FCU in the St. Johns Bayou Basin.

Vegetation Class	Farmed	Vegetated		WRP	
HGM Subclass	LGRB	LGRB	LGRO	LGRB	CD
Acreage	792	3,848	1,385	1,127	318
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	198	2,501	1,343	674	67
Detain Precipitation	428	3,463	1,039	1,042	N/A
Cycle Nutrients	190	2,617	1,080	814	129
Export Organic Carbon	150	2,617	1,080	814	129
Maintain Plant Communities	0	3,040	136	855	51
Fish and Wildlife Habitat	0	1,809	679	299	48

N/A - Not Applicable

New Madrid Floodway

There are 8,807 acres of vegetated wetlands estimated to exist within the five-year floodplain of the New Madrid Floodway. Of this total, 7,344 acres (83 percent) were classified as LGRB, 1,163 acres (13 percent) were classified as LGRO, and 300 acres (3 percent) were classified as CD. In addition to vegetated wetlands, NRCS identified 306 acres of agricultural lands as farmed wetlands, which were classified as LGRB. Additional lands are expected to be enrolled into WRP acreage over the life of the project. It is assumed that approximately 765 acres of WRP wetlands would be added to the New Madrid Floodway. Anticipated WRP lands were classified as 595 acres as LGRB and 170 acres as CD. Alternative 1, the no action alternative, is not expected to impact wetlands. However, Big Oak Tree State Park would continue to see a reduction in hydric vegetative communities without hydrological restoration.

Table 4.14 provides the FCU for each function by wetland subclass for alternative 1. As in the St. Johns Bayou Basin, alternative 1 FCU were used to quantify impacts to wetlands within the New Madrid Floodway.

Table 4.14. Alternative 1 FCU in the New Madrid Floodway.

Vegetation Class	Farmed	Vegetated			WRP	
HGM Subclass	LGRB	LGRB	LGRO	CD	LGRB	CD
Acreage	306	214	1,163	300	595	170
Function	FCU	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	77	6,463	954	159	356	36
Detain Precipitation	165	7,124	675	N/A	550	N/A
Cycle Nutrients	73	6,242	989	183	430	72
Export Organic Carbon	58	6,242	919	171	430	69
Maintain Plant Communities	0	6,830	977	201	452	27
Fish and Wildlife Habitat	0	5,655	733	171	158	26

N/A - Not Applicable

4.8.1.2 Alternative 2.1

A total of 673 acres of LGRO vegetated wetlands would be directly impacted due to channel modifications discussed in Section 2 (wetlands would be cleared and either converted to ditch habitat or filled with spoil material) and would be assumed to lose all wetland function. The remaining acres of forested LGRO, farmed wetlands, forested LGRB wetlands, and WRP areas would suffer modest decreases in function due to indirect impacts associated with hydrologic changes associated with the project.

Slight changes in both flood frequency and flood duration affected the Detain Floodwater, Export Organic Carbon and Maintain Plant Communities functions in the LGRB subclass, although this change does not show up in the Maintain Plant Communities function of the agricultural areas, since the function was already at an FCI of 0.0. Although hydrology would be impacted by installation of the pumping station, impacts would not be significant enough to effect a change in wetland status (*i.e.*, wetlands would still physically exist). Therefore, overall wetland acreage would not be impacted. Table 4.15 provides the FCU for each function by wetland subclass for alternative 2.1. Impacts (changes in FCU) associated with alternative 2.1 as compared to the no-action alternative (alternative 1) are given in Table 4.16. A summary of direct and indirect impacts to each specific function within each wetland subclass can be found in Appendix E, Part 4.

Table 4.15. Alternative 2.1 FCU in the St. Johns Bayou Basin.

Vegetation Class	Farmed	Vegetated		WRP	
HGM Subclass	LGRB	LGRB	LGRO	LGRB	CD
Acreage	792	3,848	1,385	1,127	318
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	182	2,424	691	651	69
Detain Precipitation	428	3,463	534	1,042	N/A
Cycle Nutrients	190	2,617	598	814	135
Export Organic Carbon	135	2,540	555	791	123
Maintain Plant Communities	0	3,001	555	844	48
Fish and Wildlife Habitat	0	1,809	342	299	48

N/A - Not Applicable

Table 4.16. Alternative 2.1 FCU impacts in the St. Johns Bayou Basin.

Impacts	Losses in FCU		
HGM Subclass	LGRB	LGRO	CD
Function	FCU	FCU	FCU
Detain Floodwater	-116	-653	0
Detain Precipitation	0	-505	N/A
Cycle Nutrients	0	-565	0
Export Organic Carbon	-116	-525	0
Maintain Plant Communities	-49	-580	0
Fish and Wildlife Habitat	0	-337	0

N/A - Not Applicable

4.8.1.3 Alternative 2.2

A total of 9 acres of LGRB vegetated wetlands would be directly impacted due to the installation of the closure structure detailed in Section 2 and would assumed to lose all wetland function. Indirect impacts associates with changes in both flood frequency and flood duration would affect multiple functions. In addition to functional decreases within subclasses, the hydrologic changes associated with this alternative would be significant enough to cause changes in wetland subclass from riverine subclasses [e.g., LGRB, connected depressions (CD)] to flats or unconnected depressions (UCD). Hence, functional gains would occur for flats and unconnected depressions. Likewise, functional impacts occur to LGRB and CD. Similar to the St. Johns Bayou Basin, impacts would not be significant enough to change a jurisdictional wetland to a non-wetland. Although wetland functions as a result of the pumping station and closure levee would be impacted, overall wetland acreage would not change. Table 4.17 provides the FCU for each function by wetland subclass for alternative 2.2. Impacts, as expressed by changes in FCU, associated with Alternative 2.2 as compared to the no-action alternative (alternative 1) are given in Table 4.18. A summary of direct and indirect impacts to each specific function within each wetland subclass can be found in Appendix E, Part 4.

Table 4.17. Alternative 2.2 FCU in the New Madrid Floodway.

Vegetation Class	Farmed		Forested					WRP			
HGM Subclass	LGRB	Flat	LGRB	LGRO	Flat	CD	UCD	LGRB	Flat	CD	UCD
Acreage	21	285	515	1,163	6,829	27	273	42	553	12	158
Function	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	4	N/A	427	768	N/A	15	N/A	20	N/A	2	N/A
Detain Precipitation	11	100	457	675	5,258	N/A	N/A	39	393	N/A	N/A
Cycle Nutrients	5	54	427	989	5,395	17	175	30	371	5	84
Export Organic Carbon	3	N/A	396	744	N/A	17	N/A	24	N/A	4	N/A
Maintain Plant Communities	0	0	412	849	6,078	17	205	29	376	1	61
Fish and Wildlife Habitat	0	0	300	675	4,917	21	139	11	133	2	14

N/A - Not Applicable

Table 4.18. Alternative 2.2 FCU impacts in the New Madrid Floodway.

Impacts	Losses in FCU			Gains In FCU	
HGM Subclass	LGRB	LGRO	CD	Flats	UCD
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	-6,449	-186	-179	N/A	N/A
Detain Precipitation	-7,332	0	N/A	5,651	N/A
Cycle Nutrients	-6,283	0	-234	5,765	258
Export Organic Carbon	-6,312	-174	-223	N/A	N/A
Maintain Plant Communities	-6,845	-128	-211	6,454	266
Fish and Wildlife Habitat	-5,503	-58	-181	5,050	153

N/A - Not Applicable

4.8.1.4 Alternative 2.3

Alternative 2.2 combines alternatives 2.1 and 2.2. Impacts have been previously discussed.

4.8.1.5 Alternative 3.1

St. Johns Bayou Basin

The avoid and minimize measures associated with channel modifications (Section 2) reduce the direct impact by 264 acres, therefore 409 acres would be directly impacted by implementation of alternative 3.1. The hydrologic variables that affect indirect impacts as a result of the pumping station would be identical to those in alternative 2.1. Table 4.19 provides the FCU for each function by wetland subclass for alternative 3.1. Impacts, as expressed by changes in FCU, associated with alternative 3.1 as compared to the no-action alternative (alternative 1) are given in Table 4.20. A summary of direct and indirect impacts to each specific function within each wetland subclass can be found in Appendix E, Part 4.

Table 4.19. Alternative 3.1 FCU in the St. Johns Bayou Basin.

Vegetation Class	Farmed	Vegetated		WRP	
HGM Subclass	LGRB	LGRB	LGRO	LGRB	CD
Acreage	792	3,848	1,385	1,127	318
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	182	2,424	947	651	61
Detain Precipitation	428	3,463	732	1,042	N/A
Cycle Nutrients	190	2,617	820	814	135
Export Organic Carbon	135	2,540	761	791	123
Maintain Plant Communities	0	3,001	761	844	48
Fish and Wildlife Habitat	0	1,809	468	299	48

N/A - Not Applicable

Table 4.20. Alternative 3.1 FCU impacts in the St. Johns Bayou Basin.

Impacts	Losses in FCU		
HGM Subclass	LGRB	LGRO	CD
Function	FCU	FCU	FCU
Detain Floodwater	-116	-397	0
Detain Precipitation	0	-307	N/A
Cycle Nutrients	0	-344	0
Export Organic Carbon	-115	-319	0
Maintain Plant Communities	-50	-374	0
Fish and Wildlife Habitat	0	-210	0

N/A - Not Applicable

New Madrid Floodway

A total of 9 acres of LGRB vegetated wetlands would be directly impacted due to the installation of the closure structure detailed in Section 2 and would assumed to lose all wetland function. However, instead of closing gates and turning on pumps at the onset of flooding, alternative 3.1 would maintain connectivity between the Mississippi River and the New Madrid Floodway by allowing flooding to extend to specific elevations based upon seasonality and management of socio-economic flood risks, thereby reducing indirect impacts. Similar to alternative 2.2, changes in both flood frequency and flood duration would affect multiple functions, including functional decreases within subclasses and changes in wetland subclass. Table 4.21 provides the FCU for each function by wetland subclass for alternative 3.1. Impacts, as expressed by changes in FCU, associated with alternative 3.1 as compared to the no-action alternative (alternative 1) are given in Table 4.22. A summary of direct and indirect impacts to each specific function within each wetland subclass can be found in Appendix E, Part 4.

Table 4.21. Alternative 3.1 FCU in the New Madrid Floodway.

Vegetation Class	Farmed		Forested					WRP			
HGM Subclass	LGRB	Flat	LGRB	LGRO	Flat	CD	UCD	LGRB	Flat	CD	UCD
Acreage	214	92	5,128	1,163	2,216	191	109	416	179	119	51
Function	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	32	N/A	3,226	919	N/A	84	N/A	150	N/A	14	N/A
Detain Precipitation	116	32	4,916	675	1,751	N/A	N/A	385	127	N/A	N/A
Cycle Nutrients	51	18	4,302	989	1,950	111	83	300	120	50	27
Export Organic Carbon	24	N/A	2,970	884	N/A	94	N/A	179	N/A	29	N/A
Maintain Plant Communities	0	0	4,404	942	2,061	90	94	295	122	14	20
Fish and Wildlife Habitat	0	0	3,738	721	1,573	92	67	104	43	16	5

N/A - Not Applicable

Table 4.22. Alternative 3.1 FCU impacts in the New Madrid Floodway.

Impacts	Losses in FCU			Gains In FCU	
HGM Subclass	LGRB	LGRO	CD	Flats	UCD
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	-3,487	-35	-97	N/A	N/A
Detain Precipitation	-2,423	0	N/A	1,910	N/A
Cycle Nutrients	-2,092	0	-94	2,088	110
Export Organic Carbon	-3,558	-35	-118	N/A	N/A
Maintain Plant Communities	-2,582	-35	-124	2,183	113
Fish and Wildlife Habitat	-1,970	-12	-89	1,616	71

N/A - Not Applicable

4.8.1.6 Alternative 3.2

St. Johns Bayou Basin

Impacts that were previously described for alternative 3.1 for the St. Johns Bayou Basin would be the same.

New Madrid Floodway

A total of 9 acres of LGRB vegetated wetlands would be directly impacted due to the installation of the closure structure detailed in Section 2 and would assumed to lose all wetland function. Indirect impacts are similar to that described for alternative 3.1 as changes in both flood frequency and flood duration would affect multiple functions, including functional decreases within subclasses and changes in wetland subclass. However, indirect impacts would be greater than for alternative 3.1, because the operation and management of the gate and pumps would be triggered at lower elevations. Table 4.23 provides the FCU for each function by wetland subclass for alternative 3.2. Impacts, as expressed by changes in FCU, associated with alternative 3.2 as compared to the no-action alternative (alternative 1) are given in Table 4.24. A summary of direct and indirect impacts to each specific function within each wetland subclass can be found in Appendix E, Part 4.

Table 4.23. Alternative 3.2 FCU in the New Madrid Floodway.

Vegetation Class	Farmed		Forested					WRP			
HGM Subclass	LGRB	Flat	LGRB	LGRO	Flat	CD	UCD	LGRB	Flat	CD	UCD
Acreage	171	135	4,091	1,163	3,253	191	109	333	262	95	75
Function	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	34	N/A	2,655	919	N/A	84	N/A	160	N/A	16	N/A
Detain Precipitation	92	47	3,921	675	2,635	N/A	N/A	310	186	N/A	N/A
Cycle Nutrients	41	26	3,349	989	2,765	111	83	240	176	40	40
Export Organic Carbon	26	N/A	2,410	884	N/A	94	N/A	193	N/A	31	N/A
Maintain Plant Communities	0	0	3,471	907	2,960	78	94	236	178	11	29
Fish and Wildlife Habitat	0	0	2,900	698	2,375	90	66	83	63	12	7

N/A - Not Applicable

Table 4.24. Alternative 3.2 FCU impacts in the New Madrid Floodway.

Impacts	Losses in FCU			Gains In FCU	
HGM Subclass	LGRB	LGRO	CD	Flats	UCD
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	-4,046	-35	-95	N/A	N/A
Detain Precipitation	-3,520	0	N/A	2,868	N/A
Cycle Nutrients	-3,116	0	-104	2,966	123
Export Organic Carbon	-4,102	-35	-115	N/A	N/A
Maintain Plant Communities	-3,574	-70	-138	3,138	123
Fish and Wildlife Habitat	-2,830	-35	-94	2,438	73

N/A - Not Applicable

4.8.1.7 Alternative 4

St. Johns Bayou Basin

There are no changes to impacts that were previously described for alternative 3.1 for the St. Johns Bayou Basin.

New Madrid Floodway – Alternative 4.1

A total of 9 acres of LGRB vegetated wetlands would be directly impacted due to the installation of the closure structure detailed in Section 2 and would assumed to lose all wetland function. However, alternative 4 would not manage flood risk below an elevation of 290. Therefore, alternative 4 would maintain a greater area connected to the Mississippi River. Similar to alternative 3.1 (although decreased), indirect impacts associated with changes in both flood frequency and flood duration would affect multiple functions, including functional decreases within subclasses and changes in wetland subclass. Hence, functional gains would occur for unconnected types. Table 4.25 provides the FCU for each function by wetland subclass for alternative 4.1. Impacts, as expressed by changes in FCU, associated with alternative 4.1 as compared to the no-action alternative (alternative 1) are given in Table 4.26. A summary of direct and indirect impacts to each specific function within each wetland subclass can be found in Appendix E, Part 4.

Table 4.25. Alternative 4.1 FCU in the New Madrid Floodway.

Vegetation Class	Farmed		Forested					WRP			
HGM Subclass	LGRB	Flat	LGRB	LGRO	Flat	CD	UCD	LGRB	Flat	CD	UCD
Acreage	217	89	5,194	1,163	2,150	191	109	422	173	121	49
Function	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	33	N/A	3,735	768	N/A	78	N/A	203	N/A	21	N/A
Detain Precipitation	117	31	4,980	675	1,677	N/A	N/A	393	123	N/A	N/A
Cycle Nutrients	52	17	4,357	989	1,871	111	83	304	116	51	26
Export Organic Carbon	24	N/A	3,475	744	N/A	88	N/A	245	N/A	39	N/A
Maintain Plant Communities	0	0	4,772	977	1,957	101	94	321	118	19	19
Fish and Wildlife Habitat	0	0	3,994	721	1,505	94	67	110	42	17	4

N/A - Not Applicable

Table 4.26. Alternative 4.1 FCU impacts in the New Madrid Floodway.

Impacts	Losses in FCU			Gains In FCU	
HGM Subclass	LGRB	LGRO	CD	Flats	UCD
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	-2,914	-186	-96	N/A	N/A
Detain Precipitation	-2,350	0	N/A	1,831	N/A
Cycle Nutrients	-2,032	0	-93	2,003	109
Export Organic Carbon	-2,973	-174	-113	N/A	N/A
Maintain Plant Communities	-2,188	0	-108	2,074	113
Fish and Wildlife Habitat	-1,709	-12	-86	1,547	71

N/A – Not Applicable

New Madrid Floodway - Alternative 4.2

The gate and pump would be identically installed and operated for alternative 4.2 as is described in alternative 4.1. However, alternative 4.2 would reforest all agricultural lands at and below an elevation of 290. Indirect impacts associated with changes in both flood frequency and flood duration would affect multiple functions, including functional decreases within subclasses and changes in wetland subclass. Wetland gains for this alternative did not assume any microtopographic restoration or site specific hydrologic restoration/improvements. Therefore, gains could be much greater to some functions in the event of restored microtopographic features. Although alternative 4.2 results in gains to LGRB and CD subclasses, a shift would still occur in wetland subclass for areas above an elevation of 290 feet. However, the gains attributed to reforestation would outweigh any impacts as a result of the shift. Therefore, a net wetland benefit would accrue to LGRB and CD subclasses and a limited impact would occur to the LGRO subclass. Table 4.27 provides the FCU for each function by wetland subclass for alternative 4.1. Impacts, as expressed by changes in FCU, associated with alternative 4.1 as compared to the no-action alternative (alternative 1) are given in Table 4.28. A summary of direct and indirect impacts to each specific function within each wetland subclass can be found in Appendix E, Part 4.

Table 4.27. Alternative 4.2 FCU in the New Madrid Floodway.

Vegetation Class	Farmed		Forested					WRP			
HGM Subclass	LGRB	Flat	LGRB	LGRO	Flat	CD	UCD	LGRB	Flat	CD	UCD
Acreage	217	89	18,014	1,163	2,150	2,091	109	422	173	121	49
Function	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	33	N/A	9,889	768	N/A	401	N/A	203	N/A	21	N/A
Detain Precipitation	117	31	16,903	675	1,677	N/A	N/A	393	123	N/A	N/A
Cycle Nutrients	52	17	13,587	989	1,871	909	83	304	116	51	26
Export Organic Carbon	24	N/A	10,911	744	N/A	696	N/A	245	N/A	39	N/A
Maintain Plant Communities	0	0	14,515	977	1,957	405	94	321	118	19	19
Fish and Wildlife Habitat	0	0	11,558	721	1,505	360	67	110	42	17	4

N/A - Not Applicable

Table 4.28. Alternative 4.2 FCU impacts in the New Madrid Floodway.

Impacts	Losses in FCU			Gains In FCU	
HGM Subclass	LGRB	LGRO	CD	Flats	UCD
Function	FCU	FCU	FCU	FCU	FCU
Detain Floodwater	35	-186	132	N/A	N/A
Detain Precipitation	2,650	0	N/A	1,831	N/A
Cycle Nutrients	4,122	0	496	2,003	109
Export Organic Carbon	2,027	-174	400	N/A	N/A
Maintain Plant Communities	7,555	0	196	2,074	113
Fish and Wildlife Habitat	5,855	-12	180	1,547	71

N/A - Not Applicable

4.8.1.8 Jurisdictional wetlands

In an effort to account for impacts to wetlands as a result of project implementation, USACE utilized a holistic approach which considered impacts on a watershed level, addressing both direct and indirect impacts, regardless of jurisdictional status. The result of this approach led to the conservative conclusion that all naturally vegetated land located within the five-year floodplain of the future without-project (which includes projected WRP gains) stage area curve (16,249.4 acres) would be considered wetlands for the purposes of impact analysis. As previously stated, direct impacts resulting from project implementation are relatively small, totaling 409 acres in the St. Johns Bayou Basin and 9 acres in the New Madrid Floodway, respectively. However, indirect impacts, resulting from reduced flood frequencies in both basins (but especially in the New Madrid Floodway as the St. Johns Bayou Basin already contains a closure structure), remains the critical aspect to wetland impacts when compared to the direct impacts.

Despite the conservative assumption that all vegetated lands located within the future five-year floodplain are wetlands, USACE ensured losses to federally regulated jurisdictional wetlands would be compensated. The project will impact hydrology from impounded interior runoff and backwater flooding. To determine the presence of jurisdictional wetland hydrologic requirements, which provide evidence that a site has a continuing wetland hydrologic regime and that hydric soils and associated vegetation are not relicts of past hydrologic regimes, USACE utilized the program WETSORT to process many years of water surface elevation data according to the NRCS method. Since flooding varies randomly from year to year, the annual wetland elevation varies randomly also. WETSORT facilitates the identification of a median wetland elevation determined from a multi-year analysis period. Note that WETSORT is only used to analyze surface water, not shallow groundwater or topsoil moisture. The median wetland elevation is considered representative for characterizing the long-term average wetland elevation at a site. For the purposes of this analysis, in accordance with the *Regional Supplement*, the hydrologic standard was set at 14 days of consecutive inundation. The WETSORT results indicate that a total of 7,268.2 acres of naturally vegetated lands meet the wetland hydrologic requirement, considerably less than the 16,249.4 acres considered wetlands for impact analysis by USACE.

The project will result in a net gain to jurisdictional wetland acreages and functions as a result of compensatory mitigation. Prior converted croplands are not wetlands according to the Clean Water Act and rules adopted by USACE and EPA. Project mitigation will result in restoring wetlands on approximately 2,200 acres and 7,000 acres in the St. Johns Bayou and New Madrid Floodway, respectively. It is anticipated that the majority of these areas will be jurisdictional wetlands once mitigation becomes established. The Section 404(b)(1) Evaluation Report is located in Appendix E, Part 5.

4.8.2 Terrestrial Wildlife

The Habitat Evaluation Procedures (HEP), USFWS (1980), were used to evaluate direct impacts of the St. Johns Bayou Basin and New Madrid Floodway Project on terrestrial wildlife habitat (Appendix O). The HEP is an accounting system for quantifying wildlife habitat value for impact assessment and project planning using Habitat Suitability Indices (HSI) and area (*i.e.*, acres) of available habitat. HSI models use measurements of appropriate variables to rate the habitat on a scale of zero (unsuitable) to 1.0 (optimal) (http://www.nwrc.usgs.gov/wdb/pub/hsi/hsiindex.htm). Habitat units (HU) are the basic unit of HEP to measure project effects on fish and wildlife and are calculated by multiplying the evaluation species HSI and the acreage of available habitat for a given target year. Changes in habitat quality (HSI) and quantity (i.e., acreages) are predicted for selected target years over the period of analysis for future without-project and future with-project conditions. Those values are then annualized over the period of analysis for the project, providing average annual habitat units (AAHU) for each of the modeled species. The difference in AAHU under future with-project conditions versus future without-project conditions provides a quantitative measure of project impacts. A decrease in AAHU indicates the project would negatively affect the evaluation species; whereas, an increase in AAHU indicates the project would benefit the evaluation species.

A subgroup of the interagency team (IAT) was utilized to guide the evaluation, monitor progress, approve assumptions and intermediate results, and make changes in direction, if needed. The subgroup, composed of biologists from USACE, USFWS, and MDC, selected eight HEP evaluation species to represent the terrestrial wildlife community utilizing three distinct habitat types in the project area: bottomland hardwood (i.e., large bottomland hardwood tracts), riparian ditchbank, and marsh-scrub/shrub. Although agricultural area is the dominant habitat found in the project area, it is not considered a limiting factor in terms of terrestrial wildlife value. Therefore, it was not analyzed. The evaluation species for bottomland hardwood and riparian ditchbank habitats included the fox squirrel (*Sciurus niger*), barred owl (*Stix varia*), Carolina chickadee (*Parus carolinensis*), pileated woodpecker (*Dryocopus pileatus*), and mink (*Mustela vison*). The evaluation species used for marsh or scrub/shrub habitats included red-winged blackbird (*Agelaius phoeniceus*), great blue heron (*Ardea herodias*), and muskrat (*Ondatra zibethicus*). Published HSI models were used for the fox squirrel (Allen, 1982), barred owl (Allen, 1987), pileated woodpecker (Schroeder, 1983a), mink (Allen, 1986), red-winged blackbird (Short, 1985), great blue heron (Short and Cooper, 1985), and muskrat (Allen and Hoffman, 1984). The model for the Carolina chickadee was previously developed by USFWS for projects in the region and was based on an existing model for the Black-Capped Chickadee (*Parus atricapillus*; Schroder, 1983b). Each of the evaluation species represented a guild, meaning a group of species utilizing a common environmental resource; thus, habitat changes to any one of the evaluation species would be representative of all the species within that particular guild. For example, fox squirrel, barred owl, Carolina chickadee, pileated woodpecker, and mink would also represent amphibians and reptiles normally associated with riparian ditchbank and bottomland hardwood habitats. Likewise, red-winged blackbird, great blue heron, and mink would also represent amphibians and reptiles normally associated with marsh or scrub/shrub habitats. Additional hydrologic impacts associated with the proposed project were addressed with other habitat models discussed in the draft EIS (e.g., wetlands, waterfowl, shorebirds, and fisheries).

Habitat variables were measured according to the eight selected HSI models on 12 bottomland hardwood forest plots, 12 riparian ditchbank plots, and 6 marsh scrub/shrub plots in the project area. Plot locations and sample size were selected by replication of previous studies when possible, and percentage of land cover type within each basin in relation to total area. Each plot was 0.2 acres in area (although some variables required obtaining data from a larger area) as determined through IAT coordination. A description of each habitat type can be found in Appendix O.

HSI scores for the three habitat types and changes in habitat type quantity were projected over the 50-year project life for future with- and future without-project conditions for both St. Johns Bayou Basin and New Madrid Floodway.

4.8.2.1 Alternative 1 – No Action

HSI scores of the impact areas were assumed to be the same over the 50-year project life for the no action project scenario. In reality, some of this riparian habitat would be cleared for maintenance purposes while other areas would continue to mature. Additionally, some areas could be harvested for timber/pulp production in the future. Due to the uncertainty of future actions, the HEP team used an unchanged overall condition in these impact areas for the without-project scenario.

4.8.2.2 Alternatives 2.1 and 2.2

St. Johns Bayou Basin

Alternative 2.1 consists of managing flood risks in the St. Johns Bayou Basin only. Approximately 673 acres of riparian ditchbank habitat would be impacted from the clearing and associated channel work in St. Johns Bayou, Setback Levee Ditch, and St. James Ditch for the authorized project alternative resulting in an impact to 1,262.73 AAHU in the St. Johns Bayou Basin (Table 4.29).

New Madrid Floodway

Alternative 2.2 would close the 1,500-foot levee gap and the footprint would be approximately 9 acres, resulting in an impact to 16.88 AAHUs in the New Madrid Floodway (Table 4.30).

4.8.2.3 Alternative 2.3

Alternative 2.3 combines Alternatives 2.1 and 2.2.

4.8.2.4 Alternatives 3.1 and 3.2

St. Johns Bayou Basin

The Avoid and Minimize Project Alternative would impact approximately 409 acres of riparian ditchbank habitat from the clearing and associated channel work in St. Johns Bayou, Setback Levee Ditch, and St. James Ditch, resulting in the impact to 765.65 AAHUs in the St. Johns Bayou Basin (Table 4.29).

New Madrid Floodway

Both the Authorized Project Alternative and the Avoid and Minimize Project Alternative would impact riparian ditchbank habitat due to construction of the New Madrid Floodway levee closure, resulting in an impact to 16.88 AAHUs in the New Madrid Floodway (Table 4.30)

Table 4.29. Average annual habitat units impacted by the authorized project alternative and the avoid and minimize project alternative due to construction in the St. Johns Bayou Basin.

Habitat Type	Alternative 2.1	Alternatives 3.1 and 3.2
Riparian Ditchbank	-1,262.73	-765.65
Bottomland Hardwood Forest	0	0
Marsh or Scrub/shrub	0	0
Total	**-1,262.73**	**-765.65**

Table 4.30. Average annual habitat units impacted by the authorized project alternative and alternatives 3.1 and 3.2 due to construction in the New Madrid Floodway.

Habitat Type	Alternative 2.2	Alternatives 3.1 and 3.2
Riparian Ditchbank	-16.88	-16.88
Bottomland Hardwood Forest	0	0
Marsh or Scrub/shrub	0	0
Total	**-16.88**	**-16.88**

4.8.2.5 Alternatives 4.1 and 4.2

Alternatives 4.1 and 4.2 would provide no flood protection to lands located below an elevation of 290 feet in the New Madrid Floodway. However, alternative 4.2 would entail reforestation of all agricultural land below 290 feet. Alternative 4.1 would result in an impact of 16.88 AAHU, while the reforestation feature of alternative 4.2 would offer a gain of 12,040.51 AAHU (Table 4.31).

Table 4.31. Average annual habitat units impacted by alternatives 4.1 and 4.2 due to construction in the New Madrid Floodway.

Habitat Type	Alternative 4.1	Alternative 4.2
Riparian Ditchbank	-16.88	1,048.27
Bottomland Hardwood Forest	0	10,992.24
Marsh or Scrub/Shrub	0	0
Total	-16.88	12,040.51

4.8.2.6 Impacts to Herpetological Resources

As stated previously, each of the evaluation species was chosen to represent a guild of species; thus, habitat changes to any one of the evaluation species would be representative of all the species within that particular guild. Species chosen to represent riparian ditchbank, bottomland hardwood forest and scrub shrub habitat would also represent amphibians and reptiles normally associated with those habitats.

A subgroup (biologists from USFWS, MDC and USACE) of the IAT determined that no additional, readily available HSI models exist that are capable of capturing the effects of hydrologic changes to herpetological resources. A conclusion was reached that the species represented in the HEP model, coupled with the other ecological models (EnviroFish, HGM, waterfowl and shorebird), would adequately quantify hydrologic impacts to project area wildlife resources.

Although not quantified, predictions regarding amphibian and reptilian habitat post-project can be made. Dorcas et al. (2006) found that the change from a high-volume riverine system in Great Falls, SC, to the present system of periodically flooded and isolated aquatic systems has resulted in an apparent increase in species using lentic and ephemeral aquatic habitats and an apparent decrease in species that use lotic systems. Likewise, many species of amphibians that usually breed in isolated wetlands (e.g. *Ambystoma* sp.) would likely benefit from a reduced flood pulse as the introduction of aquatic predators, typically fish, flushing of eggs and larvae, and displacement of ground litter would be reduced (J. Jackson, personal communication; Battelle, 2011). However, species favoring lotic habitats such as watersnakes (*Nerodia* sp.) could see a reduction in range as flood frequencies are reduced post-project, and overall numbers are unlikely to decline.

4.8.3 Waterfowl

A waterfowl model was developed (Heitmeyer 2010a, hereafter "DUD Manual") to calculate potential impacts of the proposed project alternatives and water management scenarios using Duck-Use-Days (DUD). The waterfowl model has been approved for use in the Mississippi Alluvial Valley by USACE. Methods and formulas provided in the DUD Manual were used to determine energetic requirements of waterfowl and the availability of foods for various habitat types in SJNM. Results were annualized and considered through the 100-year floodplain (Appendix F, Part 1).

Data inputs to the DUD Manual for this analysis were:

- Elevations that correspond to contemporary three consecutive day flood recurrence zones (0.99, 0.5, 0.2, 0.1, 0.04, 0.02 and 0.01) were determined for November (Nov), December-January (Dec-Jan), and February-March (Feb-Mar) time periods for existing and alternative project conditions in the St. Johns Bayou Basin and New Madrid Floodway.[32] The data separation into Nov, Dec-Jan, and Feb-Mar categories covers the period of time when waterfowl are present in the St. Johns Bayou and New Madrid Floodway and consistently compare project alternatives relative to proposed project operation schedules.

- Acres of 11 habitat types within the above flood frequency zones, specified time periods, and St. Johns Bayou Basin and New Madrid Floodway areas were determined, and differences in available (flooded) habitat areas for the project alternatives were also determined. Habitat categories were: 1) Corn, 2) Rice, 3) Soybeans, 4) Fallow Cropland, 5) Cypress-Tupelo Forest (C-T), 6) Bottomland Hardwood Forest (BLH), 7) Floodplain/Riverfront Forest, 8) Grassland/Pasture, 9) Seasonal Herbaceous Wetland (SHW), 10) Open Water/Aquatic, and 11) Shrub/Scrub. Other land cover types in the SJNM include small amounts of developed lands (roads, residences, building sites, cities, etc.) and other agricultural lands including winter wheat and cotton. These land cover categories were not analyzed for DUD because they do not provide significant available waterfowl food sources (e.g., cotton, developed lands) or they do not require flooding for waterfowl use.

    - Forested areas were separated into three categories (C-T, Floodplain Forest, and BLH) based on historic and remnant presence of forested types within flood frequency zones of the St. Johns Bayou Basin and New Madrid Floodway (Table 4.32). Annualized contemporary flood frequency contour maps and potential historic vegetative community maps were used to separate relative distribution of forested types into the following percentages:

[32] Previous NEPA documents and waterfowl analyses only looked at shallowly flooded habitat. This analysis utilizes a three consecutive day return interval, regardless of water depth.

Table 4.32. Forested area (%) by cover type within flood frequency zones used for DUD analysis.

Flood Frequency Zone	Forest Area (%) by Type		
	C-T	Floodplain Forest	BLH
0.99	100	-	-
0.5	50	50	-
0.2	25	25	50
0.1	10	20	70
0.04	5	15	80
0.02	-	-	100
0.01	-	-	100

- Food and energy values for the 11 habitat types, by specified time period and flood frequency zone, were determined from the DUD Manual. These energy values were related to a daily existence energy (DEE) for a mallard (1 mallard DEE = 452.44 kcal/day) and divided by the number of acres affected by project alternatives to determine the potential DUDs/acre/specified time period/habitat type/flood frequency zone. Although there are multiple species of waterfowl present in the project area, the mallard was selected to standardize all of the habitat found in the project area for the following reasons:

  a) Mallards are common in the project area during migration periods.
  b) Mallards utilize a variety of habitat including bottomland hardwoods and inundated agricultural fields. Therefore, they utilize virtually all different types of habitat available to waterfowl in the project area.
  c) A large amount of scientific research has been conducted on the habitat requirements and foraging aspects of the mallard.

  The basic formula for calculating energy values is:

$$\textit{Species}_{1\ldots m}\textit{DUD} = \frac{\sum(F_{1..j})(T_{1\ldots l})}{D_{1\ldots m}}$$

  Where,

  F = the potential food yield (g/ha) for food types $_{1\ldots j}$ in the habitat type $_{1\ldots k}$
  T= TME (kcal/g) of specific food types $_{1\ldots l}$
  D= DEE of species $_{1\ldots m}$ in kcal/day and is 4x RMR
  RMR = $100.7W^{0.74}$
  And, W = weighted body mass of species $_{1\ldots m}$ in kg

DUD amounts for alternatives were calculated by habitat type, specified time period, three consecutive days of flooding recurrence interval, and St. Johns Bayou Basin and New Madrid Floodway areas. Differences (losses or gains) between existing conditions and the project alternatives were then calculated. For example, the three consecutive day flood return interval in the St. Johns Bayou Basin for the Feb-Mar time period decreased from 287.9 feet to 286.6 feet, which results in 610.2 acres of forested area being removed from the existing three consecutive day flood return interval. Using the acres lost in the three consecutive day flood return interval reduction and multiplying them by the DUD/acre provided in Appendix F, Part 2, a net change in DUD is generated. Table 4.33 is an excerpt from Appendix F, Part 2, which shows the net change in DUD in St. Johns Bayou Basin for selected Feb-Mar habitats.

Table 4.33. St. Johns Bayou Basin authorized project net change in DUD for February-March time period in selected habitats.

Recurrence Interval	Soybean	FOREST C-T	FOREST BLH	FOREST FF	SHM	OW-AG
0.99	0.00	0.00	0.00	0.00	0.00	0.00
0.5	-69,592.96	-32,430.10	0.00	-41,572.42	22,724.91	-1,885.18
0.2	-109,069.10	-17,606.08	-136,812.57	-22,566.31	-31,892.34	-6,150.02
0.01	-64,846.60	-2,879.87	-78,323.30	-7,382.03	-14,324.16	-2,563.57
0.04	-34,076.84	-459.11	-28,585.39	-1,772.38	-3,738.35	-595.62
0.02	-40,007.14	0.00	-34,131.73	0.00	-3,899.78	-529.65
0.01	-17,735.22	0.00	-32,050.87	0.00	-12,990.77	-291.65
TOTAL	-335,327.86	-53,375.16	-309,903.86	-73,293.14	-44,120.49	-12,015.69

4.8.3.1 Alternative 1 – No Action

Future projected increases in WRP acreage without the project would potentially add 852,459 DUD to the St. Johns Bayou Basin (Table 4.34). The gain in DUD is attributed to converting sub-optimal habitat (*e.g.*, soybean fields) to higher valued habitat (*e.g.*, bottomland hardwoods). Future projected increases in WRP acreage in the New Madrid Floodway without the project would potentially increase DUD by 793,826 (Table 4.35).

Table 4.34. Gains or losses (-) in DUD for alternative 1 in the St. Johns Bayou Basin for various month/time periods.

	November	December - January	February - March	Total
Existing	218,166.00	2,335,420.00	3,606,117.00	6,159,703.00
Alternative 1	225,541.00	2,658,221.00	4,128,400.00	7,012,162.00
Net Change	7,375.00	322,801.00	522,283.00	852,459.00

Table 4.35. Gains or losses (-) in DUD for alternative 1 in the New Madrid Floodway for various month/time periods.

	November	December - January	February - March	Total
Existing	132,310.00	5,299,733.00	8,069,675.00	13,501,718.00
Alternative 1	161,436.00	5,695,027.00	8,439,081.00	14,295,544.00
Net Change	29,126.00	395,294.00	369,406.00	793,826.00

4.8.3.2 Alternatives 2.1 and 2.2

St. Johns Bayou Basin

The St. Johns Bayou Basin currently has the potential to support about 6 million DUD, most of which occurs from December through March (Table 4.34). Alternative 2.1 would provide a net loss of in 117,186 DUD's (Table 4.36). However, during the December-January time period when the flood-control gates are closed and water is impounded behind the gates (when otherwise water would drain into the relative low stage Mississippi River), a large gain in flooded C-T, Floodplain Forest, and SHW in the 0.99 and 0.5 flood frequency zones results in a gain of 978,809 DUD. In contrast, operating the proposed pumps reduces impounded interior runoff in the February-March time period, which in turn reduces DUD by 995,104. The primary impacted DUD amount in Feb-Mar is caused by reduced flooding in BLH and soybean acreage in the 0.2 flood frequency zone.

Table 4.36. Gains or losses (-) in DUD for alternative 2.1 in the St. Johns Bayou Basin for various month/time periods.

	November	December - January	February - March	Total
Future Without	225,541.00	2,658,221.00	4,128,400.00	7,012,162.00
Alternative 2.1	124,650.00	3,637,030.00	3,133,296.00	6,894,976.00
Net Change	-100,891.00	978,809.00	-995,104.00	-117,186.00

New Madrid Floodway

Total existing DUD in the New Madrid Floodway are about 13.5 million (Table 4.35). The largest amounts of existing DUD are from soybean acreage in the 0.5, 0.2, and 0.1 flood frequency zones during Feb-Mar. While soybean land has low food availability compared to most other habitat types, the large total soybean acreage in the New Madrid Floodway ultimately contributes large amounts of DUD. Alternative 2.2 has little impacts to DUD in Nov, moderate impacts to DUD during Dec-Jan, and higher DUD impacts during Feb-Mar (Table 4.37). As seen in the St. Johns Bayou Basin (although not an overall net gain), management of water levels during the December–January time period is critical in reducing impacts to DUD.

Table 4.37. Gains or losses (-) in DUD for alternative 2.2 in the New Madrid Floodway for various month/time periods.

	November	December - January	February - March	Total
Future Without	161,436.00	5,695,027.00	8,439,081.00	14,295,544.00
Alternative 2.2	134,928.00	4,438,625.00	2,197,504.00	6,771,057.00
Net Change	-26,508.00	-1,256,402.00	-6,241,577.00	-7,524,487.00

4.8.3.3 Alternative 2.3

Alternative 2.3 combines the impacts of Alternatives 2.1 and 2.2.

4.8.3.4 Alternatives 3.1 and 3.2

St. Johns Bayou Basin

There are no changes to waterfowl impacts/benefits for the avoid and minimize scenario.

New Madrid Floodway

Both avoid and minimize scenarios reduce the impacts associated with waterfowl by maintaining a larger geographic area subject to flooding during the waterfowl migratory period. Compared to DUD impacts for Alternative 2.2, the avoid-and-minimize Alternatives 3.1 and 3.2 were 75 percent and 69 percent lower, respectively (Tables 4.38 and 4.39). When combined with alternative 2.1 for the St. Johns Bayou Basin, alternatives 3.1 and 3.2 would have relatively low and similar impacts in DUD during November, net DUD gains in December-January, but would have impacts during February-March when flood-control gates would be closed to prevent backwater flooding from the Mississippi River into the New Madrid Floodway.

Table 4.38. Gains or losses (-) in DUD for alternative 3.1 in the New Madrid Floodway for various month/time periods.

	November	December - January	February - March	Total
Future Without	161,436.00	5,695,027.00	8,439,081.00	14,295,544.00
Alternative 3.1	219,026.00	7,071,781.00	5,148,295.00	12,439,102.00
Net Change	57,590.00	1,376,754.00	-3,290,786.00	-1,856,442.00

Table 4.39. Gains or losses (-) in DUD for alternative 3.2 in the New Madrid Floodway for various month/time periods.

	November	December - January	February - March	Total
Future Without	161,436.00	5,695,027.00	8,439,081.00	14,295,544.00
Alternative 3.2	219,040.00	7,071,781.00	4,699,830.00	11,990,651.00
Net Change	57,604.00	1,376,754.00	-3,739,251.00	-2,304,893.00

4.8.3.5 Alternatives 4.1 and 4.2

St. Johns Bayou Basin

There are no changes to waterfowl impacts/benefits for alternatives 4.1 and 4.2.

New Madrid Floodway

Alternatives 4.1 and 4.2 would provide no flood protection to lands located below an elevation of 290 feet. However, alternative 4.2 entails reforestation of all agricultural land below 290 feet. Implementation of alternative 4.1 yields similar results to DUD as seen in alternative 3.1, with gains in November and December-January and losses in February-March (Table 4.40). The reforestation feature of alternative 4.2 would provide considerable DUD gains for all time periods (Table 4.41).

Table 4.40. Gains or losses (-) in duck-use-days for Alternative 4.1 in the New Madrid Floodway for various month/time periods.

	November	December - January	February - March	Total
Future Without	161,436.00	5,695,027.00	8,439,081.00	14,295,544.00
Alternative 4.1	219,584.00	6,925,773.00	5,711,365.00	12,856,722.00
Net Change	58,148.00	1,230,746.00	-2,727,716.00	-1,438,822.00

Table 4.41. Gains or losses (-) in duck-use-days for Alternative 4.2 in the New Madrid Floodway for various month/time periods.

	November	December - January	February - March	Total
Future Without	161,436.00	5,695,027.00	8,439,081.00	14,295,544.00
Alternative 4.2	220,789.00	9,958,377.00	9,843,622.00	20,022,788.00
Net Change	59,353.00	4,263,350.00	1,404,541.00	5,727,244.00

4.8.4 Shorebirds

Shorebird analysis is included as Appendix H, Part 1. The shorebird model developed to determine impacts associated with the project has been approved for use by USACE. In summary, the area of investigation included 312,155 acres in the St. Johns Bayou Basin and 117,795 acres in the New Madrid Floodway that could be affected by the project. Greater than 80 percent of land cover in these basins is cropland, pasture, or other sparse vegetation that if shallowly inundated would provide habitat conditions suitable for foraging shorebirds.

All lands with tall or dense vegetation (e.g., forest or shrubs) and permanent water are considered unsuitable for shorebirds. Conversely, agricultural cropland, grassland, and other open land are suitable shorebird habitat when appropriately inundated. Initial land cover classifications within the St. Johns Bayou Basin and New Madrid Floodway were obtained from 30-m resolution, 2001 National Land Cover Data (Homer et al. 2007) and underwent verification by comparing to recent aerial imagery and conducting site visits to the project area (See Section 3.3). Adjustments were made to future land cover based on assumptions regarding WRP enrollment in both basins (See Section 4.3 and Appendix M, Part 1). It was assumed that 10 percent of the total WRP enrolled would be added each year for 10 years. Thereafter, land use remained constant. Land cover data was converted to a binary depiction of suitable or non-suitable land cover for foraging shorebirds. Only areas within the St. Johns Bayou Basin and New Madrid Floodway that had land cover suitable for shorebirds during 2007 were considered when estimating areas of potential foraging habitat.

Project area elevations were obtained (See Section 3.1). Although a one-foot elevation contour was suitable for the majority of other resource categories, shorebird analysis required finer resolution. Therefore, 0.10-foot contours were interpolated between the previously established one-foot contours. Further discussion regarding the GIS applications utilized for this effort is included in Appendix M, Parts 3 and 4 as well as the shorebird appendix (Appendix H, Part 1).

Because most shorebirds rarely forage in dry habitats, only areas that were inundated or recently exposed from inundation (i.e., mudflats) were assumed suitable for use by foraging shorebirds. However, based on differential habitat use reported by Davis (1996), only habitats that were shallowly flooded with ≤ 0.2 ft of water were assumed to be optimal foraging conditions and were assigned maximum habitat suitability (suitability index (SI) = 1.0). Suitability of habitats flooded at greater depths, up to 0.5 ft, was assumed inversely related to water depth. Therefore, reduced SI scores were assigned to flood depths 2.4 – 3.6 inches (SI = 0.8), 3.6 – 4.8 inches (SI = 0.7), and 4.8 – 6.0 inches (SI = 0.6). Similarly, because of relatively less use of mudflats by foraging shorebirds (Davis 1996), presumed spatial heterogeneity in habitat conditions, and uncertainty regarding the temporal stability of exposed mudflats due to variation in drainage and rates of evapo-transpiration, mudflats were assumed less than optimal for most foraging shorebird species. Therefore, suitability of mudflats was inversely weighted relative to length of exposure after inundation as: exposed 1 day (SI = 0.6), exposed 2 days (SI = 0.5), and exposed 3 days (SI = 0.4).

Within each river basin, for the shorebird period extending from 15 March through 30 October, reported daily elevations from 1943-2009 were used to estimate the area of landcover suitable for foraging shorebirds that was inundated with ≤6.0 inches of water within 1.2 inch intervals. Concurrently, inundations associated with reported elevations were projected for each of the previous 3 days. The total daily area of potential shorebird habitat with suitable land cover within the St. Johns Bayou Basin and New Madrid Floodway was the combined areas of inundation ≤6.0 inches in depth and mudflats exposed within the previous 3 days. For each day, this sum represents the total area (i.e., footprint) available to shorebirds for foraging.

As not all of the area available to shorebirds was considered optimal for foraging, the area of presumed suitable shorebird foraging habitat within each flood-depth interval was weighted by its depth-specified SI score. The area of presumed suitable shorebird foraging habitat exposed as mudflats was weighted relative to SI scores associated with length of exposure (1, 2, or 3 days) after prior inundation. The daily sum of these appropriately weighted foraging areas represented habitat suitability adjusted for presumed foraging quality such that it provided a measure of ‘optimal’ habitat equivalence.

The quantitative distribution of shorebirds within spring and fall migration periods is not uniform, as fewer birds are present at the beginning and end of each migration period. Using temporal distribution data for small and medium shorebirds within 35^o – 40^o north latitude in North America provided by Skagen et al. (1999), abundance was modeled as a function of time (day) within each migration period. Assuming the greatest benefit occurs when the greatest abundance of shorebirds have access to suitable foraging habitat, a maximum weight (w = 1.0) was assigned to those days (April 24 – May 23) wherein 50 percent of the population was predicted to be present. For those remaining days (April 3 – June 8) of each migration period that harbored a predicted 90 percent of the population, weight was reduced to 90 percent of maximum (w = 0.9). For all other days (March 15 – June 15), during which only 10 percent of the shorebird population was predicted to be present, the weight was reduced to 50 percent of maximum (w = 0.5). Using these weights, the daily measure of 'optimal' shorebird foraging habitat equivalence, previously estimated from suitability of flood conditions in areas of suitable land-cover, was modified to reflect temporal availability of habitat within each migration period.

4.8.4.1 Alternative 1 – No Action

Due to assumed gains in WRP, slight decreases in available optimal shorebird habitat result from alternative 1. Model output results are summarized in Table 4.42.

Table 4.42. Future without-project area (acres) of optimally equivalent shorebird habitat during spring and fall migration periods.

	St. Johns Bayou Basin		New Madrid Floodway	
Condition	Spring	Fall	Spring	Fall
Existing	410.12	16.46	886.85	26.84
Future Without	370.67	14.42	864.96	24.10

4.8.4.2 Alternatives 2.1 and 2.2

For both basins, adherence to water management conditions would reduce the amount of potential habitat that is suitable for shorebirds. The authorized project would likely reduce the availability of potential optimal shorebird foraging habitat by 31 percent and 98 percent in the St. Johns Bayou Basin and New Madrid Floodway, respectively. The daily average optimal foraging habitat resulting from the authorized project within both basins would be less than 300 acres in spring and less than 9 acres in fall (Table 4.43).

Table 4.43. Authorized project area (acres) of optimally equivalent shorebird habitat during spring and fall migration periods.

	St. Johns Bayou Basin		New Madrid Floodway	
Condition	Spring	Fall	Spring	Fall
Future Without	370.67	14.42	864.96	24.10
Alt. 2.1/2	254.21	8.74	13.25	0.05

4.8.4.3 Alternative 2.3

Alternative 2.3 combines the impacts from Alternatives 2.1 and 2.2.

4.8.4.4 Alternatives 3.1 and 3.2

Avoid and minimize measures allow increased inundation in the New Madrid Floodway during critical shorebird migration periods. Although impacts of the project would reduce the availability of shorebird foraging habitat by 60 percent (Table 4.44), impacts are less than what is observed for authorized project conditions.

Table 4.44. Alternative 3.1 and 3.2 area (acres) of optimally equivalent shorebird habitat during spring and fall migration periods.

	St. Johns Bayou Basin		New Madrid Floodway	
Condition	Spring	Fall	Spring	Fall
Future Without	370.67	14.42	864.96	24.10
Alt. 3.1	254.21	8.74	250.29	0.71
Alt. 3.2	254.21	8.74	122.96	0.75

4.8.4.5 Alternatives 4.1 and 4.2

Alternative 4 (both 4.1 and 4.2) does not provide flood protection for lands located below an elevation of 290 feet. However, a significant reduction in impacts can be seen as only 35 percent of optimal shorebird habitat would be impacted (Table 4.45).

Table 4.45. Alternative 4 area (acres) of optimally equivalent shorebird habitat during spring and fall migration periods.

	St. Johns Bayou Basin		New Madrid Floodway	
Condition	Spring	Fall	Spring	Fall
Future Without	370.67	14.42	864.96	24.10
Alt. 4	254.21	8.74	541.91	24.90

No impacts to shorebirds were quantified as a result of reforestation measures associated with Alternative 4.2. Reforesting agricultural lands is considered an overall ecological benefit. Impacts were only quantified as a result of reduced flooding, not on a change in land use that was analyzed for environmental purposes.

4.8.4.6 Model Limitations

The model utilized to quantify shorebird habitat only quantifies *potential* habitat, not actual habitat. This is true with all HEP-based models (Battelle, 2011a). The habitat approach utilized by HEP and other ecological models (including this shorebird model) provides no assurances that any wildlife population would exist at the potential levels indicated by the model nor do they include the many environmental/behavioral variables that limit populations below the habitat potential (USFWS, 1980). Potential habitat likely far exceeds what the actual habitat requirement for shorebirds is in the project area during peak migration periods. There were no existing shorebird models that have been tested or validated that existed to be used to quantify project impacts. Therefore, the methods developed for this particular analysis are new and have not been validated.

The model itself is a simple model but requires specific expertise regarding model input such as topography, land use, and daily flood elevation data. Topographic data utilized for this effort included existing LiDAR data for the New Madrid Floodway and USGS DEM data for the St. Johns Bayou Basin. These two datasets represent the best available data. Likewise, landuse was obtained from available datasets and verified through aerial photography and site visits. Flood elevation data was obtained from the hydrologic and hydraulic model utilized for other environmental and economic analysis for the project. The current method provides the most reasonable estimate of potential shorebird habitat and quantifies differences as a result of project implementation.

There is not expert consensus regarding patch size, which quantifies thresholds for the minimum size of habitat that is considered suitable. Therefore, the model does not consider patch size. During the expert review of the model, a recommendation was made to include a landscape factor. However, previous review conducted by the IEPR panel stated that, although the concept is defensible, little (or no) data exists to justify specific minimum patch size. Inclusion of such a patch size parameter would not likely significantly affect the overall shorebird evaluation because the project area is composed primarily of large homogenous, unfragmented agricultural fields.

A period of record analysis was conducted to estimate future without-project conditions. Major large scale land use changes or structural changes that would affect the Lower Mississippi River hydrograph have not been identified. Adjustments to the river-stage data to reflect different future conditions are not anticipated to affect the comparison of the amount of shorebird habitat in the no action alternative and action alternatives. The model assumes stationarity: the Mississippi River hydrograph and precipitation are highly variable from year to year and would continue to do so under future conditions within the unchanging envelope of observed conditions in the period of record). Therefore, the model assumes future wet and dry years at the same frequency, duration, and seasonality as that observed from the period of record. Although the application of non-stationarity is an emerging topic in water resources applications, stationarity is considered accepted contemporary theory.

Since input data assumed stationarity, the model does not account for any future changes as it relates to climate change. However, the draft EIS (Section 4.20, Cumulative Impacts) discuses four (4) potential climate change scenarios that were evaluated to discern the potential impact of climate change on the project. Of these, only Scenario 1 "Wetter Spring" would likely affect the amount of available shorebird foraging habitat in the project area. Increased flood frequency could increase the availability of shorebird foraging habitat in the future without-project condition for St. Johns Bayou and the New Madrid Floodway (Alternative 1).

4.8.5 Fish

Killgore *et al.*,2012 stated that the reproductive cycles of most floodplain fishes are closely related to timing, spatial extent, and duration of flooding. Numerous fish species undergo regular migrations to use inundated floodplains for a variety of reproductive purposes such as spawning, short-term incubation of eggs, and eventually as nursery habitat for yolk-sac (non-feeding) larvae (Guillory, 1979; Ross and Baker, 1983; Finger and Stewart, 1987; Copp, 1989; Scott and Nielson, 1989). Once the yolk-sac is gone, larval fish join adults in using temporarily inundated floodplains and waterbodies as foraging habitat, especially for the small insects and zooplankton that are often the initial food items (Lietman *et al*, 1991). These early life history stages are often the limiting factor in population growth, and interannual variations in flooding regimes of rivers affect reproductive success and year-class strength of many species (Starrett, 1951; Guillory, 1979; Larson *et al.*, 1981; Zeug, 2005).

The ecological model *EnviroFish* (Killgore *et al.*, 2012) was used to quantify fish spawning and rearing habitat in the project area under future without-project conditions and each respective alternative. EnviroFish has been approved for impact determination by USACE. EnviroFish is a hydraulic model coupled to a spreadsheet that estimates acres of floodplain habitat suitable for fish reproduction under a given set of hydrologic and hydraulic conditions. Utilizing the results of the hydrologic model (*i.e.*, daily elevations), EnviroFish integrates the daily flood elevations, floodplain land use, and Habitat Suitability Indices (HSI) to calculate a response variable. The response variable is in the form of a Habitat Unit, and the Habitat Evaluation Procedure (USFWS, 1980) can be used to complete the analysis of project alternatives.

EnviroFish quantifies potential spawning and rearing habitat, and can compare changes in potential spawning and rearing habitat among alternative scenarios (Battelle, 2010b). Like all ecological models, it should not be confused with actual data obtained from real-time habitat.

Specific assumptions[33] used for the project that relate to the EnviroFish model are as follows:

1) Available floodplain habitat was quantified for future without-project and project alternatives. This habitat is defined as flooded areas available to species and individuals who spawn and rear on the floodplain but do not necessarily reside in the network of drainage ditches or isolated waterbodies found in the project area.

2) Spawning and rearing habitat was combined into one life stage. Therefore, separate spawning habitat and separate rearing habitat was not evaluated.

3) Many factors dictate the overall timing of the spawning and rearing period. Optimum conditions for spawning occur when the flood pulse and temperature are coupled (Junk *et al.*, 1989). Although there are multiple variables that dictate when fishes will actually spawn, an assumption in the model was that spawning and rearing would take place from 1 March to 30 June (Killgore et al 2012; Pflieger, 1997). To account for seasonality,[34] the spawning and rearing season was further refined into the following periods:

    a. Early Season = 1 March to 30 March
    b. Mid-Season = 1 April to 15 May
    c. Late Season = 16 May to 30 June

4) Depending on land use, the upper boundary of the functional floodplain was confined to the two-year flood frequency elevation for sub-optimal habitat (*i.e.* agricultural and fallow areas) and the five-year flood frequency elevation for optimal habitat (*i.e.,* bottomland hardwoods, marsh, and waterbodies).
5) Specific hydrologic requirements were as follows:

    a. Optimal Habitat – minimum depth = 0.0 feet and minimum duration = one day. Once hatched, rearing fishes (including yolk-sac and post yolk-sac larval phases) can potentially use any area of the inundated floodplain regardless of flood depth and duration (Killgore *et al,* 2012).

    b. Sub-optimal habitat – minimum depth = 1.0 feet and minimum duration = 8 consecutive days. Killgore *et al.* (2012) stated, a minimum water depth of one foot allows adults to access shallow, flooded areas, although a water depth less than one foot is not considered realistic due to physical limitations in the spawning process. Flood duration of at least eight consecutive days ensures that suitable time is allowed for nest construction and other spawning and rearing activities by the adults and recognizes that shorter durations may result in the eggs becoming stranded and desiccated

[33] The specific assumptions were developed with input from the project team, interagency team, and the independent external peer review panel.
[34] Seasonality is the months that encompass the reproductive period of most fishes and considers early, mid, and late-season spawners during this period.

if water recedes too quickly. The minimum one foot, eight-day duration rule is considered a conservative value to delineate spawning and rearing requirements for warmwater fish species found in the Mississippi River basin (Breder and Rosen, 1966; Carlander, 1969; Carlander, 1977; Becker, 1983; Robison and Buchanan, 1988). If the water recedes too rapidly off the floodplain, organic matter, nutrients, and newly hatched aquatic organisms may be carried into the river instead of remaining in the floodplain and permanent backwaters (Sparks, 1995). The one foot, eight-day rule guarantees an effective spawning and rearing window, emphasizes longer development times, and provides a margin for temporal variation in spawning activities (*i.e.*, adult movement onto the floodplain, nest construction, and guarding/dispersal of fry) (Killgore *et al*, 2012).

Based on the Phase 2 IEPR discussions, the justification for different hydrologic criteria based on land cover type is due to mortality and stranding factors on agricultural and fallow areas. These areas provide sub-optimal habitat and quickly drain in the project area as Mississippi River stages fall due to the vast network of drainage ditches and structures. Therefore, agricultural and fallow areas were required to be inundated for a minimum 8-day duration to be considered suitable spawning and rearing habitat.

6) Based on the Phase 2 IEPR recommendations, fishery analysis was split into two different zones regarding flood frequency elevation. Zone 1 was within the two-year flood frequency. Analysis was conducted on all habitat types (optimal and sub-optimal) utilizing the hydrologic criteria outlined above. Zone 2 (*i.e.*, areas that fall between the two-year and five-year frequency elevations) analysis was limited to “optimal habitat” (*i.e.*, waterbodies, marsh, and bottomland hardwoods). Sub-optimum habitat (*i.e.*, fallow, agricultural, and developed areas) was excluded from this zone.

   The justification for the different zones was based on the following:

   a. The floodplain nearest to the river provides immediate access to reproductive fishes undergoing spawning migrations. Fish would have to travel many miles from the main stem river to reach lands flooded above the two-year flood frequency elevation (Killgore *et al.*, 2012). Therefore, fish are less likely to use the sub-optimal areas at greater distances from the river due to the long distance required.

   b. Even if adults do move great distances to spawn, eggs deposited in cleared lands far removed from the main stem river have a greater risk of becoming trapped and or desiccated (Killgore *et al*, 2012). Rapid declines in water level increase the proportion of young fish stranded on the floodplain (Sparks, 1995).

c. The independent review conducted for the EnviroFish model recommended weighting between optimal and sub-optimal habitat. Battelle (2010b) stated the following:

i. In reality, a small area of high-quality habitat is likely to outperform a large number of low-quality habitat areas, even if they both have equal HU values. Disregarding this assumption would allow the potential for rationally choosing a project alternative that provides a lot of corn field stubble and not bottomland hardwood forest over one where bottomland hardwood forest is present in moderate amounts. Implementation of this assumption would allow the organization of the model output to maximize the highest quality habitat type.

ii. …EnviroFish should not allow the opportunity to increase lots of acreage of really poor habitat for an alternative or future situation without regard for the absolute acreage of very high quality habitat. It might be more appropriate to calculate total HUs using only habitats with HSIs greater than some minimum value, for example 0.4. The planning decisions would be based on changes from what is known to be fair/good habitat to other fair/good habitat because the value of HUs would be much more comparable. Other avenues to correct for very poor or very good habitat (e.g., weighting) should also be considered.

7) The stage-area curve was adjusted to account for Mississippi River connectivity within the New Madrid Floodway.

8) Habitat types were defined as follows:

a. Agriculture – all areas in which an agricultural product was grown.
b. Developed – roads and other developed areas.
c. Fallow – agricultural lands that have been abandoned where there is a prevalence of herbaceous (non-woody cover) vegetation.[35]
d. Bottomland Hardwoods – all forested areas.
e. Marsh – areas that remain inundated/saturated for long periods of time during the growing season that do not support woody vegetation. These areas usually go dry during late summer/early fall. These areas include herbaceous wetland complexes that are managed for waterfowl.

[35] Agricultural lands typically go fallow for a variety of reasons (*e.g.*, normal crop rotation, lease agreements, transfer in ownership) during some years and revert to agricultural production. The amount of fallow land in any given year is difficult to estimate. Due to the lack of any other available data, the model assumes the GIS data was used as a "constant" throughout the life of the project. Some lands were assumed to go fallow and revert to agriculture. Although the location of fallow lands would not be known, the overall acreages at certain elevations would be constant.

f. Waterbodies – areas that retain water for the majority of the year. These areas include borrow pits, floodplain lakes (*i.e.,* Riley Lake), oxbow lakes (*i.e.*, Hubbard Lake), and artificial lakes (*i.e.*, Big Oak Tree Lake). Some of these waterbodies may become dry during spring and fall. However, for the purpose of the model, they are classified as waterbodies, because they likely retain water throughout the spawning and rearing season.

9) The Habitat Suitability Indices were as follows:

a. Agriculture = 0.2
b. Developed = 0.2[36]
c. Fallow = 0.5
d. Bottomland Hardwoods = 1.0
e. Marsh = 1.0
f. Waterbodies = 1.0

Selected HSI values were coordinated with the EnviroFish model review team, the independent external peer review team, and the interagency team. The model certification review team recommended that selected HSI values be defensible and developed specifically to represent the habitats being assessed in the project area (Battelle, 2010b). The majority of species that spawn and rear in riverine floodplains, such as the project area, are pre-adapted to structurally complex habitats such as bottomland hardwoods. Therefore, cleared lands have less value as spawning and rearing habitat. The HSI values reflect this trend, with optimum conditions occurring for bottomland hardwoods, waterbodies, and marshes (HSI = 1.0); an intermediate value for fallow fields (HSI = 0.5); and the lowest value for cleared, agricultural lands (HSI = 0.2).

HSI values utilized for the project represent a community-level perspective on the biological response of warm water fishes to flooding in riverine systems. In most large floodplain river systems, this would encompass a very large assemblage of fish species. Characteristic fish species represented by this community-level model can be found in the EnviroFish manual. Species within a guild are assumed to share similar reproductive requirements. In this particular case, fish species in the Lower Mississippi River Valley (including the St. Johns Bayou Basin and New Madrid Floodway project area) are grouped on substrate used by spawning adults and characteristic habitat (*e.g.,* channel vs. floodplain) used by larvae for species that spawn and rear in floodplains. Also, these species prefer a variety of different substrates or structural conditions to deposit eggs or construct nests: vegetation, sand, and/or crevices. For these reasons, bottomland hardwoods, marshes, and waterbodies have optimum HSI values because of their habitat heterogeneity.
Therefore, the above values were presented in the Project Work Plan that underwent independent external peer review (*i.e.,* Phase 2 IEPR). During the

[36] Developed lands were not included in the Project Work Plan that underwent Phase 2 IEPR. The same HSI value as for agricultural lands was utilized due to the similarity with agricultural lands.

Phase 2 IPER, the panel agreed with the overall ranking based on the justification presented in the Work Plan. The panel supported a Delphi process to establish HSI values for the project since data is limited (Battelle, 2010).

USACE requested the interagency team follow the Delphi process to examine whether or not established HSI values need to be changed. Several teleconferences were conducted with the interagency team to determine whether a Delphi process was necessary or if concurrence could be reached on the proposed values. From the teleconferences, the interagency team determined to add marsh habitat as a land cover type, acknowledged that impacts to waterbodies would likely be over stated, and that the HSI values were acceptable.

10) The H+H period of record used was appropriate to describe future without-project hydrologic conditions as well as alternatives. The period of record was highly variable from year to year (*e.g.,* there were some drought years, flood years, and average years). This hydrologic variability is expected to continue under future without-project conditions. Conditions are not expected to be significantly different for the life of the project from the hydrologic and hydraulic data developed for the project.

11) Although changes in agricultural practices are likely with several alternative conditions (*i.e.,* conversion of soybeans to other more valuable crops based on risk minimization and market conditions), the only anticipated land use change would be a result of lands expected to be enrolled in the Wetland Reserve Program.

12) Several alternative conditions would result in hydrologic changes (*i.e.*, reduced frequency and duration of flooding) without any changes to land use.

4.8.5.1 Seasonally Inundated Floodplain Spawning and Rearing Habitat

Average daily flooded acres (ADFA) were quantified for each of the inundated floodplain spawning and rearing habitats (waterbodies were excluded) respective to the specific season (*i.e.,* early, mid, and late season). ADFA is a unit of measure of inundation. An ADFA is an area equivalent to one acre that is inundated on every day of a defined season of a year for a specified number of years. For example, if an acre and an adjoining acre (two real on the ground acres) were flooded for every day but in only half the specified number of years, the result would still be one ADFA.

The following paragraph is provided for further clarification. By looking at the New Madrid Floodway stage-area curve (Table 3.2) and comparing it to the New Madrid Floodway interior sump elevations for the period 6 March to 31 March 2008, there are 4,315.2 ADFA that occurred during this specific period (Table 4.46).[37]

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[37] This illustrative table assumes optimal habitat only, and, for simplicity, the interior elevations were rounded to the nearest foot prior to determining the associated daily inundated acreage.

This example occurred during a significant flood. EnviroFish was used to perform similar calculations that covered the stated fisheries seasons for the entire period of record 1943-2009, for each respective land cover type within each basin, and at year 0 (current land use) and year 50 (future land use with WRP enrollment). Therefore, the analysis included flood years and drought years over a long period of record. Thus, ADFA can be considered an "average" condition.

Table 4.46. Illustrative ADFA table, St. Johns Bayou Basin and New Madrid Floodway.

Date	Interior Elevation (feet)	BLH (acres)
06Mar2008	280.85	256.2
07Mar2008	283.37	529.5
08Mar2008	285.49	834.1
09Mar2008	286.87	2,348.9
10Mar2008	287.80	3,038.2
11Mar2008	288.20	3,038.2
12Mar2008	288.04	3,038.2
13Mar2008	287.85	3,038.2
14Mar2008	287.73	3,038.2
15Mar2008	287.73	3,038.2
16Mar2008	287.67	3,038.2
17Mar2008	287.73	3,038.2
18Mar2008	287.96	3,038.2
19Mar2008	289.11	3,720.9
20Mar2008	291.14	4,282.3
21Mar2008	292.94	4,545.7
22Mar2008	294.29	4,864.7
23Mar2008	295.47	5.030.0
24Mar2008	296.23	7,620
25Mar2008	296.84[1]	7,994.7
26Mar2008	297.05[1]	7,994.7
27Mar2008	297.05[1]	7,994.7
28Mar2008	296.82[1]	7,994.7
29Mar2008	296.40	7,620.5
30Mar2008	295.96	7,620.5
31Mar2008	295.48	5.030.0
AVERAGE		**4,315.2**

[1]The 5-year frequency elevation is 296.6 feet. These elevations are greater than the 5-year frequency elevation. The EnviroFish output did not include any flooded habitat suitable for spawning and rearing above the five-year frequency elevation.

4.8.5.2 Floodplain Waterbodies

Floodplain waterbodies contribute to the overall amount of floodplain habitat available for fish. They are important habitats because they support a major proportion of riverine fish fauna (Lubinski *et al.,* 2008). Fish find refuge in floodplain waterbodies, tributaries, or the main channel when flood waters recede (Junk *et al.,* 1989). Fish may reside in these waterbodies until subsequent floods re-connect them to the floodplain and or main channel. The analysis assumed that floodplain waterbodies would provide spawning and rearing habitat regardless of river conditions (*i.e.*, since waterbodies retain water independent of river conditions, fish would utilize them throughout the spawning and rearing season). Therefore, a separate analysis was required for other seasonally inundated lands that were analyzed using EnviroFish. Although a separate analysis was conducted due to limitations with EnviroFish, the value of habitat provided by waterbodies is comparable to other inundated floodplain habitat (agricultural lands, forest, etc.).

ADFA was not calculated for floodplain waterbodies because they were assumed to retain water for the duration of the spawning and rearing period. Therefore, ADFA would be equal to surface acres. Although isolated waterbodies can provide a diverse assemblage of fish, the flood pulse must connect them at some point to be of benefit to the remainder of the floodplain/Mississippi River fishery. As previously stated, the 5-year flood frequency elevation was considered the upper limit of the functional floodplain for impacts to riverine fish spawning and rearing habitat.

4.8.5.3 Fish Access

A major concern regarding the closure and construction of a gated structure such as the authorized project in the New Madrid Floodway is the potential impact to fish access. Few studies have been conducted on fish access through culverts, and those studies that have shown impacts are related to small road crossing culverts or located in geographically disparate regions. Most predictive models, such as described in Coffman (2005), are used to predict fish passage through small diameter culverts in the Mid-Atlantic Highlands region of the United States and may not be applicable to large culverts adjacent to the Mississippi River.

Typical characteristics of culverts that can restrict fish access include perched outlets, water velocities that exceed burst swimming speeds of fish, shallow depths that hamper swimming and access, and long distances between resting areas. None of these characteristics would exist for the proposed authorized culvert design in the New Madrid Floodway for the following reasons:

- Water would be flowing into the basin during many open-gate periods, so excessive water velocity would not be an impediment to movement during these periods. In addition, those fishes that were spawned or are rearing in the basin could be easily transported back to the river when water direction through the culvert is reversed during falling Mississippi River stages.
- There would be no outlet or inlet drop in elevation from the connecting channels.
- Culvert slope would be nearly level.
- A relatively short distance would be required for fish to access the backwater.
- Water depth would be equal to the river stage up to the 10-foot height of the culvert, which would be more than adequate for swimming fishes.

In fact, culverts are being designed and constructed for the purpose of promoting fish passage throughout the country. An example of culvert construction to promote fish passage exists along the Missouri River at the Missouri Department of Conservation Eagle Bluffs Conservation Area. These culverts are specifically operated to be opened to allow the Missouri River flood pulse (and fish) to inundate portions of the conservation area. Culverts are closed on a falling hydrograph to provide a nursery in which fish complete spawning and rearing requirements. Culverts are re-opened to facilitate the passage of adults and young-of-the-year back into the Missouri River after they complete spawning and rearing.

Another example of a culvert being designed to facilitate fish passage is the Rice Lake State Fish and Wildlife Area Habitat Rehabilitation and Enhancement Project (USACE, 2011) along the Illinois River. Although not for spawning and rearing purposes, the culverts are designed to promote fish passage to prevent fish kills during drawdown/overwinter conditions. The USFWS stated that this option involves the placement of two 5-foot diameter gated culverts between Rice Lake and the quarry pits of Duck Island as currently exists in the area. Fish are carried in by flood events along the Illinois River and become trapped in the shallow lake waters once the river recedes. Lake drawdowns frequently result in fish kills. The link the culverts would provide between the shallow manipulated waters of Rice Lake and the deeper permanent pool of the gravel pit would allow for both winter and summer refugia for the fish trapped within the marsh complex. Construction of a fish passage structure would permit fish to escape to the deeper waters of the quarry during the drawdown phase as well as overwinter in the quarry pits when the rest of the shallow lake waters are frozen (USFWS, 1997).

As a final example, The Nature Conservancy is installing culverts along the Illinois River at Emiquon Refuge. These culverts are designed to restore floodplain functions to an area protected by levees as an alternative to removing the levees, and the wetland restoration and environmental remediation value of these culverts has been widely commended as a success in both scientific and lay literature. It is anticipated that newly constructed culverts in the New Madrid Floodway would be assumed to obtain similar results and positive environmental benefits.

Fish passage was monitored through the existing St. Johns Bayou gravity outlet structure (see Appendix G). The results prove that fish move through the St. Johns Bayou gravity outlet structure. Fish clearly accessed the St. Johns Bayou Basin during periods when the culvert gates were open.

Since the proposed New Madrid Floodway culverts are of similar design to the existing St. Johns Bayou gravity outlet structure, results from the St. Johns Bayou fish access study (Appendix G) were used to make predictions regarding fish passage in the New Madrid Floodway. The fish access reduction coefficient (0.73 rather than 1.0) was calculated based upon the following:

- Information and conclusions from the fish access study:
    - 13 of the 14 (93 percent) species tagged moved upstream through the structure.
    - 100 fish were tagged with transmitters, 11 above the St. Johns structure and 89 below the structure at the confluence of the New Madrid Floodway (4 fish tagged below the structure immediately moved into the Mississippi River and never returned).
    - All 11 fish tagged above the St. Johns structure traveled through the culvert and exited the basin. Therefore, egress was 100 percent for the year 2010.
    - Of the 85 fish tagged below the structure that remained in the system, all accessed the Floodway at some time during the study. Therefore, ingress was 100 percent for the year 2010 in the Floodway. These fish were tagged at the confluence of the Mud Ditch and St. Johns Bayou Basin. Therefore, due to the close proximity of the tag location to the Floodway, a conclusion that 100 percent ingress occurred would be an overstatement.
    - Of the 85 fish tagged below the structure, 29 accessed the St. Johns Bayou Basin through the structure. Therefore, ingress into St. Johns Bayou Basin was 34 percent.
    - The St. Johns Bayou outlet structure was closed 34 percent of the time when fish tagging began (14 April) to the end of the pre-defined spawning season (30 June) in 2010 (an assumption was that the gravity outlet structure was closed when New Madrid Mississippi River gage was above 29 feet).
- Fish can access the floodplain by travelling through a 10-foot by 10-foot box culvert as currently exists in the St. Johns Bayou Basin and proposed in the New Madrid Floodway while they are open. Fish could not obtain access when the gates were closed during flood events).
- Once fish access the floodplain through a culvert, the value of available habitat follows the constraints outlined by EnviroFish (*e.g.,* 5-year or 2-year floodplain, spawning and rearing hydrologic criteria, etc.).
- Based on the 2010 fish access study:
    - assume egress is 1.0
    - assume individual-level ingress is 0.52 (0.34 weighted by gate opening (66 percent))
    - assume species-level ingress is 0.93
    - Therefore, the fish access coefficient is 0.73
    - Fish Access Coefficient = $\frac{\text{(Individual ingress + Species ingress)}}{2}$

$$= (0.52 + 0.93)/2 = 0.73$$

Based on the fish surveys conducted in the St. Johns Bayou, many species and individuals have been found upstream of the culvert, particularly during the flood season when ample space and food are available to sustain high densities of fish. These fish are not likely permanent residents of St. Johns Bayou, because limited area remains once the floodwaters recede from St. Johns Bayou and other streams in the basin become small, shallow, and often hypoxic due to the non-flowing conditions. Most riverine fishes have evolved to access floodplains during high water and move out as floodwaters recede. In addition, even if some fish do not make it through the culvert prior to closure, most warm water fishes are adapted to fluctuating environmental conditions, flexible spawning behaviors, and have high reproductive potential to compensate (Sparks, 1995, Junk *et al*, 1989). Therefore, not all individuals need to access the Floodway to maintain sustainable populations considering the extent of inundation below the structure and in other near-by areas of the batture. Thus, it can be argued that those fish unable or unwilling to move through the culverts can spawn elsewhere and the fish access reduction coefficient is unnecessary. While individual reproductive success does not necessarily equate to population maintenance, self-sustaining populations in the Mississippi River are dependent on multiple factors. For most species, however, recruitment of young-of-year is often the bottleneck for population maintenance. For this reason, EnviroFish focuses on these sensitive life stages (spawning and rearing).

Arguments could be made that the fish access coefficient should be lower, suggesting that most fish would not pass through a large, concrete structure. This argument, however, ignores the conclusions of the fish access study. Culverts in the St. Johns Bayou Basin are not currently managed in any fashion for fish access; they are closed whenever the river elevation is greater than the interior sump elevation. During the fish access study, the gates were closed 34 percent of the spawning and rearing season, but fish passage events were documented numerous times. The proposed New Madrid Floodway culverts under the Avoid and Minimize alternatives would be operated to maintain a higher level of river connectivity than currently exists in the St. Johns Bayou Basin. Therefore, a strong argument can be made that a fish access coefficient for alternatives in the New Madrid Floodway should be greater than 0.73.

As an environmentally conservative assumption, the fish access coefficient was used to reduce the total amount of available habitat within the St. Johns Bayou Basin and the New Madrid Floodway (post-project) by 27 percent. The coefficient of 0.73 is based on recently observed conditions for a combination of individual and species level passage in the St. Johns Bayou Basin. Due to high water during part of the assessment period when the gate was closed, and low water during the late season period when there was not adequate water through the culvert to facilitate fish passage, all three seasons could not be evaluated. Therefore, a decision was made to develop one access coefficient that represented 95% of the species that could potentially move through the structure (based on the guild in Appendix G) realizing that season, water temperature, and river stage have contributing effects. USACE is not aware of any other studies that have been conducted in the immediate project area, on culverts that are the same exact dimensions as those proposed, and that utilized state of the art technology to monitor fish passage.

Monitoring fish passage after the project is completed would provide additional information to possibly refine access coefficients.

4.8.5.4 Impact Quantification

The following formula was used to quantify potential fish spawning and rearing habitat:

$$HU = Area \times HSI$$

- HU = Habitat Units
- Area = ADFA for seasonally inundated floodplain habitat or surface acres for floodplain waterbodies
- HSI = Habitat Suitability Index
    - Agriculture = 0.2
    - Developed = 0.2
    - Fallow = 0.5
    - Bottomland Hardwoods = 1.0
    - Marsh = 1.0
    - Waterbodies = 1.0

Habitat units were quantified for Year 0 in the St. Johns Bayou Basin and New Madrid Floodway for the early , mid, and late season fisheries. The units were quantified by multiplying ADFA by the HSI value for seasonally inundated floodplain habitat and surface acres by the HSI value for floodplain waterbodies. This process was repeated for Year 50 to account for future WRP enrollment. An Average Annual Habitat Unit (AAHU) was calculated by the following formula:

$$AAHU = \frac{HU_{Year\ 0} + HU_{Year\ 50}}{2}$$

Project impacts were calculated by the following formulas:

St. Johns Bayou Basin Project Impacts
= (AAHU Future Without-Project x Fish Access Coefficient)
– (AAHU Future With-Project x Fish Access Coefficient)

New Madrid Floodway Project Impacts
= (AAHU Future without Project AAHU)
- (AAHU Future with Project x Fish Access Coefficient)

Table 4.47 provides the overall results of the EnviroFish application for the St. Johns Bayou Basin and New Madrid Floodway. Further details regarding the overall application is found in the Fisheries Appendix (Appendix G).

Table 4.47. Impacts (AAHU) to potential fish spawning and rearing habitat, St. Johns Bayou Basin and New Madrid Floodway.

Basin	Alternative	Early-Season	Mid-Season	Late Season
St. Johns Bayou	2.1	386.6	441.3	245.3
New Madrid Floodway	2.2	2,756.1	2,794.1	1,351.8
New Madrid Floodway	3.1	1,729.5	2,061.1	1,165.8
New Madrid Floodway	3.2	2,024.7	2,340.1	1,218.8
New Madrid Floodway	4.1	1,520.8	1,492.5	720.1
New Madrid Floodway	4.2	122.8	-89.9	30.8

4.8.5.5 Alternative 1 – No Action

St. Johns Bayou Basin

The St. Johns Bayou gravity control structure would be operated as it has since its completion in 1953. Gates would be closed whenever the river elevation is greater than the interior sump elevation. Therefore, Mississippi River backwater flooding is prevented. However, impounded interior runoff would continue. Fish access through the culverts, as observed in the flood of 2010, would be expected to continue. Table 4.48 provides the inundated acreage as well as the associated potential fish spawning and rearing habitat value under future without project conditions as assumed WRP enrollment is considered.

Table 4.48. Potential fish spawning and rearing habitat and AAHU for alternative 1 in the St. Johns Bayou Basin.

	Functional Floodplain Acres[1]		Average Annual Habitat Units		
Habitat Type	Existing	Alt. 1	Early	Mid	Late
Agriculture/Developed	7,322.80	6,237.90	152.15	151.76	54.72
Fallow	287.12	287.12	14.56	14.67	4.54
Forest	4,710.04	5,833.72	857.42	917.53	407.62
Herbaceous/Scrub-Shrub	206.09	527.14	52.24	57.06	24.26
Open Water	310.02	470.55	284.97	284.97	284.97
Total	12,836.07	13,356.43	1,361.33	1,425.99	776.11

[1]Agricultural and fallow areas were limited to the 2-year floodplain.

New Madrid Floodway

The Mississippi River would continue to periodically inundate the lower portion of the New Madrid Floodway through the 1,500-foot gap (Table 4.49).

Table 4.49. Potential fish spawning and rearing habitat and AAHU for alternative 1 in the New Madrid Floodway.

	Functional Floodplain Acres[1]		Average Annual Habitat Units		
Habitat Type	Existing	Alt. 1	Early	Mid	Late
Agriculture/Developed	25,893.77	25,159.38	624.69	603.31	186.75
Fallow	202.64	202.64	10.60	11.46	5.04
Forest	7,845.02	8,439.39	1570.06	1629.08	733.53
Herbaceous/Scrub-Shrub	753.76	923.58	315.20	306.40	157.05
Open Water	686.02	770.93	728.47	728.47	728.47
Total	35,381.21	35,495.92	3,249.02	3,278.72	1,810.84

[1]Agricultural and fallow areas were limited to the 2-year floodplain.

4.8.5.6 Alternatives 2.1 and 2.2

St. Johns Bayou Basin – 2.1

Operation of the St. Johns Bayou pump station would reduce the frequency and duration of flood events attributed to impounded interior runoff. The 1,000 cfs pump station would reduce the 5-year flood frequency, which equates to fish spawning and rearing habitat functional floodplain limit from an elevation of 294.1 feet to an elevation of 292.6 feet. Similarly, the 2-year flood frequency elevation would be reduced from an existing value of 291.0 feet to a with-project value of 290.4 feet. Operating the pump would reduce potential fish spawning and rearing habitat from 1,361.3, 1,426.0, and 776.1 to 974.7, 984.6, and 530.8 AAHU in the St. Johns Bayou Basin for the early, mid, and late seasons, respectively (Table 4.50). Therefore, operation of the pumps would impact 386.6, 441.3, and 245.3 AAHU in the St. Johns Bayou Basin in the early, mid, and late season. There are no expected changes to the operation of the St. Johns Bayou gravity outlet structure. Therefore, no impacts to fish access are expected. Fish access coefficient (0.73) remains constant.

New Madrid Floodway – 2.2

Closure of the New Madrid Floodway and operation of a 1,500-cfs pump would reduce flood frequencies, flood duration, and fish access (although access would not be a significant impact). The authorized project would reduce the 5-year flood frequency from an elevation of 296.6 to an elevation of 286.5. Similarly, the 2-year flood frequency elevation would be reduced from an existing value of 292.1 feet to a with-project value of 285.7 feet. Operation of the gated structure would mimic the operation of the existing St. Johns Bayou gravity outlet structure (*i.e.*, gates would be closed when river elevations are greater than the interior sump elevation). Therefore, fish access would be reduced from that of open access through the 1,500-foot gap (Fish Access Coefficient = 1.0) to restricted access through the structure (Fish Access Coefficient = 0.73). The authorized project would reduce potential fish spawning and rearing habitat from 3,249.0, 3,278.7, and 1,810.8 to 492.9, 484.7, and 459.0 AAHU in the New Madrid Floodway for the early, mid, and late season periods, respectively (Table 4.51). Therefore, the authorized project would impact 2,756.1, 2,794.1, and 1,351.8 AAHU in the New Madrid Floodway in the early, mid, and late season periods, respectively.

Table 4.50. Fish spawning and rearing habitat for alternative 2.1 in the St. Johns Bayou Basin.

Habitat Type	Functional Floodplain Acres[1]		Average Annual Habitat Units					
			Early		Mid		Late	
	Alt. 1	Alt. 2.1	Alt. 1	Alt. 2.1	Alt. 1	Alt. 2.1	Alt. 1	Alt. 2.1
Agriculture/Developed	6,237.9	4,674.5	152.2	83.9	151.8	81.1	54.7	21.0
Fallow	287.1	254.8	14.6	9.4	14.7	8.8	4.5	1.9
Forest	5,833.7	5,423.0	857.4	570.2	917.5	582.3	407.6	217.8
Herbaceous/Scrub-Shrub	527.1	477.5	52.2	33.4	57.1	34.7	24.3	12.3
Open Water	470.6	450.9	285.0	277.8	285.0	277.8	285.0	277.8
Total	13,356.4	11,280.6	1,361.3	974.7	1,426.0	984.6	776.1	530.8
Impact	2,075.9		386.6		441.3		245.3	

[1]Agricultural and fallow areas were limited to 2-year floodplain.

Table 4.51. Fish spawning and rearing habitat for alternative 2.2 in the New Madrid Floodway.

Habitat Type	Functional Floodplain Acres[1]		Average Annual Habitat Units					
			Early		Mid		Late	
	Alt. 1	Alt. 2.2	Alt. 1	Alt. 2.2	Alt. 1	Alt. 2.2	Alt. 1	Alt. 2.2
Agriculture/Developed	25,159.4	1,955.4	624.7	3.4	603.3	1.7	186.8	1.1
Fallow	202.6	73.0	10.6	0.9	11.5	0.9	5.0	0.6
Forest	8,439.4	2,353.7	1,570.1	70.9	1,629.1	64.2	733.5	45.6
Herbaceous/Scrub-Shrub	923.6	709.7	315.2	10.4	306.4	10.5	157.0	4.5
Open Water	770.9	430.0	728.5	407.3	728.5	407.3	728.5	407.3
Total	35,495.9	5,521.9	3,249.0	492.9	3,278.7	484.7	1,810.8	459.0
Impact	29,974.1		2,756.1		2,794.1		1,351.8	

[1]Agricultural and fallow areas were limited to the 2-year floodplain.

4.8.5.7 Alternative 2.3

Alternative 2.3 combines the impacts from Alternatives 2.1 and 2.2.

4.8.5.8 Alternatives 3.1 and 3.2

St. Johns Bayou Basin

Although the avoid and minimize measures that are formulated for the St. Johns Bayou Basin reduce impacts to other resource categories, they do not reduce impacts to potential fish spawning and rearing habitat in the St. Johns Bayou Basin.

New Madrid Floodway

Avoid and minimize measures would result in keeping the proposed gravity gate through the closure structure open for a longer period of time at specified river elevations during the non-crop season as well as refraining from pumping activities until certain elevation thresholds are reached. Therefore, impacts to potential fish spawning and rearing habitat would be reduced. Reduced impacts would be attributed to higher flood elevations and longer durations during the fish spawning and rearing period compared to the authorized project conditions.

Keeping the gates open for greater periods of time would increase fish access opportunities compared to authorized project conditions. However, the same fish access coefficient value was used to quantify avoid and minimize measures which results in an under estimate of habitat accounting for fish access. For example, the fish access reduction coefficient is based on the observed conditions found in the St. Johns Bayou Basin. This structure is not managed in any way to keep the gates open for longer periods of time for environmental purposes. Therefore, a reasonable conclusion is that the fish access coefficient value of 0.73 is a worst case scenario and should be higher in conditions that allow for additional fish access. In the event that future fish access studies conclude that access is positively correlated to extent of gate opening, compensatory mitigation requirements would be adjusted accordingly.

Avoid and minimize measures would reduce the 5-year flood frequency elevations in the New Madrid Floodway from a future without-project condition value of 296.6 feet to 288.7 feet and 288.3 feet for alternatives 3.1 and 3.2, respectively. Similarly, the 2-year flood frequency elevation would be reduced from an existing value of 292.1 feet to a with-project value of 287.6 feet and 287.2 feet for alternatives 3.1 and 3.2, respectively. Both avoid and minimize measures would reduce impacts of the authorized project. However, they would still result in impacts to potential fish spawning and rearing habitat. Alternative 3.1 results in an impact of 1,729.5, 2,061.1, and 1,165.8 AAHU in the New Madrid Floodway during the early, mid, and late fish spawning and rearing seasons, respectively (Table 4.52). Alternative 3.2 results in an impact 2,024.7, 2,340.1, and 1,218.8 AAHU in the New Madrid Floodway during the early, mid, and late fish spawning and rearing seasons, respectively (Table 4.53).

Table 4.52. Fish spawning and rearing habitat for alternative 3.1 in the New Madrid Floodway.

Habitat Type	Functional Floodplain Acres[1]		Average Annual Habitat Units					
			Early		Mid		Late	
	Alt. 1	Alt. 3.1	Alt. 1	Alt. 3.1	Alt. 1	Alt. 3.1	Alt. 1	Alt. 3.1
Agriculture/Developed	25,159.4	5,912.5	624.7	105.6	603.3	45.5	186.8	2.4
Fallow	202.6	172.1	10.6	3.4	11.5	2.1	5.0	0.7
Forest	8,439.4	4,510.9	1,570.1	713.8	1,629.1	490.6	733.5	110.4
Herbaceous/Scrub-Shrub	923.6	801.7	315.2	220.0	306.4	202.8	157.0	54.9
Open Water	770.9	620.0	728.5	476.7	728.5	476.7	728.5	476.7
Total	35,495.9	12,017.3	3,249.0	1,519.5	3,278.7	1,217.7	1,810.8	645.1
Impact	23,478.6		1,729.5		2,061.1		1,165.8	

[1]Agricultural and fallow areas were limited to the 2-year floodplain.

Table 4.53. Fish spawning and rearing habitat for alternative 3.2 in the New Madrid Floodway.

Habitat Type	Functional Floodplain Acres[1]		Average Annual Habitat Units					
			Early		Mid		Late	
	Alt. 1	Alt. 3.2	Alt. 1	Alt. 3.2	Alt. 1	Alt. 3.2	Alt. 1	Alt. 3.2
Agriculture/Developed	25,159.4	4,785.4	624.7	53.4	603.3	16.8	186.8	1.3
Fallow	202.6	160.4	10.6	1.9	11.5	1.4	5.0	0.7
Forest	8,439.4	4,164.8	1,570.1	481.5	1,629.1	295.7	733.5	89.2
Herbaceous/Scrub-Shrub	923.6	793.7	315.2	217.2	306.4	154.5	157.0	30.5
Open Water	770.9	602.3	728.5	470.2	728.5	470.2	728.5	470.2
Total	35,495.9	10,506.6	3,249.0	1,224.3	3,278.7	938.6	1,810.8	592.0
Impact	24,989.4		2,024.7		2,340.1		1,218.8	

[1]Agricultural and fallow areas were limited to the 2-year floodplain.

4.8.5.9 Alternatives 4.1 and 4.2

St. Johns Bayou Basin

As with alternatives 3.1 and 3.2, avoid and minimize measures formulated for the St. Johns Bayou Basin reduce impacts to other resource categories, they do not reduce impacts to potential fish spawning and rearing habitat in the St. Johns Bayou Basin.

New Madrid Floodway

Alternative 4 is similar to alternative 3 in that all project features are constructed; however, with the exception of waterfowl season, alternative 4 would not close the New Madrid Floodway structure or utilize pumps until floods reach an elevation in which roads are threatened (approximate elevation of 289.5 feet). Alternative 4.1 calls for construction of the flood risk management features only with no additional measures to areas below an elevation of 289.5 feet. Alternative 4.2 calls for reforestation of agricultural lands below an elevation of 289.5 feet in conjunction with the structural flood risk management measures previously stated. There are 13,340 acres of agricultural lands below an elevation of 289.5 feet.

Implementation of alternative 4 would reduce the 5-year flood frequency elevations in the New Madrid Floodway from a future without-project condition value of 296.6 feet to 289.6 feet for alternatives 4.1 and 4.2. Similarly, the 2-year flood frequency elevation would be reduced from an existing value of 292.1 feet to a with-project value of 288.5 feet for alternatives 4.1 and 4.2. Both alternatives would reduce impacts of the authorized project. However, they would still result in impacts to potential fish spawning and rearing habitat. Alternative 4.1 results in an impact of 1,520.8, 1,492.5, and 720.1 AAHU in the New Madrid Floodway during the early, mid, and late fish spawning and rearing seasons, respectively (Table 4.54). Due to reforestation, alternative 4.2 results in much more modest impact of 122.8, -89.9, and 30.8 AAHU in the New Madrid Floodway during the early, mid, and late fish spawning and rearing seasons, respectively (Table 4.55).

Table 4.54. Fish spawning and rearing habitat for alternative 4.1 in the New Madrid Floodway.

Habitat Type	Functional Floodplain Acres		Average Annual Habitat Units					
			Early		Mid		Late	
	Alt. 1	Alt. 4.1	Alt. 1	Alt. 4.1	Alt. 1	Alt. 4.1	Alt. 1	Alt. 4.1
Agriculture/Developed	25,159.4	8,942.1	624.7	165.6	603.3	177.6	186.8	60.7
Fallow	202.6	187.9	10.6	4.2	11.5	4.3	5.0	1.8
Forest	8,439.4	5,225.9	1,570.1	847.9	1,629.1	901.4	733.5	428.1
Herbaceous/Scrub-Shrub	923.6	815.9	315.2	221.4	306.4	213.8	157.0	110.9
Open Water	770.9	654.4	728.5	489.2	728.5	489.2	728.5	489.2
Total	35,495.9	15,826.2	3,249.0	1,728.2	3,278.7	1,786.2	1,810.8	1,090.8
Impact	19,669.7		1,520.8		1,492.5		720.1	

Table 4.55. Fish spawning and rearing habitat for alternative 4.2 in the New Madrid Floodway.

Habitat Type	Functional Floodplain Acres		Average Annual Habitat Units					
			Early		Mid		Late	
	Alt. 1	Alt. 4.2	Alt. 1	Alt. 4.2	Alt. 1	Alt. 4.2	Alt. 1	Alt. 4.2
Agriculture/Developed	25,159.4	143.6	624.7	3.8	603.3	4.3	186.8	1.8
Fallow	202.6	187.9	10.6	4.2	11.5	4.3	5.0	1.8
Forest	8,439.4	16,570.1	1,570.1	2,274.9	1,629.1	2,507.5	733.5	1,112.6
Herbaceous/Scrub-Shrub	923.6	2,573.5	315.2	354.1	306.4	363.2	157.0	174.6
Open Water	770.9	654.4	728.5	489.2	728.5	489.2	728.5	489.2
Total	35,495.9	20,129.5	3,249.0	3,126.2	3,278.7	3,368.6	1,810.8	1,780.0
Impact	15,366.5		122.8		-89.9		30.8	

4.8.6 Waterbody Connectivity and Fish Species Assemblages

Residential fish species diversity in waterbodies is positively correlated with the degree of flooding (*i.e.*, percent connected to the flood source) (Lubinski *et al.* 2008). Although the EnviroFish model results quantify the impacts associated with spawning and rearing habitat as a result of the project, qualitative changes to fish species diversity that reside in project area waterbodies are not measured. Lubinski *et al.*, (2008) found that many riverine species are more common in lakes with higher degrees of connectivity (*i.e.*, greater percent connection to the interior sump elevation), whereas more lentic/lake species were associated with waterbodies exhibiting lower degrees of connectivity. Therefore, the general trend is that waterbodies that have higher percent connections have more species present than those that have lower percent connections (Galat *et al.*, 1998; Miranda, 2005).

4.8.6.1 Alternative 1 – No Action

There are 313 and 725 acres of open water habitat in the PIA of the St. Johns Bayou Basin and New Madrid Floodway, respectively (see Tables 3.1 and 3.2). Acreages would be expected to increase to 546 and 798 acres with the addition of WRP lands under no action conditions in the St. Johns Bayou Basin and New Madrid Floodway, respectively. Since these waterbodies are located at different elevations, they are connected to the sump elevation at different percentages. Tables 4.56 and 4.57 provide the number of surface acres and percent time they would be connected under no action conditions. There likely would be no changes to percent connectivity under no action conditions. Although the flood pulse may homogenize/reshuffle fish communities between the river channel and floodplain lakes (Miranda, 2005; Lubinski *et al.*, 2008), overall long-term residential fish species richness would not be expected to change significantly in existing waterbodies.

Table 4.56. Future without-project, waterbodies percent connected, St. Johns Bayou Basin.

St. Johns		Early	Mid	Late
	Waterbodies	Season	Season	Season
Elevation	Acres	% Connected	% Connected	% Connected
280	0.0	53.9	51.0	28.2
281	100.2	49.7	46.8	25.3
282	0.1	44.7	43.4	22.8
283	0.4	40.6	40.5	20.1
284	57.9	37.3	37.2	17.8
285	2.6	32.3	33.5	15.7
286	43.1	27.6	30.0	13.6
287	78.5	24.0	26.8	10.9
288	32.3	20.0	23.0	8.5
289	24.7	16.4	18.8	7.0
290	36.3	13.4	15.3	5.6
291	30.8	10.3	11.7	4.0
292	33.3	7.0	8.4	3.0
293	17.9	4.0	6.1	2.4
294	11.6	1.8	3.4	1.7
295	9.2	1.4	2.7	0.9
296	16.2	< 1.0	< 1.0	< 1.0
297	25.6	< 1.0	< 1.0	< 1.0
298	14.5	< 1.0	< 1.0	< 1.0
299	7.8	< 1.0	< 1.0	< 1.0
300	3.3	< 1.0	< 1.0	< 1.0

Table 4.57. Future without-project, waterbodies percent connected, New Madrid Floodway.

NMF		Early	Mid	Late
	Waterbodies	Season	Season	Season
Elevation	Acres	% Connected	% Connected	% Connected
280	-	54.4	51.1	27.6
281	78.8	50.1	47.3	24.6
282	28.5	45.1	43.6	22.1
283	24.6	40.8	40.9	19.6
284	65.9	37.3	37.3	17.3
285	51.0	33.2	33.4	15.2
286	153.8	29.2	30.2	13.1
287	148.8	26	27.2	10.8
288	57.6	22.9	24.2	8.3
289	38.3	19.7	21.3	6.6
290	27.9	17	18.6	5.6
291	13.4	14.1	14.7	4.6
292	13.8	11.3	10.9	4.1
293	8.9	8.8	8.4	3.5
294	34.6	6.4	6.2	3
295	17.3	4.8	4.1	2.4
296	6.8	3.2	2.6	1.8
297	8.4	1.5	1.3	0.8
298	4.9	< 1.0	< 1.0	< 1.0
299	8.4	< 1.0	< 1.0	< 1.0
300	6.5	< 1.0	< 1.0	< 1.0

4.8.6.2 Alternatives 2.1 and 2.2

Alternatives 2.1 and 2.2 would lower the frequency and duration of floods in both basins. Therefore, percent connection would decrease (Tables 4.58 and 4.59). Thus, there could be a shift in fish species from that of a more lotic type to that of a more lentic type. Note that impacts to project area lakes that are within the pre-project 5-year floodplain that would no longer be within the post-project 5-year floodplain were quantified as a "complete loss" in terms of fisheries value. Although these lakes would still exist, they would no longer function as spawning and rearing habitat. In addition to impacts to spawning and rearing habitat, fish species richness would shift to a more lentic type. Waterbodies that retain a connection (within the post-project 5-year floodplain) would still provide spawning and rearing habitat.

Table 4.58. Alternative 2.1, waterbodies percent connected, St. Johns Bayou Basin.

St. Johns		Early	Mid	Late
	Waterbodies	Season	Season	Season
Elevation	Acres	% Connected	% Connected	% Connected
280	0.0	38.4	36.9	16.9
281	100.2	34.9	32.9	14.7
282	0.1	30.5	29.8	12.8
283	0.4	27.4	27.6	10.8
284	57.9	24.7	25.3	9.5
285	2.6	21.8	22.4	7.5
286	43.1	18.4	19.4	6.3
287	78.5	16.5	17.3	5.1
288	32.3	14.1	14.8	4.4
289	24.7	12.3	11.4	3.9
290	36.3	8.5	8.0	3.2
291	30.8	4.1	5.2	2.3
292	33.3	2.1	4.0	1.7
293	17.9	1.8	3.4	1.0
294	11.6	nc	nc	nc
295	9.2	nc	nc	nc
296	16.2	nc	nc	nc
297	25.6	nc	nc	nc
298	14.5	nc	nc	nc
299	7.8	nc	nc	nc
300	3.3	nc	nc	nc

nc = not connected

Table 4.59. Alternative 2.2, waterbodies percent connected, New Madrid Floodway.

NMF Elevation	Waterbodies Acres	Early Season % Connected	Mid Season % Connected	Late Season % Connected
280	-	3.0	3.9	2.0
281	78.8	2.4	2.5	1.0
282	28.5	2.0	1.7	0.7
283	24.6	1.9	1.2	0.4
284	65.9	1.7	0.9	0.4
285	51.0	1.4	0.3	0.3
286	153.8	1.0	0.1	nc
287	148.8	0.7	nc	nc
288	57.6	nc	nc	nc
289	38.3	nc	nc	nc
290	27.9	nc	nc	nc
291	13.4	nc	nc	nc
292	13.8	nc	nc	nc
293	8.9	nc	nc	nc
294	34.6	nc	nc	nc
295	17.3	nc	nc	nc
296	6.8	nc	nc	nc
297	8.4	nc	nc	nc
298	4.9	nc	nc	nc
299	8.4	nc	nc	nc
300	6.5	nc	nc	nc

nc = not connected

4.8.6.3 Alternative 2.3

Alternative 2.3 would combine impacts from Alternatives 2.1 and 2.2.

4.8.6.4 Alternatives 3.1 and 3.2

Avoid and minimize measures in the St. Johns Bayou Basin would result in decreases to direct impacts of the project only. No proposed changes to the operation of the gate and pump are considered. Thus, changes to fish species richness in the St. Johns Bayou Basin for alternatives 3.1 and 3.2 would be the same as alternative 2.1.

Alternatives 3.1 and 3.2 provide a greater level of connectivity with the Mississippi River and the New Madrid Floodway as compared to alternative 2.2 (Tables 4.60 and 4.61). Thus, there could be a less gradual shift from a more lotic fishery to a more lentic fishery in the waterbodies.

Table 4.60. Alternative 3.1, waterbodies percent connected, New Madrid Floodway.

	Waterbodies	Early Season	Mid Season	Late Season
Elevation	Acres	% Connected	% Connected	% Connected
280	-	54.7	51.3	14.8
281	78.8	50.5	47.7	13.5
282	28.5	45.6	44.2	12.1
283	24.6	41.7	34.3	6.2
284	65.9	38.6	21.6	0.7
285	51.0	34.0	18.4	0.0
286	153.8	27.4	14.7	0.0
287	148.8	19.4	9.1	0.0
288	57.6	4.5	1.4	0.0
289	38.3	0.9	0.1	0.0
290	27.9	nc	nc	nc
291	13.4	nc	nc	nc
292	13.8	nc	nc	nc
293	8.9	nc	nc	nc
294	34.6	nc	nc	nc
295	17.3	nc	nc	nc
296	6.8	nc	nc	nc
297	8.4	nc	nc	nc
298	4.9	nc	nc	nc
299	8.4	nc	nc	nc
300	6.5	nc	nc	nc

nc = not connected

Table 4.61. Alternative 3.2, waterbodies percent connected, New Madrid Floodway.

Elevation	Waterbodies Acres	Early Season % Connected	Mid Season % Connected	Late Season % Connected
280	-	54.7	51.2	14.4
281	78.8	50.5	40.0	9.0
282	28.5	45.6	22.7	1.0
283	24.6	41.6	20.4	0.2
284	65.9	37.3	17.7	nc
285	51.0	29.2	13.3	nc
286	153.8	8.4	1.8	nc
287	148.8	4.5	0.6	nc
288	57.6	2.0	nc	nc
289	38.3	0.6	nc	nc
290	27.9	nc	nc	nc
291	13.4	nc	nc	nc
292	13.8	nc	nc	nc
293	8.9	nc	nc	nc
294	34.6	nc	nc	nc
295	17.3	nc	nc	nc
296	6.8	nc	nc	nc
297	8.4	nc	nc	nc
298	4.9	nc	nc	nc
299	8.4	nc	nc	nc
300	6.5	nc	nc	nc

nc = not connected

4.8.6.5 Alternative 4

As with alternatives 3.1 and 3.2, avoid and minimize measures in the St. Johns Bayou Basin would result in decreases to direct impacts of the project only. No proposed changes to the operation of the gate and pump are considered. Thus, changes to fish species richness in the St. Johns Bayou Basin for alternatives 4.1 and 4.2 would be the same as alternative 2.1.

Alternative 4 maintains a greater level of connectivity of the Mississippi River to the New Madrid Floodway as compared to alternative 2.2 (Table 4.62). Thus, there could be an even less shift from a lotic fishery to a lentic fishery in the waterbodies than seen in other avoid and minimize alternatives.

Table 4.62. Alternative 4, waterbodies percent connected, New Madrid Floodway.

	Waterbodies	Early Season	Mid Season	Late Season
Elevation	Acres	% Connected	% Connected	% Connected
280	-	54.7	51.5	28.1
281	78.8	50.5	48.0	25.1
282	28.5	45.6	44.6	22.9
283	24.6	41.8	42.2	20.7
284	65.9	38.7	39.0	18.6
285	51	34.1	35.0	16.5
286	153.8	30.3	32.4	14.7
287	148.8	25.0	28.4	12.0
288	57.6	14.1	17.8	7.0
289	38.3	6.8	9.2	2.5
290	27.9	0.2	0.3	nc
291	13.4	nc	nc	nc
292	13.8	nc	nc	nc
293	8.9	nc	nc	nc
294	34.6	nc	nc	nc
295	17.3	nc	nc	nc
296	6.8	nc	nc	nc
297	8.4	nc	nc	nc
298	4.9	nc	nc	nc
299	8.4	nc	nc	nc
300	6.5	nc	nc	nc

nc = not connected

4.9 Other Ecological Resources

4.9.1 Freshwater Mussels

Freshwater mussel surveys were conducted in 2010 to update previous surveys (Barnhart 1998, USACE 2005) and aid in determining appropriate methods for implementing long-term monitoring of the freshwater mussel resource. Previous coordination between USACE and Federal and state resource agencies resulted in the recommendation that long-term monitoring be conducted over a 10-year time period to measure recolonization following channel alteration.

Beginning in 2009 and continuing through the present time (December 2011), 356 miles of project area ditches have been subjected to vegetation and sediment removal through an Emergency Watershed Protection (EWP) plan administered by NRCS following the 2008 floods (NRCS, personal communication). Prior to these recent channel cleanouts, the project area supported a relatively diverse, abundant, and stable freshwater mussel population typical of a deltaic stream system. These cleanouts may have reduced the number of live mussels collected in 2010 as compared to earlier mussel surveys within the project area. Whether this decrease in population is permanent or merely temporary is unknown at this time.

The majority of the species in the project area have relatively small populations. Barnhart (1998) reported that 20 of the 24 species found totaled less than 5 percent of the 998 individual mussels collected. USACE (2010) reported similar results where 12 of the 15 species found totaled less than 10 percent of the 160 individual mussels collected.

Several construction items are authorized in the St. Johns Bayou Basin that may potentially impact mussel habitat. These items consist of channel enlargements in the lower 3.7 miles of St. Johns Bayou, 8.1 miles of Setback Levee Ditch, and 3.5 miles of St. James Ditch. Deepening and widening existing channels in the St. Johns Bayou Basin could adversely impact local mussel fauna; the most direct effect would be the physical removal and destruction of mussels. Mussel colonies can persist through channel modifications. For example, Barnhart (1998) found a number of mussels in Setback Levee Ditch that had apparently survived a previous channel enlargement event. Also, in 2010, USACE surveyed a recently "cleaned out" site and observed a strip of mussels on the opposite bank from where the construction occurred. This indicates areas of mussels would remain where the heavy equipment does not disturb any existing mussel beds. Because mussels are essentially motionless, recovery of depleted populations would depend upon recruitment of juveniles transported by fish hosts from adjacent populations unaffected by the dredging.

4.9.1.1 Alternative 1 – No Action

The no action project conditions are difficult to estimate. Based on past surveys, the mussel resource can recolonize following ditch modification activities. However, the method of re-colonization is not known and may have occurred from individuals/groups that were not impacted by construction activities (as explained previously), or from a seed source located outside of any particular construction reach. During most years, channel maintenance is conducted on a limited number of areas. Thus, a potential seed source is typically available within the general vicinity. However, recent ditch maintenance was wide-spread, covering over 350 miles in a relatively short time period. Therefore, a suitable seed source that could quickly recolonize previous areas that contained mussels may no longer be available.

4.9.1.2 Alternatives 2.1, 2.2, and 2.3

Prior to recent channel cleanouts, excavation would have removed a large portion of the mussel fauna within the St. Johns Bayou Basin. Impacts would be attributable to a direct impact (physically removing and destroying the mussel during construction activities) as well as an indirect impact from removing potential colonization habitat. However, mussels are no longer found within the construction reaches at levels that occurred pre-basin-wide maintenance. Therefore, no significant impacts to mussels would occur. The closure levee and pumping stations would likely not impact freshwater mussels, except for individuals that may be found within the direct construction footprint. The effect whether the pumping stations and the closure levee would benefit freshwater mussels is not known. For example, prior to the recent maintenance activities, freshwater mussels occurred at healthy levels in the St. Johns Bayou. No significant mussel populations have ever been found in the New Madrid Floodway. Although speculative, the stabilization effects provided from a closure levee and structure should be considered. The New Madrid closure levee would prevent channel instabilities (*i.e.*, head cuts) that originate from the Mississippi River and move up into New Madrid Floodway channels. Mussels require stable habitat. Therefore, the closure levee could be beneficial. In addition, no significant population has ever been found in the lower portion of St. Johns Bayou Basin. The stagnant impounded interior runoff that occurs under existing conditions may be detrimental to mussels. The establishment of flow from a pumping station could be beneficial.

4.9.1.3 Alternatives 3.1, 3.2, 4.1, and 4.2

Direct impacts would be similar to those described for Alternative 2.3 except that construction would only occur from one bank. Therefore, indirect impacts would be considerably less. Many areas that contained mussels prior to the EWP maintenance (right descending bank of Setback Levee Ditch) would be avoided.

Recent surveys did not detect the presence of significant freshwater mussel populations that existed prior to the recent channel maintenance activities. Therefore, no significant impacts to mussels would be anticipated. However, the length of time for mussels to recolonize the area is unknown. Prior to channel modifications, the Corps will conduct additional surveys to ensure the conclusions are still valid. These surveys will be coordinated with the interagency team to determine if any additional mitigation is necessary. For example, previous mitigation originally proposed in 2006 after consultation with the Missouri Department of Conservation and U.S. Fish and Wildlife Service recommended relocation and monitoring of recolonization. Routine maintenance conducted by state and local entities does not require a Clean Water Act Section 404 permit or results in significant adverse impacts. Furthermore, there are no Federally listed species of concern. Therefore, no mitigation is required. Thus, it is reasonable to conclude that if there is no significant adverse impact for conducting existing ditch maintenance prior to construction then it is also reasonable to conclude that future maintenance work will not necessitate a permit or result in a significant adverse impact following construction of this project.

4.9.2 Endangered Species

Correspondence from USFWS dated 13 December 2010 stated that two federally listed species should be included in this assessment: interior least tern (*Sterna antillarum athalassos*) and pallid sturgeon (*Scaphirhynchus albus*). Additionally, the correspondence acknowledged the bald eagle (*Haliaeetus leucocephalus*) is known to occur within the project area, and although it was removed from the endangered species list, it remains protected by the Bald and Golden Eagle Act and the Migratory Bird Treaty Act. A Biological Assessment (BA) has been finalized and was sent to USFWS for concurrence on 6 October 2011 (Appendix J). The Fish and Wildlife Service did not concur with the assessment on the Interior Least Tern. Therefore, USACE requested formal consultation with the Fish and Wildlife Service on 21 June 2012. Formal consultation is ongoing.

4.9.2.1 Evaluation of Potential Impacts to the Interior Least Tern

The closest interior least tern colony to the project area is at the Kentucky Point Dike Field a few miles downstream of New Madrid. The proposed project would not impact sandbar habitat, thus the biological assessment indicated that no impacts to nesting habitat would be expected.

The proposed project would reduce the duration and frequency of seasonal flooding in the project area. The impacts associated with the reduction in flood frequencies and durations were assessed by a series of environmental models, including EnviroFish that quantifies fish spawning and rearing habitat. The biological assessment concluded that the proposed project would not likely adversely affect least tern foraging, because least terns forage on ubiquitous forage fish throughout the Lower Mississippi River, and ample spawning and rearing habitat would remain for these species. A complete review of the interior least tern and its association with the project area can be found in Appendix J.

The Fish and Wildlife Service did not concur with the conclusions of the USACE biological assessment regarding least terns citing the conclusion reached in their 1999 Biological Opinion. Formal consultation with the Fish and Wildlife Service regarding potential impacts to least terns is ongoing.

4.9.2.2 Evaluation of Potential Impacts to the Pallid Sturgeon

Project-related impacts to the pallid sturgeon population in the Lower Mississippi River, including impacts to resting, spawning, and foraging habitats, would not be likely. Pallid sturgeon are a main channel species avoiding backwaters and small tributaries. They inhabit deep thalwegs with hard-packed, sandy substrate, or channel border areas with steep shorelines near fast water, including dikes. Spawning occurs over gravel bars or possibly other hard substrates (*e.g.*, riprap stones) in fast-flowing waters. These habitats do not occur in the project area. Despite the apparent absence of pallid sturgeon in the project area and lack of suitable spawning habitat, sturgeon could enter the mouth of Mud Ditch for feeding purposes. However, sturgeon are rarely documented in tributaries, and one of the primary forage items eaten by pallid sturgeon are river chubs belonging to the *Macrhybopsis* genus. Chubs are bottom-oriented fishes occupying swift currents over sand and gravel substrates in medium to large, turbid rivers similar to habitats preferred by pallid sturgeon (Pflieger 1997). A complete review of the pallid sturgeon and its association with the project area can be found in Appendix J.

4.9.2.3 Evaluation of Potential Impacts to the Bald Eagle

Although no longer a federally endangered species, the bald eagle still represents a species of special significance. Although no surveys were conducted specifically for bald eagle nests, multiple habitat assessments were conducted for the draft EIS and did not reveal any nests in the proposed construction footprint. If any active bald eagle nests are discovered in the proposed footprint prior to construction, avoidance measures and minimum work distances would be adhered to according to the National Bald Eagle Management Guidelines.

4.10 Water Quality

ERDC completed a water quality assessment for the St. Johns Bayou Basin and New Madrid Floodway Project. These analyses are a revision to the work reported by Ashby et al. (2000) and are based on an expanded hydrologic period of record that extends from 1 October 1942 to 12 November 2009 (67 years). Differing hydrologic scenarios were considered for the New Madrid Floodway and for St. Johns Bayou Basin. The with- and without-project condition for both basins was represented by the actual, daily, hydrologic data, and project alternatives were evaluated using simulated daily water surface elevations. Details of these analyses, including extended descriptions of the methods and results, are found in Appendix I.

A query of state agencies and Federal databases resulted in only one station in the project area with recent water quality data. St. Johns Bayou at Henderson Mound, Missouri (site # 7042450 – New Madrid County) has been sampled monthly between 1999 and 2010 for temperature, dissolved oxygen, pH and hardness, suspended and dissolved solids, total nitrogen (TN), total phosphorus (TP), and discharge by the USGS. Discharge reflected seasonal and annual variability with values ranging from near 0 to over 2000 cubic feet per second (Figure 4.7). Dissolved oxygen concentrations were similar to observations between 1994 and 1998 of the National Water Quality Assessment Program (NAWQA) study. Temperatures varied seasonally with maximum values near 25 – 30 °C. Dissolved oxygen concentrations varied between near 4 mg/l and > 9 mg/l. Values of pH were mostly between 7 and 8 standard units with hardness concentrations near 125 mg/l with occasional lower values coincident with increased discharge. Suspended solids concentrations were predominantly below 50 mg/l except during periods of increased discharge when concentrations ranged between 100 and 200 mg/l. Dissolved solids concentrations were mostly between 125 and 150 mg/l with concentrations below 100 mg/l during some periods of increased discharge. Total nitrogen was highly variable with concentrations ranging from less than 0.5 to greater than 2.0 mg/l with higher concentrations occurring during periods of increased discharge. Total phosphorous concentrations ranged from near 0.25 to over 0.5 mg/l with higher concentrations occurring during periods of increased discharge.

4.10.1 Water Quality Effects on Waters within the Project Area

State and federal agencies (Missouri DNR, Missouri Dept of Conservation, and USGS) were polled to identify any existing water quality data for streams and other water bodies within the project area and establish a baseline (see Section 3.10). Very limited data were uncovered by this effort. Nonetheless, periods of inundation were reasonably assumed to be accompanied by increased sedimentation, depressed oxygen levels, and elevated inputs of plant nutrients to water bodies within the project area. Such conditions are commonly experienced by natural water bodies within an unregulated floodplain, so substantial negative impacts from project operations would not be expected. However, the net balance of positive or negative influences of the altered inundation regime on an individual water body could only be evaluated with additional, site-specific data.

Impacts during construction would include temporarily increased sediment loads that would result in minor increases in suspended solids and turbidity. However, impacts during construction would be minimized by best management practices, such as silt fences. Decreased hydrologic connectivity may impact biological functions to a higher degree than project area water quality. Thus, compensatory mitigation is proposed. Since Big Oak Tree State Park is the major interior wetland/water body of concern, re-connectivity would provide water quality benefits. With the establishment of the proposed mitigation measures and environmental design features, such as riparian buffer strips, winter runoff would be expected to contain decreased exports of sediment and nutrients from the project area. Improved "filtering capacity" for water quality in Mississippi River flood waters would be expected at sites located downstream of the project area.

4.10.2 Mississippi River

The analysis by Ashby et al. (2000) concluded that the effects of the project on Mississippi River water quality would not be discernible. This was based on several lines of evidence, including (1) the ratio of project outflow volume to Mississippi River flow volume (< 1 percent), (2) the finding that the project would reduce the material load from the project area to the river relative to the existing condition, and (3) the finding that the project area would likely exhibit a net retention and processing of material that enters from the Mississippi River, although a small net loss of retention relative to the existing condition would be possible.

4.10.3 Quantification of Impacts on Material Export for All Alternatives

The water quality analysis reported by Ashby et al. (2000) was revised with updated land cover data, an expanded hydrologic period of record, and a modified approach that uses simulated daily water elevations and places the export of material from the project area into a more complete context. In this revision, instead of evaluating five, representative hydrologic scenarios, the extent and duration of inundation in each season within the 67-year period of record was evaluated under each project alternative to produce a time-series of exports. Further, the current analysis fully incorporated export from the land within the project area that would be above the level of inundation. This approach allowed the influence of various project alternatives to be viewed within the context of total export from the project area. The previous approach emphasized the relative differences between alternatives.

To make use of detailed (daily) hydrologic data (and simulations), and to improve the overall transparency of the analyses, SAS® program code was used to implement the equations from the spreadsheet used in the 2000 report. Some advantages to this approach are that (1) the results are calculated as a time-series that can be easily visualized, (2) the equations and parameters used in the calculations are organized into a few tables and a series of sequential steps that can be viewed in text form, and (3) the modification of inputs and assumptions is greatly simplified (and more transparent) compared with a spreadsheet approach.

The results show the expected export (under the differing project alternatives) of phosphorus, nitrogen, organic carbon, and sediment from the project area over the period 1943-2009. Because the current analysis fully incorporated export via runoff, the estimates were substantially higher than those reported by Ashby et al. (2000). However, the effect of the authorized project on export, relative to the existing condition, remained similar (i.e., 15% reduction in total phosphorous (TP) and total nitrogen (TN) export, up to 60% reduction in sediment export). The conclusion of no discernible impact on Mississippi River water quality was also reconfirmed.

Export from the two areas (i.e., St. Johns Bayou Basin and the New Madrid Floodway) within the overall project is addressed separately. The analysis assumed that effects in the two areas would be independent and thus strictly additive. Therefore, the effect of any combination of management actions in two separate areas on export can be inferred by adding the separate effects together.

The effect of the project alternatives on material export in comparison to future without-project conditions varies considerably among the constituents of interest and between the two project areas. For example, in the New Madrid Floodway, net average export of total phosphorus would be reduced on future without-project conditions by about 15-20 percent by either alternative 2 (Authorized Project) or alternative 3 (Avoid and Minimize Scenarios). However, in the St. Johns Bayou Basin, the authorized project showed little effect on TP export in comparison with the future without-project condition. Likewise, TN export showed no discernible influence from the authorized project in St. Johns Bayou Basin, but in the New Madrid Floodway, the authorized project and avoid and minimize scenarios all reduce average nitrogen export by about 15% from future without project conditions. Likewise, the authorized project in the St. Johns Bayou Basin showed little influence on organic carbon export (possibly a 10-15 percent increase), but in the New Madrid Floodway, the authorized project cuts export in half, and the avoid and minimize scenarios reduce organic carbon export by about 40 percent. The pattern of sediment is similar to carbon. The authorized project has little influence on sediment export from the St. Johns Bayou Basin (possible 10 percent increase) but cuts export from the New Madrid Floodway by nearly 60 percent. The avoid and minimize scenarios reduce sediment export from the New Madrid Floodway by about half. The reforestation alternative for the New Madrid Floodway reduces exports by an additional 30-50 percent over the other authorized project alternatives.

Time series analyses (annual time step) of these same, seasonal data emphasized the effects of the project and showed the strong, positive influence of high water on material export (Table 4.63). For example, the difference between existing conditions and the authorized project export of TP in the New Madrid Floodway during high water was dramatic, but only accounted for a 15 percent difference in average, total export over the period of record. This is more easily understood in the context of the relatively high "baseline" export (e.g., 30 metric tons/year) of phosphorus that occurred in extended periods without inundation.

Table 4.63. Seasonal exports (metric tons) of phosphorus, nitrogen, organic carbon and sediment from the New Madrid Floodway and St. Johns Bayou Basin during the period of record 1943 to 2009. The seasonal (Nov-May) export in each water year is calculated as the sum of two parts of the overall inundation season (season 1 is Nov - Jan and season 2 is Feb - May).

Basin	Alternative	Total Phosphorous			
		Min.	Max.	Mean	N
St. Johns Bayou Basin	1	17	72	22	67
	2.1	20	66	24	67
New Madrid Floodway	1	29	130	38	67
	2.2	30	33	31	67
	3.1	30	40	32	67
	3.2	30	40	32	67
	4.1				67
	4.2	24	28	25	67
Basin	Alternative	Total Nitrogen			
		Min.	Max.	Mean	N
St. Johns Bayou Basin	1	200	520	230	67
	2.1	210	470	230	67
New Madrid Floodway	1	370	1,200	440	67
	2.2	370	390	380	67
	3.1	370	440	390	67
	3.2	370	440	390	67
	4.1				67
	4.2	150	180	160	67
Basin	Alternative	Organic Carbon			
		Min.	Max.	Mean	N
St. Johns Bayou Basin	1	130	1,500	260	67
	2.1	200	13,000	290	67
New Madrid Floodway	1	216	3,300	500	67
	2.2	252	350	280	67
	3.1	250	600	320	67
	3.2	250	600	310	67
	4.1				67
	4.2	200	470	260	67

Table 4.63. Continued.

Basin	Alternative	Suspended Sediment			
		Min.	Max.	Mean	N
St. Johns Bayou Basin	1	4,600	74,000	10,000	67
	2.1	7,500	62,000	11,000	67
New Madrid Floodway	1	7,600	179,000	22,000	67
	2.2	8,700	115,000	10,000	67
	3.1	8,700	23,000	11,000	67
	3.2	8,700	23,000	11,000	67
	4.1				67
	4.2	6,000	20,000	7,500	67

4.10.4 Conclusion

Analysis indicates that the authorized project, with or without the avoid-and-minimize alternatives would generally reduce export of materials from the project area into the Mississippi River. Alternative 4.2, which converts agriculture to forest in much of the project area in the New Madrid basin, would reduce phosphorus exports by an additional 20 percent and would reduce nitrogen exports by an additional 60 percent. Likewise, sediment reduction under alternative 4.2 is estimated to be 60 percent of the existing condition. These reductions would be a positive ecological effect. Further, the analysis of the limited water quality that exists for water bodies within the project area gave no indication that the project would further degrade water quality in these water bodies.

4.11 Project Area Ditches

The St. Johns Bayou Basin and New Madrid Floodway Project consists of managing flood risks by means of closure of the 1,500 foot Mississippi River Levee gap in the New Madrid Floodway, construction of two pumping stations (one in each of the two basins), and channel modifications in the St. Johns Bayou Basin. A key aspect of the channel improvement features is to reduce flooding in East Prairie. In fact, East Prairie has recently received grant money from EPA to help improve the city's storm water conveyance. However, during periods of high Mississippi River stages, impounded interior runoff still has the potential to back up into St. James Bayou and inundate the city.

In 2007, the State of Missouri partnered with USACE to develop the State of Missouri Stream Mitigation Method (MSMM) with the purpose of compensating for unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. Although the MSMM is not a certified model, it is routinely used in the state of Missouri to quantify linear impacts to streams and determine appropriate amounts of mitigation. Additional, the MSMM was used for this project at the request of the interagency team (IAT). Although the Stream Mitigation Guidelines were primarily designed for impacts associated with natural streams, they were utilized for impacts associated with manmade drainage ditches for the purposes of this project.

4.11.1 Alternative 1 – No Action

The ditches within the project area currently experience periodic maintenance activities common to intensively farmed watersheds (*e.g.*, channel cleanouts, vegetative clearing, culvert replacements, etc.) in order to facilitate drainage. Future maintenance activities would continue under no action conditions.

4.11.2 Alternative 2.1

Figure 4.8 provides a map of proposed construction reaches. The lower 3.7 miles of St. Johns Bayou would be cleared and enlarged on both sides; the bottom width would be increased from approximately 80 feet to 200 feet. Approximately 2,485,000 cubic yards of material would be deposited along both banks creating a 220-foot wide embankment on each side. The bottom width along the lower 8.2 miles of Setback Levee Ditch would be enlarged from approximately 40 feet to 50 feet. The work would take place along the left descending bank and approximately 675,000 cubic yards of material would be placed in a 120-foot wide embankment. St. James Ditch would be enlarged along the left descending bank. Bottom width along the lower 3.5 miles would be enlarged from approximately 35 feet to 45 feet. The remaining 7.8 miles of channel would see no increase in bottom width; however, top width would be increased along the left descending bank to an 80-foot average. Approximately 630,000 cubic yards of material would be placed on a 100-foot embankment on the left descending bank. Although construction activities in the St. Johns Bayou Basin will enlarge the ditches, significant degradation and significant secondary effects are not expected, because these ditches are not natural streams. The ditches were constructed decades ago to allow for profitable agricultural production. Agricultural ditches in the project area consist of straight, trapezoidal channels with a relatively flat, uniform bed devoid of substantial structure. All ditches undergo routine vegetation and sediment removal. Following channel enlargement, ditches will still be morphologically similar (straight, trapezoidal channels with limited structure).

In addition to the proposed channel modifications, nine transverse dikes would be constructed with rip-rap in the lower 3.7 miles of St. Johns Bayou to create a low flow sinuous channel. Although scientifically recognized as improvement features, the placement of transverse dikes to create a sinuous low flow channel has been requested to be addressed as an impact by EPA. Although each of the nine proposed dikes varies slightly in size, an average dike fill area of 200 feet by 50 feet will be used in impact determination. While the footprints of the dikes themselves are classified as an impact, the benefit to the overall reach of the ditch will also be calculated as mitigation measures. In addition to the nine transverse dikes, four areas will be protected by the placement of riprap to stabilize the ditch channel: the confluence of St. Johns Bayou and Setback Levee Ditch, the confluence of Setback Levee Ditch and St. James Ditch, as well as two bridge crossings along Setback Levee Ditch. These measures, transverse dikes and hard points, at the confluence of tributaries, as well as the replacement of adjacent culverts, also ensure the proposed project does not inadvertently lead to channel incision or stability problems.

Following IAT guidance, the PDT consulted with the Memphis District USACE Regulatory Branch to determine the construction reaches along project area ditches that would trigger the MSMM. The Regulatory Branch concluded that the proposed activity along the upper 7.8 miles of St. James Ditch would not be considered an impact as bottom widths would remain unchanged. The reach, however, should be a target location for mitigation as the ditch is commonly planted and farmed to top bank (Figure 3.2).

Adverse Impacts

Following USACE and MSMM guidelines (Appendix P, Part 1), data sheets were completed to determine adverse impacts in the St. Johns Bayou resulting from the authorized project (Appendix P, Part 2). The following assumptions were used:

- St. Johns Bayou (Dominant Impact Type 1 and 2), Setback Levee Ditch (Dominant Impact Type 3), and St. James Ditch (Dominant Impact Type 4) were classified as perennial stream type. The perennial stream type designation was applied due to the fact that these ditches have flowing water year-round during a typical year.
- St. Johns Bayou, Setback Levee Ditch, and St. James Ditch were classified as tertiary for priority area. The tertiary designation was assigned due to these ditches not meeting criteria to establish them as primary or secondary. A 19 April 13 search of the USFWS Critical Habitat Portal revealed no critical habitat (including fish spawning and rearing) for Mississippi, Scott, and New Madrid Counties, MO.
- St. Johns Bayou, Setback Levee Ditch, and St. James Ditch were considered functionally impaired as at least one of the following required criteria has been met:
    - The ditch was previously channelized.
    - The ditch has little or no riparian buffer on one or both sides.
    - The ditch has extensive human-induced sedimentation.
- Duration of impact considered permanent for St. Johns Bayou and the nine transverse dikes (Dominant Impact Type 5) to be placed within St. Johns Bayou. This designation has been made due to impacts being permanent. Examples of permanent impacts include: armoring, detention, morphological change, impoundments, piping, and channelization.
- Duration of impact considered recurrent for Setback Levee Ditch and St. James Ditch. The recurrent impact duration is assigned as these areas will undergo reshaping/maintaining a drainage ditch in an already channelized stream segment.
- Activity for St. Johns Bayou, Setback Levee Ditch, St. James Ditch, and the nine transverse dikes was classified as a morphological change. A Morphologic change is classified as channelization, dredging, or otherwise altering the established or natural dimensions, depths, or limits of a ditch/stream corridor.

- Activity for the stability structures at the confluences of St. Johns Bayou and Setback Levee Ditch (Dominant Impact Type 6), and St. James Bayou and Setback Levee Ditch (Dominant Impact Type 7), as well as the rip-rap placement at bridge crossings along two county road bridges over Setback Levee Ditch (Dominant Impact Types 8 and 9) was assigned the armor designation, which is applied when activities consist of riprap, bulkhead, or use other rigid methods to contain stream channels.
- Linear Impact was calculated as described in the MSMM for St. Johns Ditch, Setback Levee Ditch and St. James Ditch. The nine transverse dikes, stability structures at confluences and riprap located at bridge crossings all were under 1,000 feet of impact and were assigned a linear impact based on designations contained in the adverse stream impact worksheet.

The authorized project would result in the requirement to mitigate for 699,685.6 stream credits in the St. Johns Bayou Basin according to the MSMM.

4.11.3 Alternative 2.2

Alternative 2.2 concerns the closure of the 1,500-foot gap at the lower end of the New Madrid Floodway across Mud Ditch. The levee would be constructed of approximately 233,000 cubic yards of earthen material. Cross sectional dimensions would be a crown elevation of 317.0 feet, a top width of 16 feet, a base width of approximately 302 feet, and side slopes of 1:4.5. Similar to the St. Johns Bayou Basin, significant secondary effects are not expected in the New Madrid Floodway because these ditches are not natural streams. The ditches were constructed decades ago to convert bottomland hardwoods to cropland. Agricultural ditches in the project area consist of straight, trapezoidal channels with a relatively flat, uniform bed devoid of substantial structure. All ditches undergo routine vegetation and sediment removal. Following channel enlargement, ditches will still be morphologically similar (straight, trapezoidal channels with limited structure).

Adverse Impacts

Following USACE and MSMM guidelines, data sheets were completed to determine adverse impacts in the New Madrid Floodway resulting from the authorized project (Appendix P, Part 2). The following assumptions were used:

- Mud Ditch was classified as perennial stream type. This designation was given due to the fact that Mud Ditch has flowing water year-round during a typical year.
- Mud Ditch (Dominant Impact Type 1) was classified as tertiary for priority area. The tertiary designation was assigned due to the ditch not meeting criteria to establish them as primary or secondary. A 19 April 13 search of the USFWS Critical Habitat Portal revealed no critical habitat (including fish spawning and rearing) for Mississippi, Scott, and New Madrid Counties, MO.
- Mud Ditch was considered functionally impaired as at least one of the following required criteria has been met:

  - o The ditch was previously channelized.
  - o The ditch has little or no riparian buffer on one or both sides.
  - o The ditch has extensive human-induced sedimentation.
- Duration of impact was considered permanent for Mud Ditch. This designation has been made due to impacts being permanent.
- Activity for Mud Ditch is classified as pipe, which is defined as routing a ditch/stream through pipes, box culverts, or other enclosed structures.
- Linear Impact for Mud Ditch was assigned 0.1 as the impact reach would be between 200-500 feet.

The authorized project would result in the requirement to mitigate for 1,087.2 stream credits in the New Madrid Floodway according to the MSMM.

4.11.4 Alternatives 2.3, 3.1, 3.2, 4.1, and 4.2

Alternative 2.3 combines the impacts from alternatives 2.1 and 2.2, resulting in the need for 700,772.8 mitigation credits. The avoid and minimize alternatives (3.1, 3.2, 4.1 and 4.2) proposed by USACE include reducing the bottom width enlargement on St. Johns Bayou from 200 feet to 120 feet and conducting the channel enlargement on all three reaches from one side only. However, the current MSMM guidelines do not acknowledge any type of credit from reducing the impact as proposed. Impacts are determined by linear feet along a ditch, i.e., there are no differences in computed impacts from widening a ditch by one foot or 100 feet or by conducting channel enlargement from one side as opposed to both. Due to these issues, implementation of avoidance and minimization measures would require the same mitigation as the authorized project. Regardless, USACE intends to implement these avoid and minimize measures as an environmental design feature.

4.12 Ecosystem Services

In an effort to calculate all benefits and impacts for the project, ecosystem services, specifically carbon sequestration and nutrient cycling, have been quantified to show the impacts/benefits for selected project alternatives. While reported monetary values widely vary for these services in literature, results are presented as actual units stored or released as a result of project alternatives. While a carbon footprint was calculated for the project, no mitigation is required or included to offset the carbon footprint, as that burden typically falls on the producer (power plants) rather than the consumer. Alternative 3.1 (and 2.1 for the St. Johns bayou Basin) is the tentatively selected plan. Detailed mitigation scenarios were not developed for other project alternatives; therefore, ecosystem service quantification will be limited to the alternatives with developed mitigation scenarios and major land cover changes.

4.12.1 Carbon Sequestration

Carbon sequestration was calculated for live tree carbon, soil carbon, and other carbon, which consists of standing dead woody material, dead and down woody material and forest floor carbon. The carbon footprint consists solely of the anticipated carbon dioxide (CO_2) emissions produced by the two electrical pumping stations required for pumping operations. Anticipated energy required by pumping operations was calculated from the 67 year period of record and determined by hydrologic requirements of each alternative. Soil carbon sequestration values were obtained from Murray et al (2009), which are equal to gains in afforested areas of 69.23 lbs/acre/year. To estimate carbon sequestration on agricultural areas, conventional tillage is assumed. As a result of crop production, carbon levels in agricultural lands tend to decrease over time as carbon is oxidized and released into the atmosphere (Jenkins et al 2010). Therefore, soil carbon losses in agricultural areas are assumed to be 45.91 lbs/acre/year (Murray et al 2009). Live tree carbon sequestration estimates were obtained from Shoch et al (2009), who reported carbon gains of 4.88 tons/acre/year. Other carbon values (standing dead, dead and down and forest floor) were obtained from the FORCARB2 (Smith et al. 2006) table for carbon stocks for oak-gum-cypress stands in the South Central U.S., which equate to gains in carbon storage of 230.2 lbs/acre/year. All losses/gains of carbon were calculated on changes in landcover classification (i.e., carbon gains for forest that stayed in forest were not calculated).

4.12.1.1 Alternative 1 – No Action

The project would not be constructed. Therefore, there would not be an associated deviation in carbon footprint. However, as assumed WRP gains occur, agricultural land is taken out of production and the change of land classifications to forest, herbaceous or open water land cover classifications results in carbon sequestration gains (Tables 4.64 and 4.65); all other land use classes remain constant. An assumption for the ecosystem services for alternative 1 is that the WRP enrollment land cover is used throughout the 50-year project life; in reality, the WRP gains would occur over time, which leads to an overestimate of ecosystem services provided by the alternative. Alternative 1, over the 50-year project life, would sequester 565,593.13 tons of carbon, all gained by converting agriculture to other land classes.

Table 4.64. Carbon sequestered in the St. Johns Bayou Basin from alternative 1 implementation.

	Agriculture	Forest	Herbaceous	Open Water
Existing (acres)	37,010.40	6,441.00	264.70	313.10
Alt. 1 (acres)	34,680.08	8,072.27	730.80	546.16
Net Change (acres)	-2,330.32	1,631.27	466.10	233.06
Soil Carbon (Mg/ha/year)	-0.05	0.08	0.08	-
Soil Carbon (lbs/acre/year)	-45.91	69.23	69.23	-
Soil Carbon (lbs/year)	106,982.96	112,938.36	32,269.69	-
Project Life Soil Carbon (tons)	2,674.57	2,823.46	806.74	-
Live Tree Carbon (tonnes/acre/year)	-	4.43	-	-
Live Tree Carbon (tons/acre/year)	-	4.88	-	-
Live Tree Carbon (tons/year)	-	7,965.88	-	-
Project Life Live Tree Carbon (tons)	-	398,293.96	-	-
Other Carbon (Mg/acre/year)	-	0.26	-	-
Other Carbon (lbs/acre/year)	-	230.20	-	-
Other Carbon (lbs/year)	-	375,511.43	-	-
Project Life Other Carbon (tons)	-	9,387.79	-	-
Total Project Life Carbon Sequestered (tons)	2,674.57	410,505.21	806.74	0.00

Table 4.65. Carbon sequestered in the New Madrid Floodway from alternative 1 implementation.

	Agriculture	Forest	Herbaceous	Open Water
Existing (acres)	65,637.61	8,859.67	772.16	709.58
Alt. 1 (acres)	64,784.20	9,457.06	942.85	794.92
Net Change (acres)	-853.41	597.39	170.68	85.34
Soil Carbon (Mg/ha/year)	-0.05	0.08	0.08	-
Soil Carbon (lbs/acre/year)	-45.91	69.23	69.23	-
Soil Carbon (lbs/year)	39,179.49	41,359.32	11,816.95	-
Project Life Soil Carbon (tons)	979.49	1,033.98	295.42	-
Live Tree Carbon (tonnes/acre/year)	-	4.43	-	-
Live Tree Carbon (tons/acre/year)	-	4.88	-	-
Live Tree Carbon (tons/year)	-	2,917.20	-	-
Project Life Live Tree Carbon (tons)	-	145,859.80	-	-
Other Carbon (Mg/acre/year)	-	0.26	-	-
Other Carbon (lbs/acre/year)	-	230.20	-	-
Other Carbon (lbs/year)	-	137,516.57	-	-
Project Life Other Carbon (tons)	-	3,437.91	-	-
Total Project Life Carbon Sequestered (tons)	979.49	150,331.70	295.42	0.00

4.12.1.2 Alternatives 2.1 and 3.1

Anticipated energy use of pumps was calculated from simulating pumping operations during a 67 year period of record (1 October 1942 through 12 November 2009). It was determined that 112,133,784 kilowatt hours (kWh) and 75,928,114 kWh would have been required to remove impounded interior water according to operating conditions for the St. Johns Bayou Basin and New Madrid Floodway, respectively (Tables 4.66 and 4.67). Additionally, proposed mitigation for the alternatives would take 10,484.37 acres out of agricultural production and reforest 9,493.14 acres, leading to increases in carbon sequestration. The tentatively selected plan would sequester 2,294,491.51 tons of carbon over the course of the project life. As seen with the no-action alternative, taking agriculture out of production coupled with the land use conversion to forest yields considerable gains in carbon sequestration.

Table 4.66. Carbon sequestered in the St. Johns Bayou Basin from alternative 2.1 implementation.

	Agriculture	Forest	Herbaceous	Open Water
Future without-Project (acres)	34,680.08	8,072.27	730.80	546.16
Alt. 2.1 with Mitigation (acres)	31,894.71	10,358.41	843.03	933.16
Net Change (acres)	-2,785.37	2,286.14	112.23	387.00
Soil Carbon (Mg/ha/year)	-0.05	0.08	0.08	-
Soil Carbon (lbs/acre/year)	-45.91	69.23	69.23	-
Soil Carbon (lbs/year)	127,873.91	158,277.24	7,770.06	-
Project Life Soil Carbon (tons)	3,196.85	3,956.93	194.25	-
Live Tree Carbon (tonnes/acre/year)	-	4.43	-	-
Live Tree Carbon (tons/acre/year)	-	4.88	-	-
Live Tree Carbon (tons/year)	-	11,163.77	-	-
Project Life Live Tree Carbon (tons)	-	558,188.26	-	-
Other Carbon (Mg/acre/year)	-	0.26	-	-
Other Carbon (lbs/acre/year)	-	230.20	-	-
Other Carbon (lbs/year)	-	526,259.72	-	-
Project Life Other Carbon (tons)	-	13,156.49	-	-
Total Project Life Carbon Sequestered (tons)	3,196.85	575,301.68	194.25	0.00
Total Carbon Sequestered (tons)	578,692.78			
Pump Use (kWh)	83,681,928.36			
CO_2 from Pumps (tons)	63,598.27			
Net Gain in Carbon Sequestered (tons)	515,094.51			

Table 4.67. Carbon sequestered in the New Madrid Floodway from alternative 3.1 implementation.

	Agriculture	Forest	Herbaceous	Open Water
Future without-Project (acres)	64,784.20	9,457.06	942.85	794.92
Alt. 3.1 with Mitigation (acres)	60,567.20	13,614.06	942.85	854.92
Alt. 3.1 Batture Mitigation (acres)	-3,482.00	3,050.00	0.00	432.00
Net Change (acres)	-7,699.00	7,207.00	0.00	492.00
Soil Carbon (Mg/ha/year)	-0.05	0.08	0.08	-
Soil Carbon (lbs/acre/year)	-45.91	69.23	69.23	-
Soil Carbon (lbs/year)	353,454.39	498,965.09	0.00	-
Project Life Soil Carbon (tons)	8,836.36	12,474.13	0.00	-
Live Tree Carbon (tonnes/acre/year)	-	4.43	-	-
Live Tree Carbon (tons/acre/year)	-	4.88	-	-
Live Tree Carbon (tons/year)	-	35,193.49	-	-
Project Life Live Tree Carbon (tons)	-	1,759,674.72	-	-
Other Carbon (Mg/acre/year)	-	0.26	-	-
Other Carbon (lbs/acre/year)	-	230.20	-	-
Other Carbon (lbs/year)	-	1,659,020.80	-	-
Project Life Other Carbon (tons)	-	41,475.52	-	-
Total Project Life Carbon Sequestered (tons)	8,836.36	1,813,624.36	0.00	0.00
Total Carbon Sequestered (tons)	1,822,460.72			
Pump Use (kWh)	56,662,794.03			
CO2 from Pumps (tons)	43,063.72			
Net Gain in Carbon Sequestered (tons)	1,779,397.00			

4.12.1.3 Alternative 4.2

Alternative 4.2 entails providing flood protection in the New Madrid Floodway only to elevations greater than 290 feet as well as reforestation of all agricultural areas below 290 feet. The St. Johns Bayou Basin alternative 2.1 carbon sequestration results would be coupled with alternative 4.2 in the New Madrid Floodway to obtain overall carbon sequestration results for this alternative. Energy required to pump to the required elevation is substantially lower for alternative 4.2, as protection is provided to only elevations at 290 feet and above. Carbon sequestration results for alternative 4.2 are provided in Table 4.68. Alternative 4.2, over the course of the project life, would sequester 3,746,928.81 tons of carbon.

Table 4.68. Carbon sequestered in the New Madrid Floodway from Alternative 4.2 implementation.

	Agriculture	Forest	Herbaceous	Open Water
Future without-Project (acres)	64,784.20	9,457.06	942.85	794.92
Alt. 4.2 (acres)	50,064.25	22,276.44	2,843.41	794.92
Net Change (acres)	-14,719.95	12,819.38	1,900.56	0.00
Soil Carbon (Mg/ha/year)	-0.05	0.08	0.08	-
Soil Carbon (lbs/acre/year)	-45.91	69.23	69.23	-
Soil Carbon (lbs/year)	675,780.10	887,529.22	131,582.23	-
Project Life Soil Carbon (tons)	16,894.50	22,188.23	3,289.56	-
Live Tree Carbon (tonnes/acre/year)	-	4.43	-	-
Live Tree Carbon (tons/acre/year)	-	4.88	-	-
Live Tree Carbon (tons/year)	-	62,600.08	-	-
Project Life Live Tree Carbon (tons)	-	3,130,004.00	-	-
Other Carbon (Mg/acre/year)	-	0.26	-	-
Other Carbon (lbs/acre/year)	-	230.20	-	-
Other Carbon (lbs/year)	-	2,950,966.84	-	-
Project Life Other Carbon (tons)	-	73,774.17	-	-
Total Project Life Carbon Sequestered (tons)	16,894.50	3,225,966.41	3,289.56	0.00
Total Carbon Sequestered (tons)	3,246,150.46			
Pump Use (kWh)	18,837,061.19			
CO_2 from Pumps (tons)	14,316.17			
Net Gain in Carbon Sequestered (tons)	3,231,834.30			

4.12.2 Nutrient Cycling

Nutrient cycling analysis consisted of estimating nitrogen loading using conventional agricultural practices for five main crop species (all others were classified as "other") in the project area. Estimated nitrate (NO_3) losses on agricultural land as well as the denitrification potential of wetlands were obtained from Jenkins et al. (2010).

4.12.2.1 Alternative 1 – No Action

The project would not be constructed. However, the no action alternative does assume that agricultural land would continue to be enrolled in WRP. Nitrogen loading gains/losses for alternative 1 are provided in Tables 4.69 and 4.70.

Alternative 1 results in a combined ecosystem service benefit of removing 3,876.77 tons of nitrogen from the project area over the 50 year project life.

4.12.2.2 Alternatives 2.1 and 3.1

The tentatively selected plan would remove 12,183.92 tons of nitrogen from the project area over the course of the project life due to compensatory mitigation for fish and wildlife impacts (Tables 4.71 and 4.72). As with the no action alternative, tremendous gains in nitrogen reduction are seen by the removal of agricultural land from production, and when coupled with reforestation, the effects on adjacent and downstream landscapes would be very beneficial.

4.12.2.3 Alternative 4.2

Alternative 4.2 entails providing flood protection in the New Madrid Floodway only to elevations greater than 290 feet as well as reforestation of all agricultural areas below 290 feet. The St. Johns Bayou Basin alternative 2.1 nitrogen loading results would be coupled with alternative 4.2 in the New Madrid Floodway (Table 4.73) to obtain overall nitrogen loading results for this alternative.

If implemented, alternative 4.2, combined with results from alternative 2.1, would result in a nitrogen loading reduction of 20,645.18 tons over the course of the project life.

Table 4.69. Nitrogen loading gains/loss from alternative 1 in the St. Johns Bayou Basin.

Existing Conditions								
	Corn	Cotton	Rice	Soy	Wheat	Other	WRP Gains	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
St. Johns Bayou Basin Acres (300' & Below)	2,810.53	188.34	3,222.32	30,182.82	24.58	581.85		37,010.44
Crop NO_3 Contribution (lbs/year)	62,354.14	4,933.64	200,688.99	779,893.89	124.83	6,791.41		1,054,786.90
Project Life Crop NO_3 Contribution (tons)	1,558.85	123.34	5,017.22	19,497.35	3.12	169.79		26,369.67
Future without-Project								
	Corn	Cotton	Rice	Soy	Wheat	Other	WRP Gains	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
St. Johns Bayou Basin Acres (300' & Below)	2,633.57	176.49	3,019.42	28,282.37	23.03	545.21		34,680.09
Crop NO_3 Contribution (lbs/year)	58,428.12	4,623.23	188,052.20	730,788.16	116.96	6,363.75		988,372.41
Project Life Crop NO_3 Contribution (tons)	1,460.70	115.58	4,701.30	18,269.70	2.92	159.09		24,709.31
Acres of Projected WRP Gains	N/A						2,330.35	
Estimated Denitrification Rates (kg N/ha/year)							23.62	
Estimated Denitrification Rates (lbs N/acre/year)							21.05	
WRP Denitrification (lbs N/year)							49,043.19	
Project Life WRP N Denitrification (tons)							1,226.08	
Reduction in NO_3 Loss/WRP Denitrification Gains (tons)	98.15	7.76	315.92	1,227.64	0.20	10.69	1,226.08	2,886.44

N/A - Not Applicable

Table 4.70. Nitrogen loading gains/loss from alternative 1 in the New Madrid Floodway.

Existing Conditions								
	Corn	Cotton	Rice	Soy	Wheat	Other	WRP Gains	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
New Madrid Floodway Acres (300' & Below)	5,365.90	182.42	565.38	57,313.38	63.38	2,147.15		65,637.61
Crop NO_3 Contribution (lbs/year)	119,047.22	4,778.68	35,212.49	1,480,920.37	321.88	25,061.76		1,665,342.40
Project Life Crop NO_3 Contribution (tons)	2,976.18	119.47	880.31	37,023.01	8.05	626.54		41,633.56
Future without-Project								
	Corn	Cotton	Rice	Soy	Wheat	Other	WRP Gains	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
New Madrid Floodway Acres (300' & Below)	5,296.13	180.05	558.03	56,568.19	62.56	2,119.23		64,784.20
Crop NO_3 Contribution (lbs/year)	117,499.38	4,716.54	34,754.67	1,461,665.59	317.70	24,735.91		1,643,689.78
Project Life Crop NO_3 Contribution (tons)	2,937.48	117.91	868.87	36,541.64	7.94	618.40		41,092.24
Acres of Projected WRP Gains	N/A						853.41	853.41
Estimated Denitrification Rates (kg N/ha/year)							23.62	23.62
Estimated Denitrification Rates (lbs N/acre/year)							21.05	21.05
WRP Denitrification (lbs N/year)							17,960.46	17,960.46
Project Life WRP N Denitrification (tons)							449.01	449.01
Reduction in NO_3 Loss/WRP Denitrification Gains (tons)	38.70	1.55	11.45	481.37	0.10	8.15	449.01	990.33

N/A - Not Applicable

Table 4.71. Nitrogen loading gains/loss from alternative 2.1 in the St. Johns Bayou Basin.

Future without-Project								
	Corn	Cotton	Rice	Soy	Wheat	Other	Mitigation	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
St. Johns Bayou Basin Acres (300' & Below)	2,633.57	176.49	3,019.42	28,282.37	23.03	545.21		34,680.09
Crop NO_3 Contribution (lbs/year)	58,428.12	4,623.23	188,052.20	730,788.16	116.96	6,363.75		988,372.41
Project Life Crop NO_3 Contribution (tons)	1,460.70	115.58	4,701.30	18,269.70	2.92	159.09		24,709.31
Alternative 2.1								
	Corn	Cotton	Rice	Soy	Wheat	Other	Mitigation	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
St. Johns Bayou Basin Acres (300' & Below)	2,422.05	162.31	2,776.91	26,010.83	21.18	501.42		31,894.71
Crop NO_3 Contribution (lbs/year)	53,735.38	4,251.91	172,948.52	672,093.89	107.57	5,852.63		908,989.90
Project Life Crop NO_3 Contribution (tons)	1,343.38	106.30	4,323.71	16,802.35	2.69	146.32		22,724.75
Acres of Projected Mitigation Gains	N/A						2,398.38	2,398.38
Estimated Denitrification Rates (kg N/ha/year)							23.62	23.62
Estimated Denitrification Rates (lbs N/acre/year)							21.05	21.05
Mitigation Denitrification (lbs N/year)							50,474.91	50,474.91
Project Life Mitigation N Denitrification (tons)							1,261.87	1,261.87
Reduction in NO_3 Loss/Mitigation Denitrification Gains (tons)	117.32	9.28	377.59	1,467.36	0.23	12.78	1,261.87	3,246.44

N/A - Not Applicable

Table 4.72. Nitrogen loading gains/loss from alternative 3.1 in the New Madrid Floodway.

Future without-Project								
	Corn	Cotton	Rice	Soy	Wheat	Other	Mitigation	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
New Madrid Floodway Acres (300' & Below)	5,296.13	180.05	558.03	56,568.19	62.56	2,119.23		64,784.20
Crop NO_3 Contribution (lbs/year)	117,499.38	4,716.54	34,754.67	1,461,665.59	317.70	24,735.91		1,643,689.78
Project Life Crop NO_3 Contribution (tons)	2,937.48	117.91	868.87	36,541.64	7.94	618.40		41,092.24
Alternative 3.1								
	Corn	Cotton	Rice	Soy	Wheat	Other	Mitigation	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
New Madrid Floodway Acres (300' & Below)	4,951.39	168.33	521.71	52,885.99	58.48	1,981.29		60,567.19
Crop NO_3 Contribution (lbs/year)	109,850.98	4,409.53	32,492.38	1,366,521.17	297.02	23,125.77		1,536,696.86
Project Life Crop NO_3 Contribution (tons)	2,746.27	110.24	812.31	34,163.03	7.43	578.14		38,417.42
Agricultural Acres Removed in Batture for Mitigation	N/A						3,482.00	3,482.00
Batture Crop NO_3 Contribution (lbs/acre/year)							25.41	25.41
Batture Crop NO_3 Contribution (lbs/year)							88,477.62	88,477.62
Project Life Batture Crop NO_3 Contribution (tons)							2,211.94	2,211.94
Acres of Projected Mitigation Gains							7,699.00	7,699.00
Estimated Denitrification Rates (kg N/ha/year)							23.62	23.62
Estimated Denitrification Rates (lbs N/acre/year)							21.05	21.05
Mitigation Denitrification (lbs N/year)							162,028.69	162,028.69
Project Life Mitigation N Denitrification (tons)							4,050.72	4,050.72
Reduction in NO_3 Loss/Mitigation Denitrification Gains (tons)	191.21	7.68	56.56	2,378.61	0.52	40.25	6,262.66	8,937.48

N/A - Not Applicable

Table 4.73. Nitrogen loading gains/loss from alternative 4.2 in the New Madrid Floodway.

Future without-Project								
	Corn	Cotton	Rice	Soy	Wheat	Other	Reforestation	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
New Madrid Floodway Acres (300' & Below)	5,296.13	180.05	558.03	56,568.19	62.56	2,119.23		64,784.20
Crop NO_3 Contribution (lbs/year)	117,499.38	4,716.54	34,754.67	1,461,665.59	317.70	24,735.91		1,643,689.78
Project Life Crop NO_3 Contribution (tons)	2,937.48	117.91	868.87	36,541.64	7.94	618.40		41,092.24
Alternative 4.2								
	Corn	Cotton	Rice	Soy	Wheat	Other	Reforestation	Total
Estimated NO_3 loss (kg/ha/year)	24.90	29.40	69.90	29.00	5.70	13.10	N/A	-
Estimated NO_3 loss (lbs/acre/year)	22.19	26.20	62.28	25.84	5.08	11.67		-
New Madrid Floodway Acres (300' & Below)	5,123.51	176.47	370.68	42,238.70	61.97	2,092.91		50,064.24
Crop NO_3 Contribution (lbs/year)	113,669.68	4,622.70	23,086.28	1,091,405.77	314.73	24,428.65		1,257,527.82
Project Life Crop NO_3 Contribution (tons)	2,841.74	115.57	577.16	27,285.14	7.87	610.72		31,438.20
Acres of Projected Reforestation Gains	N/A						14,719.95	14,719.95
Estimated Denitrification Rates (kg N/ha/year)							23.62	23.62
Estimated Denitrification Rates (lbs N/acre/year)							21.05	21.05
Reforestation Denitrification (lbs N/year)							309,787.53	309,787.53
Project Life Mitigation N Denitrification (tons)							7,744.69	7,744.69
Reduction in NO_3 Loss/Mitigation Denitrification Gains (tons)	95.74	2.35	291.71	9,256.50	0.07	7.68	7,744.69	17,398.74

N/A - Not Applicable

4.12.3 Ecosystem Services Conclusions

Management efforts must be made at specific landscape locations to reduce nutrient runoff, which would improve the water quality of streams and rivers, leading to a reduction of the hypoxic zone in the Gulf of Mexico (Robertson et al., 2009). Results from nitrogen loading analysis (Table 4.74) indicate that agricultural land taken out of production and reforested would yield nitrogen loading reductions, possibly leading to a reduction or a delay in growth of the hypoxic zone in the Gulf of Mexico. Sequestration of carbon (Table 4.74) mirrors the trend seen in nitrogen loading reductions, helping to offset the effects of global warming by mitigating greenhouse gas emissions.

Table 4.74. Gains in tons of carbon sequestration and nutrient retention over the project life for selected project alternatives.

	St. Johns Bayou Basin		New Madrid Floodway		
Alternative	1	2.1	1	3.1	4.2
Soil Carbon	6,304.78	7,348.03	2,308.89	21,310.49	42,372.29
Live Tree Carbon	398,293.96	558,188.26	145,859.80	1,759,674.72	3,130,004.00
Other Carbon	9,387.79	13,156.49	3,437.91	41,475.52	73,774.17
Total Carbon*	413,986.52	515,094.51	151,606.61	1,779,397.00	3,231,834.30
Nitrogen Loading	2,886.44	3,246.44	990.33	8,937.48	17,398.74

* Includes deduction for Pump Operations (Alternatives 2.1, 3.1 and 4.2).

Although not calculated, phosphorous loading is also a significant contributor to degraded water quality throughout the MAV. Robertson et al (2009) had calculated TP yields in the project area of 166 – 858 kg/km^2/year, which makes it a top 15 (of 847) watershed for contributions of phosphorous loading in the MAV. As with nitrogen reductions from project implementation, phosphorous loading would be expected to be reduced as well.

Implementation of the preferred project alternative (New Madrid Floodway 3.1 and St. Johns Bayou Basin 2.1) would yield considerable gains in ecosystem services, both within the project area as well as in adjacent and downstream ecosystems primarily from mitigation necessary to compensate for impacts to fish and wildlife resources. Conversion of agricultural land to forest, coupled with the proposed stream bank buffers, would help mitigate greenhouse gas emissions and reduce (or delay expansion) the hypoxic zone in the Gulf of Mexico.

4.13 Cultural Resources

No effect to cultural resources would be expected for Alternative 1. However, as interior water levels are reduced under Alternatives 2.1, 2.2, 3.1, 3.2, 4.1 and 4.2, the effects on cultural resources would be similarly reduced.

Mitigation sites would undergo cultural resources surveys and results coordinated with the SHPO to ensure that any ecological mitigation does not impact cultural sites.

4.14 Recreation

4.14.1 Alternative 1 – No Action

Under the no-action alternative, conditions within the recreational environment would continue as they have in the past and would be dictated by the natural land use patterns and processes. Recreational resources would remain as stated in Section 3.13 and would continue to be affected by Mississippi River flood events. Lands available for recreational hunting, fishing and wildlife viewing would be impacted by floodwaters causing closures and reducing the opportunities for active and passive recreation. However, flooding can create opportunities for duck hunting as Duck Use Days (DUD) would increase but only by 14 percent. Floodwaters can also help repopulate borrow ponds and lakes with fish stock improving the recreational fishing experience once floodwaters recede. Big Oak Tree State Park would continue to be hydrologically cut-off from the Mississippi River and therefore drier vegetative species would be predominate and the park would continue to decline in ecological significance. The value of the recreational opportunity and experience would gradually decline.

4.14.2 Alternative 2.1

Alternative 2.1 concerns the management of flood risks in the St. Johns Bayou Basin only. Actions taken under this alternative mostly improve bayou and ditch channel drainage, in addition to constructing a pump station. There would be no direct impacts to recreational facilities, such as boat launches and other park recreation features as the proposed bayou and ditch enlargements avoid these areas. Temporary, direct impacts to recreational fishing and hunting could occur in the work zone as construction activities disturb wetlands causing turbidity and recreational species to shift away from the area.

Indirect benefits to recreational resources are expected to be minimal but include reducing the number of days recreation is unavailable due to impounded interior floodwaters which will be drained via a pump station. During waterfowl season (1 December to 31 January), existing gates would be closed to impound interior runoff in the lower St. Johns Bayou Basin for the benefit of waterfowl, which would provide opportunities for waterfowl hunting or wildlife viewing.

4.14.3 Alternative 2.2

Alternative 2.2 concerns the management of flood risks in the New Madrid Floodway only and includes the closure of the 1,500-foot levee gap at the lower end of the floodway and improving drainage. Direct impacts are similar to those described for alternative 2.1. Indirect impacts of alternative 2.2 include benefits of reduced recreational resource damages related to the Mississippi River inundation of Big Oak Tree State Park and of Ten Mile Pond Conservation Area and part of Donaldson Conservation Area. Construction of a levee across the 1,500-foot gap in the lower floodway would reduce inundation damages to recreation infrastructure as a result of Mississippi River floods. Parks and Conservation areas would not close and the value of the recreation experience would increase as recreation features will be available, on average, more days of the year. During waterfowl season (1 December to 31 January) gates would be closed to impound interior runoff in the lower New Madrid Floodway for the benefit of waterfowl and providing an opportunity for recreational hunting, fishing and wildlife viewing.

4.14.4 Alternative 2.3.

Alternative 2.3 would combine the impacts to recreational resources of alternatives 2.1 and 2.2.

4.14.5 Alternative 3.1

Alternative 3.1 constructs all previously described flood risk management features described in Alternatives 2.1, 2.2, and 2.3 (closure levee, 1,500 cfs pumping station in the New Madrid Floodway, 1,000 cfs pumping station in the St. Johns Bayou Basin, and channel modification reaches in the St. Johns Bayou Basin). Direct and indirect impacts from construction of alternative 3.1 would include those mentioned for the authorized project alternative 2.3. New avoid and minimize measures included in alternative 3.1 would reduce the environmental impact associated with the authorized project. Recreational resources impacts from the avoid and minimize measures are discussed below.

St. Johns Bayou Basin

Direct impacts, from the St. Johns Basin Channel modifications, to recreational fishing and hunting could occur in the work zone as construction disturbs wetlands causing turbidity and temporarily causing recreational species to shift away from the work area. Indirect impacts to recreational resources from restored ditch functions that improve channel flow and bank stability designed to prevent erosion and maximize fish and wildlife habitat may increase fish and wildlife in the area, improving recreational opportunities. Restored wetlands, too, would provide an attractive wildlife habitat as would the ecological design and construction of 387 acres of borrow pits. Seasonally inundating 244 acres of farmland during the spring shorebird migration period would help improve recreational hunting, fishing and wildlife viewing opportunities.

There are no direct impacts to recreational resources from the gate and pump management plan proposed for alternative 3.1. Indirect impacts to recreational resources occur and relate to the timing, frequency and duration of the flood pulse. A flood pulse that occurs during February would benefit waterfowl and provide more opportunity for hunting but would neither benefit fisheries nor shorebirds; since fish spawning and rearing occur later in the year and shorebirds typically are not present in the project area in February.

New Madrid Floodway

Alternative 3.1 is the tentatively selected plan (TSP). The TSP includes measures that would maintain a level of connectivity with the river and floodplain while managing flood risk according to the specific season while recognizing the ecological significance of the flood pulse. The avoid and minimize measures for alternative 3.1 include management of water levels in the New Madrid Floodway by means of the gated structure and pump. There are no direct impacts to recreational resources from the water management measure. Indirect impacts to recreational resources include benefits from the management plan which allows varying levels of flood waters to naturally inundate the Floodway between November and May each year. During waterfowl season (Dec – Jan), gates would be closed to impound interior runoff which should provide opportunities for recreational hunting. Recreational fishing should also realize benefits from low level floodwaters improve that improve fishing stocks and recreational fishing opportunities.

4.14.6 Alternative 3.2

Overall management of alternative 3.2 is the same as alternative 3.1 except that additional flood protection in the New Madrid Floodway is provided in the spring.

4.14.7 Alternatives 4.1 and 4.2

Direct and indirect impacts to recreational resources from Alternative 4.1 would be the same as for Alternative 3.1. However, alternative 4.2 would provide the added recreational benefit offered by the reforestation of all agricultural lands below an elevation of 290 feet.

4.14.8 Project Benefits to Recreational Resources

St. Johns Bayou Basin

The mitigation plan for the St. Johns Bayou Basin would positively impact recreational resources. Restoring vegetated wetlands on about 2,200 acres of agricultural land will benefit wildlife by providing habitat conducive to a variety of recreationally hunted and viewed species. Recreational fishing and hunting should also benefit from 387 acres of ecologically designed borrow pits. Finally, seasonally inundating 244 acres of farmland during the spring shorebird migration period will provide recreational wildlife viewing opportunities.

New Madrid Floodway

Recreational resources would see positive impacts from implementation of the mitigation plan. For the New Madrid Floodway, the mitigation plan calls for a hydrologic connection between Big Oak Tree State Park and the Mississippi River. Managed freshwater input to the park should improve habitat for wildlife and in turn create more opportunities for recreation. The acquisition of 1,800 acres of prior converted cropland surrounding the park would be restored to bottomland hardwood forest providing valuable habitat for sought after recreationally viewed and hunted species. Additionally, the mitigation plan calls for ecologically designing and constructing 60 acres of borrow pits and 432 acres of floodplain lakes than can be used for both fishing and hunting. The TSP also calls for inundating 1,286 acres of farmland during the spring shorebird migration period which would attract more wildlife and wildlife viewing. Finally, restoring vegetated wetlands on over 2,300 acres of additional cropland should also benefit fish and wildlife and opportunities for hunting and wildlife viewing in the vicinity.

4.15 Section 122 Items

Each of the alternatives carried into detailed analysis has similar if not identical effects to each of the following Section 122 items. Temporary construction effects may be slightly increased as the closure levee is lengthened; however, long-term effects from operation and maintenance would be the same. The construction and long-term operation effects of the two pumping stations and channel work would also be the same on the following Section 122 items.

4.15.1 Noise

Alternative 1 – No Action

Under the no action alternative, there would be no impact on the noise environment.

Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

Noise would increase during channel enlargement and pumping plant construction due to equipment operation; however, the increase would be confined to the immediate area of construction/pumping, and the noise levels generated would be of the same magnitude as noise resulting from the extensive agricultural operations that already take place in the project area. Following construction, noise levels should return to normal over most of project area. Pumping operations would elevate noise levels at the pumping stations, but the use of electric pumps would limit noise acceptable levels. Because the proposed pumping stations would occupy relatively remote locations, noise impacts would be negligible. No noise mitigation measures would be required for any of the alternatives although Occupational Safety and Health Administration (OSHA) regulations might require the use of hearing protection for personnel.

4.15.2 Air Quality

Alternative 1 – No Action

Under the no action alternative, there would be no impact to air quality.

Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

Construction activity would generate regulated pollutants including ozone (O_3), carbon monoxide (CO) and course particulate matter (PM_{10}), such emissions would slightly and temporarily degrade local air quality. However, all construction activity would be conducted in such a manner as to meet all applicable State and Federal air quality guidelines and none of the proposed alternatives would significantly affect the local air quality.

4.15.3 Aesthetic Value

Alternative 1 – No Action

Under the no action alternative, visual resources would remain as stated in the existing conditions or be manipulated as dictated by future land-use maintenance requirements.

Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

Vegetative clearing and construction of a pumping station would reduce the aesthetic value of the project area in that location. However, establishment of a grass cover on the ROW should offset adverse impacts associated with construction of project features, and reforestation of agricultural lands as part of the proposed mitigation for this project would enhance aesthetics.

4.15.4 Displacement of People

Alternative 1 – No Action

Under the no action alternative, there would be no displacement of people.

Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

None of the proposed action alternatives would result in the displacement of people. The area agricultural income is anticipated to be increased over levels expected under the no action alternative.

4.15.5 Community Cohesion

Alternative 1 – No Action

Under the no action alternative, there would be no impact to community cohesion.

Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

The communities within the project area support the enhanced flood protection for the area. Farmers have also expressed support for alternatives that would permit them to increase production. Since the project will minimize flooding on roads, communities will no longer be isolated during periods of floods. Therefore, there would be a benefit. Accordingly, no adverse impacts to community cohesion are anticipated.

4.15.6 Local Government Finance, Tax Revenues, and Property Values

Alternative 1 – No Action

Under the no action alternative, the housing values and business of the study area would change very little in the future. As a result, the tax revenues generated in the study area are presumed to remain stagnant.

Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

Following the completion of the levee construction and pumping stations, house and property values would be expected to rise with the additional protection. Agricultural revenue would be lost from the acquisition of agricultural land used for mitigation. Furthermore, revenue from property taxes generated from the land that would be acquired and removed would decrease. However, agricultural land would be purchased for the fair market value. In the long term, new businesses and new houses would be built in the project area and the value of these businesses and homes would increase with the newly offered flood risk reduction.

4.15.7 Displacement of Businesses and Farms

Alternative 1 – No Action

Under the no action alternative, businesses and farms would continue to be vulnerable to flooding in the future. Additional displacement of businesses and farms (and therefore employment opportunities) would be possible under the no action alternative. Without the return of businesses to the area, employment opportunities would not improve; therefore, there would be an adverse permanent impact on farms and employment in the project area.

Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, and 4.1

No businesses or farms would be displaced either directly or indirectly as a result of the proposed alternatives. However, the proposed mitigation plan requires the purchase and reforestation of 14,720 acres of cropland. Purchase of the mitigation lands would occur from willing sellers. Therefore, displacement of businesses and farms would only occur to those that are willing.

<u>Alternative 4.2</u>

Landowners in the project area do not support Alternative 4.2 (St. John Levee and Drainage District, personal communication). Therefore, farms would be displaced in the event that Alternative 4.2 is implemented.

4.15.8 Public Services and Facilities

<u>Alternative 1 – No Action</u>

Under the no action alternative, public services would continue to be operated as described under existing conditions. It is expected that period maintenance would occur.

<u>Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2</u>

All project alternatives are designed to manage flood risks to protect area roads. Therefore, an increase to public services and facilities would result from the project.

4.15.9 Community and Regional Growth

<u>Alternative 1 – No Action</u>

Under the no action alternative, there would be no impact to community or regional growth.

<u>Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2</u>

Project alternatives would not contribute substantially to regional growth; however, elimination of historical flooding problems might induce an increase in East Prairie commerce. Individuals' homes, churches and community centers in the project area would be better protected. This would benefit the overall income, employment, and tax base of the area.

4.15.10 Employment

<u>Alternative 1 – No Action</u>

Under the no action alternative, there would be no impact to employment in the area.

<u>Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2</u>

The proposed alternatives would require construction that, in turn, would temporarily increase employment demand in the area, as well as increase support for local businesses. Project alternatives are designed to manage flood risks. Since the risk of flooding would be reduced, a net increase in employment would be expected.

4.16 Hazardous, Toxic, and Radioactive Waste

Alternatives 1, 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

No impacts to hazardous, toxic, and radioactive waste (HTRW) would be anticipated under any alternative. Based on information gathered during the subsequent ESA, no sites of potential HTRW concern appear to be located in the project area. Refer to Appendix K for a list of sources consulted in preparation of this section.

4.17 Environmental Justice

Under the no action alternative, the closure levee and pumping stations would not be constructed. Thus, the same socioeconomic issues plaguing landowners and residents at all economic levels in the project area would continue.

With the implementation of the TSP, disproportionate impacts on minorities, low income families, and children is not anticipated. In fact, within the project area, implementation of the project would reduce flood risks to everyone, regardless of age, race, or income level. The lost flood storage resulting from floodway closure would have no effect on communities outside of the floodway (see Section 4.4). Therefore, there would be a positive benefit to environmental justice. Furthermore, average annual days of flooding above an elevation of 290 feet (elevation of roads in the New Madrid Floodway) would also be reduced through project implementation (Table 4.75).

Table 4.75. Average annual days, by basin and alternative, during hydrologic period of record that flooding occurred at elevations above 290 feet.

Basin	St. Johns Bayou Basin		New Madrid Floodway				
Alternative	Existing	Alt. 2.1	Existing	Alt. 2.2	Alt. 3.1	Alt. 3.2	Alt. 4
Days/Year of Flooding Above 290'	17.4	11.9	20.4	0.0	0.0	0.0	0.2

4.18 Birds Point-New Madrid Floodway Operation

Appendix L contains information regarding the 2011 operation of the Birds Point-New Madrid Floodway.

4.18.1 Alternative 1 – No Action

The Birds Point-New Madrid Floodway would continue be operated as authorized. Following operation, levees would be repaired to provide the level of authorized protection.

4.18.2 Alternatives 2.1, 2.2, 2.3, 3.1, 3.2, 4.1 and 4.2

The Birds Point-New Madrid Floodway would continue be operated as authorized. Closure of the 1,500-foot gap at the lower end of the New Madrid Floodway will have no effect on the timing and frequency of operation of the New Madrid Floodway. Following operation, levees would be repaired to provide the level of authorized protection. The cost for future activation of the floodway and associated levee repairs would be identical to alternative 1. However, closure of the 1,500-feet gap would require raising portions of the Setback Levee to protect the St. Johns Bayou Basin from the Mississippi River flooding during the operation of the New Madrid Floodway. The grade of the Setback Levee would be raised to maintain the authorized freeboard. The cost of this requirement is included as part of this project.

4.19 Relationship Between Short-Term uses of the Environment and Maintenance and Enhancement of Long-Term Productivity

Socioeconomic benefits and adverse environmental impacts represent tradeoffs between the local short-time use and the long-term stability and productivity of the environment. Implementation of the TSP would convert approximately 420 acres of various wetland habitat types to non-wetland habitat. Impacts to aquatic and wetland habitats would be compensated through the use of reforestation and marsh restoration, thereby enhancing long-term productivity of the environment.

Although changes to the project's authorization would be required, construction of the closure levee and pumping stations would not result in an irreversible commitment that cannot be reversed. There may be minor irretrievable losses to environmental resources for period of time due to the amount of time necessary for mitigation to become established. However, this is minimized with the transition periods that have been incorporated into the ecological modeling.

The project has considered and disclosed unavoidable adverse actions that have been identified through public scoping, interagency coordination, and IEPR. Mitigation is proposed to compensate for significant unavoidable impacts according to each specific model. Although the project may impact specific individuals during construction or operation, impacts to the overall environment have considered and significant impacts have been compensated.

4.20 Cumulative Impacts

The President's Council on Environmental Quality defines cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Impacts, or effects, include both direct effects and indirect effects. Ecological effects refer to effects on natural resources and on the components, structures, and functioning of affected ecosystems, whether direct, indirect, or cumulative.

In assessing cumulative impacts, consideration is given to (1) the degree to which the proposed action affects public health or safety, (2) unique characteristics of the geographic area, (3) the degree to which the effects on the quality of the human environment are likely to be highly controversial, (4) the degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks, and (5) whether the action is related to other actions with individually insignificant but cumulatively significant impacts on the environment.

Cumulative effects can result from many different activities including the addition of materials to the environment from multiple sources, repeated removal of materials or organisms from the environment, and repeated environmental changes over large areas and long periods. Cumulative effects occur when stresses of different types combine to produce a single effect or suite of effects. Large, contiguous habitats can be fragmented, making it difficult for organisms to locate and maintain populations in disjunctive habitat fragments. Cumulative impacts may also occur when the timing of perturbations are so close in space that their effects overlap.

Geographic Boundaries

Although the project area is limited to the St. Johns Bayou Basin and the New Madrid Floodway, cumulative impacts involve the broader Mississippi Alluvial Valley (MAV). For that reason, most of the information presented in this cumulative impacts analysis represents the cumulative impacts to the MAV in general. Information used in this report has been obtained from published sources and government documents.

Temporal Boundaries

The cumulative impacts on the project area began in the 1850's with the clearing of vast bottomland hardwood forests and the construction of flood damage reduction levees, which continues to the present day.

Past

McCarty (2005) stated,

> "One hundred fifty years ago, Missouri's bootheel was an immense wilderness of swamps, flatwoods, bottomland hardwood forests and lakes. Black bear and elk roamed there; turtles and snakes basked on logs; beaver, muskrats and otters swam the waters; red-shouldered hawks, barred owls and ivory-billed woodpeckers flew overhead; wildflowers bloomed; and the air carried the songs of millions of birds, frogs and insects in one of the world's great wetland wilderness. Lazy streams filtered through bald cypress swamps, openings from time to time to clearwater lakes. On higher ground the forests of huge oaks and elms went on, and on …

> This productive land long attracted Native Americans who built homes and farms. Later it supported the French and Spanish, and finally the Americans. By 1900, drainage technology allowed tapping the vast timbers of the region, supporting huge commercial operations. The forest was so thoroughly consumed that in all its 2.5 million acres, only a single 80-acre piece went uncut.[38] That 80 acre tract is now the core and heart of Big Oak Tree State Park. And all around it, aided by flood control projects but mostly for the quality of its very soil, the land remains so valuable for crops that only 50,000 acres of timber has been let to regenerate in the entire bootheel region."

Past impacts that have occurred in the project area have transformed it from "one of the world's great wetland wilderness" to some of the world's most productive farmland. Appendix D contains a description of historic landscape conditions that existed in the project area prior to habitat alteration (Figure 3.7). Today over 80 percent of the project area is devoted to agricultural production (Figure 3.8). The farmland found in the project area is some of the most productive found within the State of Missouri as well as the United States. The productivity of the farmland in the project area is so significant that it warrants special status from the USDA as prime and unique.

Large-scale alteration of the landscape began in the 1850s as a result of the Swamp Land Acts of 1849 and 1850. An 1859 State Almanac stated that the "whole county is susceptible of being made a perfect garden, the soil being a rich loam which can be rendered dry in the wettest seasons by a little drainage and rich enough to produce everything that can mature in this latitude." Local levee and drainage districts were established to oversee the conversion of the swampland into farmland. Drainage of southeast Missouri's vast swamp was so intense that is has been termed "one of the greatest drainage projects ever undertaken in America" (Bock, 2007). Further Congressional actions following the Flood of 1927 authorized the Mississippi River and Tributaries Project (MRT). Construction of the Mississippi River and Tributaries Project continues today. The Mississippi River and Tributaries Project saved the Nation approximately $62 billion of flood-related damages during the 2011 flood alone (MG Walsh, 15 August Mississippi River Commission Hearings, New Madrid, MO).

Although the MRT has saved a considerable amount of resident's from disparity caused by flooding, ecological consequences are only starting to be understood. The MAV covers the floodplain area below the confluence of the Mississippi and Ohio Rivers, principally located in the states of Missouri, Arkansas, Tennessee, Mississippi, and Louisiana. Once containing nearly 25 million acres of bottomland hardwood forest, the MAV had only 7 million acres remaining by the 1980s following many decades of hydrological alteration and agricultural expansion. The major land use of the region is now agriculture, dominated by cultivation of corn, cotton, rice, and soybeans.

In an attempt to quantify past ecological impacts that have occurred in the project area, the same ecological models that were used throughout this draft EIS were utilized to

[38] The 2.5 million acres and 50,000 acres of remaining timber are for the entire bootheel region of Missouri, which includes the project area.

develop baseline conditions that were likely found in the project area prior to large-scale conversion (Table 4.76). The acreages provided below include the entire St. Johns Bayou Basin, New Madrid Floodway, and the adjacent batture area found within the State of Missouri.[39]

[39] Therefore, acreages are greater than the project's primary impact area.

Table 4.76. Historic habitat conditions (circa 1780), St. Johns Bayou and New Madrid Floodway.

Habitat Type	Acres	Wetlands (acres)	Wetlands (FCU)	Terrestrial Wildlife (AAHU)	Waterfowl (DUD) Nov	Dec - Jan	Feb-Mar	Shore-birds	Fish (AAHU) early	mid	late
Low BLH and Floodplain lakes	115,419	115,419	115,419	111,956	33,102,169	24,284,158	37,257,253	0	83,219	79,210	37,197
Intermediate BLH	114,574	114,574	114,574	111,137	83,959,827	90,662,406	71,906,642	0	44,226	24,862	917
High BLH	62,070	62,070	62,070	60,208	45,484,896	49,115,991	38,955,132	0	17,069	9,186	0
High BLH – Natural Levee	2,879	2,879	2,879	2,793	2,109,731	2,278,153	1,806,860	0	135	43	0
Terrace Hardwood	108,755	0	0	65,253	0	0	0	0	0	0	0
Riverfront Forest	44,901	44,901	44,901	35,921	9,114,903	9,873,730	9,290,017	0			
Slope Forest	694	0	0	486	101,740	109,860	87,097	0	0	0	0
Sand Savanna	21,617	0	0	0	0	0	0	0	0	0	0
Sand Prairie (GLO)	13,687	0	0	0	0	0	0	0	0	0	0
Sand Prairie (HGM matrix)	11,405	0	0	0	0	0	0	0	0	0	0
TOTAL	**484,596**	**339,843**	**339,843**	**387,754**	**173,873,266**	**176,324,298**	**159,303,001**	**0**	**144,649**	**113,301**	**38,114**

The following assumptions were made regarding Table 4.76.

- Historic habitat type and acreages were established and defined by Heitmeyer (2010) [Appendix D]. These areas include the entire St. Johns Bayou Basin, New Madrid Floodway, and the adjacent batture area within the State of Missouri.

- It was assumed that all bottomland hardwoods and riverfront forests would be jurisdictional if Section 404 criteria were applied to pre-settlement conditions. Likewise, FCI would be a value of 1.0. Note FCU = FCI * acres. Terrace hardwoods, slope forest, sand savanna, and sand prairie were considered non jurisdictional wetlands.

- The following terrestrial HSI scores were used:

    - Low BLH and floodplain lakes: predominantly bald cypress. HSI was assumed to be 0.97.

    - Intermediate BLH: pin oak, Nuttal oak, sugarberry, sweetgum. HSI was assumed to be 0.97.

    - High BLH – Natural Levee: willow, pin, and cherrybark oaks. HSI was assumed to be 0.97.

    - Terrace Hardwoods: HSI was assumed to be 0.6 due to infrequent flooding.

    - Riverfront Forest: early succession tree species such as black willow and silver maple. HSI was assumed to be 0.8.

    - Slope Forest: HSI was assumed to be 0.7 due to infrequent flooding,

    - Sand Savanna: HSI was assumed to be 0 due to selected HSI model species.

    - Sand Prairie: HSI was assumed to be 0 due to selected HSI model species.

- Depth, duration, type, and timing of floods (*i.e.*, the flood pulse) are responsible for the species and zones of plants (McCarty, 2005). Therefore, based upon the historic landscape, the following flood frequencies and durations can be assumed:

    - Low BLH and floodplain lakes: Frequency < 1.01 years. Water would be present throughout the year, except in cases of drought.

    - Intermediate BLH: Frequency = 2 years. Flood duration would be approximately 25 percent of the growing season.

    - High BLH – Natural Levee: Frequency = 2 years. Flood duration would be approximately 12.5 percent of the growing season.

  - Terrace Hardwoods: Frequency > 100 year

  - Riverfront Forest: Frequency = 2 years. Flood duration would be approximately 31 percent.

  - Slope Forest: Frequency > 10 year

  - Sand Savanna: Frequency > 100 year

  - Sand Prairie: Frequency > 100 year

- Waterfowl assumptions (See Appendix R, Table 14, DUD per acre for habitat type):

  - Low BLH and Floodplain Lakes – predominantly cypress tupelo with a flood frequency of 1.01. Therefore, one could expect 286.8, 210.4, 322.8 DUD/acre for the November, December-January, and February-March time periods, respectively.

  - Intermediate BLH – predominantly bottomland hardwoods with a flood frequency of 2.0. Therefore, one could expect 732.8, 791.3, and 627.6 DUD/acre for the November, December-January, and February-March time periods, respectively.

  - High BLH and High BLH/Natural Levee – predominantly bottomland hardwoods with a flood frequency of 2.0. Therefore, one could expect 732.8, 791.3, and 627.6 DUD/acre for the November, December-January, and February-March time periods, respectively.

  - Terrace hardwoods, sand savannas and sand prairies were assumed not to provide significant waterfowl habitat.

  - Riverfront forest – predominantly willow/cottonwood with a flood frequency of 2.0. Therefore, one could expect 203, 219.9, and 206.9 DUD/acre for the November, December-January, and February-March time periods, respectively.

  - Slope Forest – predominantly bottomland hardwoods with a flood frequency of 10.0. Therefore, one could expect 146.6, 158.3, and 125.5 DUD/acre for the November, December-January, and February-March time periods, respectively.

  - The energy values provided in the DUD manual were used to estimate annual production (kg/ha) per habitat type.

- Shorebirds
    - Historically, the project area did not provide any suitable shorebird habitat.

- Fish
    - Low BLH and floodplain lakes were divided to determine historic fish habitat. Approximately 20,000 acres of bottomland lakes were historically found in the project area (Heitmeyer, 2010). The remaining 95,419 acres were made up of low BLH.
    - Terrace hardwoods, slope forest, sand savanna, and sand prairie are greater than the five-year flood frequency. Therefore, they do not provide fish spawning and rearing habitat.
    - Remaining historic cover types have a HSI value of 1.0.
    - EnviroFish was not conducted to determine ADFA of historic cover because of likely changes in flood durations. However, overall trends regarding the river hydrograph are assumed to be the same from current observed conditions (*e.g.*, usually at its highest during the spring, lowest during the fall, etc.). Table 4.77 provides assumptions regarding ADFA per acre.

Table 4.77. Estimated historic ADFA/acre, St. Johns Bayou Basin and New Madrid Floodway.

Habitat Type	Acres	AAHU and (ADFA percent per acre)		
		Early Season	Mid-Season	Late Season
Bottomland Lakes	20,000	20,000 (100)	20,000 (100)	20,000 (100)
Low BLH and Floodplain lakes	115,419	63,219 (54.7)	59,210 (51.3)	17,197 (14.9)
Intermediate BLH	114,574	44,226 (38.6)	24,862 (21.7)	917 (0.8)
High BLH	62,070	17,069 (27.5)	9,186 (14.8)	0 (0)
High BLH – Natural Levee	2,879	135 (4.7)	43 (1.5)	0 (0)
Terrace Hardwood	108,755	0 (0)	0 (0)	0 (0)
Riverfront Forest	44,901	13,919 (31)	13,919 (31)	13,919 (31)
Slope Forest	694	0 (0)	0 (0)	0 (0)
Sand Savanna	21,617	0 (0)	0 (0)	0 (0)
Sand Prairie (GLO)	13,687	0 (0)	0 (0)	0 (0)
Sand Prairie (HGM)	11,405	0 (0)	0 (0)	0 (0)
TOTAL	516,001	158,568	127,220	52,033

Present

Present conditions for most resources have been discussed throughout this document. This section summarizes the points that are most pertinent to the discussion of cumulative impacts.

The soils throughout the area are fertile and are productive farmlands. Most of the lands that could be cleared for crop production have been cleared. A majority of farmland is so valuable for crop production that it requires special designation as prime farmland from the U.S. Department of Agriculture.

Hydrology has been significantly altered:

- All natural watercourses have been channelized. Thus, the vast majority of bottomland lakes no longer exist. The majority of existing bottomland lakes are borrow pits that were utilized for the construction of the levee system.

- New ditches have been dug across the landscape to facilitate drainage. Following drainage developments, bottomland hardwoods were cleared for agricultural purposes.

- The Mississippi River channel alignment is relatively stable due to the amount of channel stabilization structures constructed to maintain the navigation channel. Therefore, there are no new meanders and oxbow lakes being routinely formed through natural processes.

- Levees have been constructed throughout the project area including federally maintained levees as well as private levees. Therefore, connectivity to the Mississippi River has been greatly severed throughout the Lower Mississippi River Valley. Remaining connectivity has been greatly altered in the project area, and no longer provides the kind of natural connection described in the flood pulse concept (Junk *et al.,* 1989). Rather, it is a result of an engineered design of the New Madrid Floodway. Although the response of Mississippi River flows has been altered due to flood control projects (*e.g.,* levees, reservoirs, locks, dams) and navigation features, connectivity in the batture lands remains intact and relatively unaltered. Therefore, a reasonable conclusion is that the historic 484,596 acres that was once connected to the Mississippi River prior to flood control/navigation now consists of 324,173 acres of un-connected area in the St. Johns Bayou Basin, 66,967 acres of un-connected area above an elevation of 300 feet in the New Madrid Floodway, 65,638 acres of altered connection below an elevation of 300 feet in the New Madrid Floodway, and approximately 27,818 acres of unaltered connection in the batture lands.

Past habitat alteration has had a significant impact on fish and wildlife resources. As a result of past impacts, existing fish and wildlife resources consists of ecologically ubiquitous resources and common species compositions that can tolerate the severe level of impairment (*e.g.,* fish), ecological resources that are adapted to agricultural conditions (*e.g.,* waterfowl and shorebirds), and ecological resources that can withstand the isolated patchiness of remaining habitat (*e.g.,* terrestrial wildlife).

Vegetated Wetlands

Based on the existing landcover data, there are 29,210 acres (6,441 acres in the St. Johns Bayou Basin and 8,860 acres in the New Madrid Floodway below an elevation of 300 feet, and 13,909 acres in the batture) of forested areas remaining in the project area. There are 17,384.3 acres of naturally vegetated lands that could potentially be considered wetlands. The NRCS has estimated that there are 1097.5 acres of farmed wetlands. In addition, the 13,909 acres of forested area in the batture are assumed to be wetlands. Therefore, there are a total of 30,307.5 acres that could potentially be considered wetlands remaining in the project area. Note that this estimate includes totals for each entire basin, an area greater than the primary impact area for wetlands. Therefore, wetland acreage has been reduced by approximately 91 percent from historic levels. This is consistent with figures provided by Dahl and Allord (1997) and EPA's website (2012) regarding how agriculture is responsible for over 80 percent of wetland losses in the United States including 87 percent of the wetlands in Missouri.

As a result of channel modifications in the St. Johns Bayou Basin, 409 acres of wetlands would be cleared and filled. Therefore, the project would directly impact approximately 0.1 percent of lands that could have been historical wetlands or 0.8 percent of existing wetlands. Through compensatory mitigation, the project would restore wetlands to an approximate total of 2,410 acres (400 acres below an elevation of 285, 1,816 acres below the five-year flood frequency elevation, and 194 acres of ecologically designed borrow pits[40]) in the St. Johns Bayou Basin. Compensatory mitigation proposed in the New Madrid Floodway would restore wetlands to an approximate total of 9,046 (1,800 acres surrounding Big Oak Tree State Park, 387 acres below an elevation of 285, approximately 2,000 acres below the post-project five-year flood frequency elevation, 3,050 acres of batture land, and 30 acres of borrow pits). Therefore, the tentatively selected plan (Alternative 3.1) would restore wetlands to a total of 9,644 acres that is currently farmland. Thus, there would be approximately 57,182 acres of wetlands (a 20 percent gain) following completion of the project (Figure 4.9). The 20 percent gain to existing wetland acreage would result in a significant benefit to wetland resources.

Terrestrial Wildlife

There are 29,210 acres (6,441 acres in the St. Johns Bayou Basin below an elevation of 300, 8,860 acres in the New Madrid Floodway, and 13,909 acres in the batture) of forested areas remaining in the project area. Approximately 47 percent of remaining forested areas occur in the adjacent batture lands. At an assumed HSI of 0.75 for all remaining forested areas, approximately 21,908 wildlife AAHU would result. Therefore, a 94 percent reduction has occurred in terrestrial wildlife AAHU from historic conditions. The project would impact a total of 778.5 AAHU (765.7 and 12.8 in the St. Johns Bayou

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[40] This translates into half of the borrow pit surface acreage.

basin and New Madrid Floodway, respectively). Therefore, 21,130 AAHU would remain in both basins at and below an elevation of 300 feet (a reduction of 3.6 percent).

Compensatory mitigation would result in a net gain of a total of 8,415 (877.7 and 7,537.3 AAHU in the St. Johns Bayou Basin and New Madrid Floodway/batture land, respectively). Therefore, there would be a total of 29,545 AAHU following completion of the project. Thus, there would be a significant benefit to terrestrial wildlife with a net habitat value increase of 35 percent (Figure 4.10).

Waterfowl

Historically, the St. Johns Bayou and New Madrid Floodway project area provided approximately 173,873,000, 176,324,000, and 159,303,000 DUD during the November, December-January, and February-March time periods, respectively. There are currently 218,166, 2,335,420, and 3,606,117 DUD in the St. Johns Bayou Basin during the November, December-January, and February-March time periods, respectively. There are currently 132,310, 5,299,733, and 8,069,675 DUD in the New Madrid Floodway during the November, December-January, and February-March time periods, respectively. Approximately 2,823,527, 3,058,589, and 2,877,772 DUD occur in the batture (13,909 acres of riverfront forest at a two-year flood frequency) during the November, December-January, and February-March time periods, respectively. Therefore, there is a total of approximately 3,175,000, 10,693,000, and 14,534,000 DUD during the November, December-January, and February-March time periods, respectively. The project would impact a total of 43,301 and 4,285,890 DUD during the November and February-March time periods, respectively. The project would benefit 2,355,563 DUD during the December – January time period. Therefore, there would be 3,130,702, 13,049,305, and 10,267,674 DUD during the November, December-January, and February-March time periods, respectively.

Compensatory mitigation would result in a net gain of 11,284,607, 13,214,366, and 2,549,166 DUD during the November, December-January, and February-March time periods, respectively. Therefore, following mitigation, a total of approximately 14,415,309, 26,263,671, and 12,816,840 DUD would accrue during the November, December-January, and February-March time periods. The project would provide additional waterfowl habitat even though there would be reduced flooding in the project area. Thus, the project would provide benefits to waterfowl (Figure 4.11).

Shorebirds

Historically, the project area did not provide any shorebird habitat. However, due to the extensive clearing that has occurred, the project area now provides 1,208 optimal equivalent acres (365 optimal and 843 optimal equivalent acres in the St. Johns Bayou Basin and New Madrid Floodway, respectively). The project would impact a total of 708 optimal equivalent acres, leaving 500 remaining optimal acres. Compensatory mitigation would not benefit shorebirds, based upon the model (Figure 4.12).

Although the model indicates no impact and no benefits as a result of mitigation, a significant unquantifiable benefit would likely result from compensatory mitigation features. Farmland would be seasonally inundated every year regardless of Mississippi River conditions. Under existing conditions, there is either an enormous amount of habitat available to shorebirds that could never be used in its entirety (*i.e.*, more flooded acres than shorebird need) or no habitat at all (during years that the river does not reach flood stage). However, critical shorebird habitat would be provided with mitigation in the event that there is no other available habitat provided by the river. Although this gain is unquantifiable according to the model, it is likely significant to the overall shorebird population in the Mississippi Valley, since an existing unmet need during low flow years on the Mississippi River would be provided.

<u>Fish Spawning and Rearing</u>

Historically, the project area provided 158,568, 127,220, and 52,033 AAHU for the early, mid, and late season spawning and rearing period. Past activities have virtually destroyed all significant habitat. According to the model, 4,498, 4,587, and 2,523 AAHU occur during the early, mid, and late season periods, respectively. The majority of this remnant habitat consists of highly altered, sub-optimal agricultural areas followed by highly fragmented bottomland hardwoods. These impacts and the addition of the Asian carp are so severe that several non-governmental organizations have stated that the overall ecosystem is destroyed (Missouri Coalition for the Environment, 2011). Likewise, the National Fish Habitat Action Plan Report (NFHAP, 2011) states that intensive agricultural practices in southeastern Missouri affect fish habitat in reservoirs and rivers through sedimentation, loss of structural habitat, excessive nutrient input, loss of shoreline habitat, and altered water flow. The report, which references existing conditions, also states that alteration of large rivers (*i.e.*, Mississippi) has substantially adversely affected ecological characteristics by eliminating natural floodplains, sandbars, and meanders, and impeding fish migration routes. Based on those comments, this project can reasonably be considered to have an insignificant impact to fish spawning and rearing habitat, because no remaining significant habitat is left in the project area.

However, USACE utilized the EnviroFish model to quantify potential habitat and concluded that the tentatively selected plan would impact a total of 2,460, 2,817, and 1,696 AAHU during the early, mid, and late seasons, respectively.

Compensatory mitigation would provide optimal habitat conditions, utilizing a wide range of techniques that provide variable habitat, as opposed to existing conditions that is made up of mostly sub-optimum farmland. According to the model results, impacts to mid-season spawning and rearing habitat are fully compensated and impacts to early and late seasons are overcompensated (Figure 4.13). There are also significant unquantifiable benefits as a result of compensatory mitigation. Sparks (1995) stated that although the water regime might be sub-optimal in a given year for fish, most warm water fishes are adapted to a variable system by means of high reproductive potential that enables them to quickly compensate for lost year classes.

Future

This section describes a variety of likely future scenarios and the potential impact that may result to the various resource categories discussed in Sections 3 and 4.

Local Flood Protection

The existing vast network of drainage ditches that characterize the project area would continue to be maintained in the future. Ditches require periodic maintenance to ensure adequate drainage capacity. Therefore, a reasonable assumption is that any habitat provided in the network of drainage ditches and canals would be in a constant state of flux. With time, ditches fill with sediment until a point is reached that requires a "cleanout", which resets conditions. Many aquatic organisms, such as freshwater mussels, require stable habitat for colonization. Aquatic communities with similar constraints would likely not colonize at significant/historic levels, and the existing ubiquitous community would continue through previous adaptation to the perturbed conditions.

A major feature of compensatory mitigation is the establishment of buffers along area ditches. Although this action is meant to compensate for stream impacts as a result of channel modifications, the amount of sediment that enters into ditches would likely be reduced. Thus, the establishment of vegetated buffers would reduce the overall need for ditch cleanout and a surge in colonization of historic aquatic communities could result.

In addition, through mitigation monitoring and adaptive management, buffer strips would be monitored. If the buffer strips are effective at reducing sedimentation in the project area streams in addition to compensating for impacts, a strong likelihood is that local levee and drainage districts would implement buffer strips in additional areas outside of the project area. Although local levee and drainage districts may implement buffers as a tool to reduce maintenance costs, the cumulative benefit on the environment would be substantial.

Mississippi River and Tributaries Project

Construction, maintenance, and operation activities would continue under the Mississippi River and Tributaries Project. The existing St. Johns Bayou structure is nearing its project design life and will likely be replaced in the future. The Peafield pumping station located in the northern part of the New Madrid Floodway would continue to operate by pumping impounded interior runoff over the levee during periods of elevated Mississippi River stages. Likewise, the Drinkwater Pumping stations located in the northern portion of the St. Johns Bayou Basin would continue to be operated in a similar manner. The Mississippi Mainline Levees would continue to be maintained as authorized, and improvements to the integrity of the system (*e.g.*, installation of relief wells, berms, slurry trenches) would continue.

Although gated structures and pumping stations are a common management technique employed throughout the Mississippi River and Tributaries Project, the Avoid and Minimize measures investigated in this draft EIS present a new way of managing flood risks. Lessons learned from project monitoring and adaptive management could be adopted in other parts of the system. For example, there are 11 pumping stations (not including those constructed in the City of Memphis) in the Memphis District ranging in size from a capacity of 26 cfs (Dyersburg SE) to 12,000 cfs (Huxtable Pumping Station). Although some protect urban areas, most of them provide flood relief to agricultural areas. The overall management strategy for these systems is to close gates whenever the river elevation is greater than the interior pool elevation to prevent Mississippi River backwater flooding. Pumps are used to pump impounded interior runoff over the levee system during periods of high river stages. Pumps are turned off and gates are opened whenever the river elevation falls below the interior pool elevation to allow for gravity drainage. Avoid and minimize measures employed in this draft EIS deviate in two ways from this basic management strategy.

First, gates and pumps would be used to impound interior runoff during periods of the waterfowl season. Due to past channelization projects throughout the region and Lower Mississippi River, waterfowl habitat has declined from historic levels. Although the WRP program and non-governmental organizations such as Ducks Unlimited are making great strides to restore habitat, lack of habitat continues to be the limiting factor. If determined successful within the St. Johns Bayou Basin and New Madrid Floodway, a reasonable expectation is that operation plans would be modified at other gate/pumping stations to provide necessary habitat. Therefore, lessons learned from this project could significantly improve waterfowl habitat throughout the region and the Lower Mississippi Valley.

Second, avoid and minimize measures would maintain a level of connectivity between the Mississippi River and its floodplain by managing floods for the good of social resources, environmental resources, and economic resources. Although connection between the river and its floodplain still exists in the batture areas and other areas not protected by levees, the Mississippi River and Tributaries Project has resulted in a loss of connectivity between the river and its floodplain. However, the project has prevented billions of dollars in damages to the nation and has a net benefit of approximately 32:1 (MG Walsh, Commander, Mississippi Valley Division, USACE, personal communication). This project has shown that nature and economic benefits can co-exist by allowing flood waters to occur at elevations that do not result in social impacts or at periods of the year that do not significantly impact economic benefits. If determined successful through adaptive management, there is a potential that management plans for other Mississippi River and Tributaries project features could be revised. Therefore, this project could significantly restore connectivity to the Mississippi River and its floodplain throughout the region and the Lower Mississippi Valley.

In addition to flood risk management, the Mississippi River and Tributaries Project also provides reliable navigation. The navigation channel is expected to continue to be maintained as authorized. Maintaining reliable navigation has prevented the Mississippi River from forming new channels and creating permanent lake/aquatic habitat. The Lower Mississippi River Conservation Committee (LMRCC) is actively pursuing the restoration of side cannel habitat by notching dikes in the river. The notches would; improve water quality, facilitate fish passage to critical extrachannel habitat, increase habitat quantity and quality for endangered species, increase recreational opportunities, and increase the amount of feeding and resting habitat for migrating birds (LMRCC, 2011). The LMRCC also maintains a list of potential habitat restoration activities. Many of the compensatory mitigation measures provided by this project are complementary to the goals of the LMRCC. For example, the restoration of Riley Lake, other floodplain waterbodies, or reforestation of the batture would significantly improve aquatic habitat for the entire region, not just compensate for impacts attributed to the project.

A major compensatory mitigation feature is the restoration of hydrology to Big Oak Tree State Park by means of a gated structure through the Mississippi River levee. No structures are currently located in the Lower Mississippi River levee system for the sole purpose of habitat restoration or mitigation. Some structures are in the design/construction phase in the Upper Mississippi River, most notably at Emiquon Refuge located on the Illinois River. The Nature Conservancy and its partners are restoring river connectivity by installing gated structures to a segment of its historic floodplain. Lessons learned from Emiquon Refuge and those from Big Oak Tree State Park could be used to explore similar opportunities that could be employed elsewhere in the Lower Mississippi River Valley. Accordingly, lessons learned from the restoration of Big Oak Tree State Park could significantly restore river connectivity to other high valued areas throughout the Lower Mississippi River Valley.

Prior to any changes implemented on any portion of the Mississippi River and Tributaries Project, applicable studies, authorizations, and approvals would be necessary.

Birds Point-New Madrid Floodway

It is anticipated that the Birds Point-New Madrid Floodway would continue to be operated at levels authorized by Congress. The ensuing flood pulse would result in the inundation of 130,000 acres of mostly farmland at a rate of approximately 550,000 cfs. This would likely cause isolated scour holes at the locations of the crevasse sections, isolated erosion on ridges located in the upper section of the Floodway (outside the PIA), and sanding in the vicinity of the crevassed sections. Socioeconomic impacts would be similar to those described in this draft EIS. There would be limited environmental benefits[41] to fish and wildlife resources by the ensuing flood pulse. However, operation of the Floodway does provide limited connectivity to the Mississippi River at its operational level of once in every 80 years. Because every project impact was calculated as a complete loss, project impacts were overstated, albeit slightly, as it does not account for this infrequent connectivity caused by the Floodway project.

In the event of future Birds Point-New Madrid Floodway Operation, levees would be restored to heights that provide the level of protection that existed prior to operation as authorized by Congressional legislation. Infrastructure would be expected to be repaired by levee and drainage districts, state government, and local governments. Although the local population would likely decrease in the years immediately following operation,

[41] Environmental benefits would be limited due to the infrequency of the event.

residential populations would be expected to return. Any damage caused by operating the Floodway would be reset to conditions that existed prior to operation.

Global Climate Change and Ecosystem Services

USACE's ability to predict the impacts of climate change on a river system as large as the Mississippi River is wrought with significant uncertainties. Ultimately, it would be desirable to integrate climate change studies and water resource evaluations to the point where we are able to predict changes in river discharges and attribute those changes to either climate variability or change. However, at this point in time, our efforts remain rudimentary and integration of the multitude of driving variables that influence discharge for the Mississippi have not led to conclusive predictions of change. For instance, a recent paper by Caldwell et al. (2012) discussed that increases in impervious cover by 2060 may offset the impact of climate change during the growing season in some watersheds, while in other areas, increased water withdrawals for human consumptions, industrial utilization and irrigation could either offset or exacerbate climate change impacts. Hirsch and Ryberg (2012) concluded that there was not strong statistical evidence relating historic flood magnitudes to changes in global mean CO_2 levels. Additionally, the Mississippi River basin has had significant annual and inter-annual variability throughout the period of historical record. As a recent example, between the flood of the spring of 2011 and the drought of 2012, water levels at the gage in Memphis, Tennessee varied by 59 feet. Natural interannual and inter-decadal variability make it difficult to detect potential climate changes due to anthropogenic or other sources.

Despite these constraints, climate scientists have suggested a few trends for the watershed that may be useful to consider. Bonnin et al. (2011) have presented evidence that there will be an increase in heavy, flood-inducing precipitation events, particularly in the Ohio Basin that would have a direct influence in the LMR. Raff et al. (2009) also found that for the James River in the Missouri River Basin climate projections result in an increased simulated annual maximum flood potential through time. Also, Kunkel et al. (2013) report that although there is also large interannual variability in regional temperatures, historical tendencies for the Midwest U.S. as a whole are towards increased annual temperatures. Easterling (1993) used the climate scenario of the 1930's as a baseline to describe the response in the Missouri, Iowa, Nebraska, and Kansas (MINK) region as a consequence of global climate change. Conclusions from the study indicated that farm level adjustments plus new technological advancements, when combined with CO_2 enrichment, would limit the negative impact of climate change. In addition, the panel agreed that accurate quantitative predictions of changes in future stream flow characteristics would be extremely difficult, if not impossible, to accomplish.

The consideration of climate change would involve greater uncertainty than can be accommodated in the current evaluation of this project. The uncertainty of the future values of variables, such as temperature and the amount of precipitation, applies to means and variability, both seasonally and over decades. The project design has been optimized for the climatic conditions experienced over the past seven decades. That analysis period in itself comprehends considerable variability in temperature and precipitation. An attempt to optimize the project for one or more possible climatic futures would deemphasize the significance of the existing data collected and modeled. Moreover, if the most widely accepted forecasts of climate change should occur, there is no reason to believe that the project would be economically unfeasible, or that project mitigation areas would perform unsatisfactorily.

According to the United States Global Research Program, agriculture is considered to be one of the most adaptable sectors to changes in climate. One example of adapting to climate change would be to adjust the planting dates to avoid late season heat stress. Another key effect of climate change is the potential for increased storms. "Precipitation has become less frequent but more intense, and this pattern is projected to continue across the United States." (Global Climate Change Impacts in the United States, 2009). Therefore, the need for flood protection and water management options would continue to be a necessity in the future for farmers to grow and harvest their crops. In addition, limiting the social costs of high water events by flood damage reduction measures is a goal of national importance.

The following section provides a qualitative description of potential impacts of global climate change and the completion of the project. The National Academies of Science (2011) provided potential impacts as a result of global climate change. The report outlined seven main findings. The findings and potential ramifications to the St. Johns Bayou and New Madrid Floodway Project are as follows:

(1) **The human contribution to global warming is due to increases in the concentration of greenhouse gases and aerosol particles, which alter the Earth's energy budget. In the special case of the greenhouse gas carbon dioxide, cumulative emissions are also an important metric or measure of the effect of humans on the climate system.** As indicated in Section 4.12, although the project would construct two electric pumping stations that would obtain electrical power by means of coal-fired facility, the CO_2 equivalent to offset these emissions would be a total of 416 (Alternatives 2.1 and 2.2) and 243 (Alternative 3.1) acres in the St. Johns Bayou basin and New Madrid Floodway, respectively. The conceptual mitigation would restore forested areas to over 2,000 and 8,000 acres in the St. Johns Bayou and New Madrid Floodway, respectively. Therefore, the project area could offset enough carbon that would be the equivalent of a project that has 15 times the carbon output as this project. In cumulative terms, the project <u>decreases</u> the amount of carbon emitted to the atmosphere.

(2) **The higher the total or cumulative carbon dioxide emitted and the higher the resulting atmospheric concentration, the higher the warming will be for the next thousand years.** Continued warming due to emissions would result in amplified warming from Earth's natural systems. Examples include additional release of natural carbon stores in deep seas sediments.

(3) **Many aspects of climate are expected to change in a linear fashion as temperatures rise.** In general terms, each degree Celsius of global temperature increase can expect to create the following results:

- 5-10 percent changes in precipitation across many regions
- 3-10 percent increases in the amount of rain falling during the heaviest precipitation events.
- 5-10 percent changes in streamflow across many river basins
- 15 percent decreases in the annually averaged extent of sea ice across the Arctic Ocean, with 25 percent decreases in the yearly minimum extent in September.
- 5-15 percent reductions in the yields of crops as currently grown.
- 200-400 percent increases in the area burned by wildfire in parts of the western United States.

Based on recent literature, it appears that wetter areas would get wetter with more extreme weather events and drier areas would get drier. Therefore, four scenarios were developed to discern the potential impact of the project.

Scenario 1 – Wetter Spring

A wetter spring with more intense rainfall patterns over the Upper Mississippi River and Ohio River basins would equate to increased project benefits. Although multiple factors influence the Mississippi River hydrograph in the project area, for the purpose of this section, five-year floodplain increases from elevation 296.6 to 299 were assumed. Figure 4.14 plots the stage area curve at selected elevations in the New Madrid Floodway. Although any potential increases in rainfall could result in a higher flood frequency elevation and thus flood more acreage, acreage that exists at higher elevations is almost entirely farmland. Forested areas equate to better habitat and no economic damages while agricultural areas equate to poor habitat and economic damages. With the exception of shorebirds, farmland is less valuable to fish and wildlife resources than forested areas. Therefore, project benefits (flood risk management to prime farmland) would rise at a higher rate than environmental impacts. Therefore, the benefit:cost would likely be greater than what is currently reported in the event of a wetter spring pattern.

Although shorebirds may benefit from higher flood frequency elevations, shorebirds as a group would likely be very susceptible to sea level rises. Thus any potential increases in habitat would be negated by sea level rise along the coast.

Scenario 2 – Drier Spring

Decreases in flood frequency elevations would relate to fewer project benefits. However, deceases in flood frequency elevations would also result in fewer impacts. Since the project area is already extensively drained, decreases in flood frequency elevations could result in areas that are currently jurisdictional wetlands to lose the hydrologic criterion necessary to retain that jurisdictional status. Depending on the severity of the change, the project would no longer be needed due to a reduction in flood risk or could still be needed but with a smaller ecological impact.

Scenario 3 – Warmer Summer

Warmer summers would place a greater strain on agricultural commodities within the region. The project area would become even more valuable because of its close proximity to an irrigation source (*i.e.*, Mississippi River). Therefore, crop prices are likely to go up. Thus, the benefit:cost would be greater than what is currently reported in the event of a warmer summer pattern.

Scenario 4 – Intense Rainfall Patterns

As previously stated, many variables control the Mississippi River hydrograph. Although many ecological resources can tolerate some extreme events, most are adapted to the "average condition." Therefore, any rapid rise in Mississippi River water levels in response to isolated but catastrophic rain events in other parts of the country would likely not be beneficial to ecological resources. However, these events could be extremely damaging to economic resources. Operation and management of the gates and pumps would mitigate the risk. Therefore, benefits would likely rise to economic resources without an increase to environmental damages.

Although the loss of flooding from project implementation results in impacts to wetlands as well as fish habitat, considerable ecosystem services gains are generated. The mitigation proposed to offset impacts generated by the TSP requires land currently used for agricultural production to be reforested. This practice, coupled with the implementation of buffer strips along previously un-buffered agricultural fields, yields considerable improvements to ecosystem services in the project area as well as the MAV. Analysis indicates that the TSP would sequester an additional 1.7 million tons of carbon when compared to the no-action alternative, helping to offset the effects of climate change by mitigating greenhouse gas emissions. In addition, nitrogen loading analysis indicates that agricultural land taken out of production and reforested would yield nitrogen loading reductions of over 8,300 tons when compared to the no-action alternative, thereby benefiting the MAV and the Nation by providing a reduction or a delay in growth of the hypoxic zone in the Gulf of Mexico.

Loss of Connectivity

There is a perception that this project would close off the last remaining natural backwater area along the Mississippi River. This perception is unfounded for three primary reasons. First, the New Madrid Floodway is not a natural system. It has undergone extensive engineering design that has resulted in a backwater condition. Although the Mississippi River hydrograph can be considered pseudo-natural,[42] the 1,500-foot gap in a man-made levee system is not natural. Neither is the constructed

[42] The Lower Mississippi River is free flowing and does not have any main stem locks and dams. However, upstream and tributary flows are heavily regulated by locks and dams and the channel itself has had numerous navigation "improvements."

Mud Ditch outlet. Second, there are approximately 47,000 acres of batture lands in the immediate project area. This figure jumps drastically when you consider areas across the river or within Southeast Missouri. A significant amount of "true" backwater areas are located within the region (Table 4.78).

Table 4.78. Mississippi River backwater areas within 120 miles of the project area.

Basin	Distance From Project Area	Acres Flooded[1]
Little River Headwater Diversion (MO)	118 miles	6,400
Cache River (IL)	71 miles	12,200
Mayfield Creek (KY)	61 miles	26,300
Bayou DuChien/Obion Creek (TN)	33 miles	157,400
Forked Deer/Obion River (TN)	70 miles	50,900
Hatchie River (TN)	116 miles	66,800
TOTAL		320,000

[1]Acres flooded based on 1997 satellite imagery corresponding to a 25-year flood event. Values shown do not include batture land.

The existing 25-year flood occurs at an approximate elevation of 300 feet which corresponds to about 85,000 acres flooded. Even if the erroneous conclusion is accepted for the sake of argument that this project would sever all connection to the entire New Madrid Floodway, that figure would only equate to approximately 27 percent of available non-batture backwater areas within the region. However, floodplains can never be totally isolated due to groundwater interactions (Battelle, 2010). Moreover, the tentatively selected plan simply does not sever surface water connectivity. It maintains a level of connection that results in variable flooding to the remaining natural habitat within the New Madrid. Alternative 3.1 maintains connectivity up to an elevation of 290 feet. As can be seen by Figure 4.14 and Table 3.2, this elevation would maintain a connection with approximately 5,966 acres of natural vegetation in the New Madrid Floodway. Lastly, the project makes special consideration for Big Oak Tree State Park, the last vestige of uncut bottomland hardwoods in the region. Restoration would restore a natural hydrologic cycle to the park.

Large Scale Ecosystem Restoration Initiatives

USACE has recently completed the Lower Mississippi River Resource Assessment reconnaissance level report. A watershed study is being considered that would look for opportunities to restore habitat within and along the Mississippi River. Compensatory mitigation as a result of the St. Johns Bayou and New Madrid Floodway Project could be used to complement this potential project.

Large scale restoration in the project area is not likely in the future because of the existing highly productive farmland. Future demands on agriculture products would cause a higher demand on existing agricultural areas like the St. Johns Bayou Basin and New Madrid Floodway. Therefore, a greater emphasis on agriculture than environmental restoration in the project area would be likely.

Cumulative Impacts Conclusions

Since agriculture does not provide optimal habitat or wetland functions, the project, combined with its compensatory mitigation, would result in significant cumulative benefits to the ecosystem within the immediate project area as well as the region. Based on the specific models utilized for the project, the following conclusions can be made:

- The project would restore hydrology to Big Oak Tree State Park that represents the last remnant of un-cut forest in the project area and regionally.

- The project's mitigation would restore 9,046 acres of vegetated wetlands. This increases the amount of vegetated wetlands within the project area by 20%.

- Terrestrial wildlife functions as a result of the project's mitigation would increase by a total of 35%. However, significant additional benefits are anticipated that were not modeled. For example, the conversion of bottomland hardwoods to cropland has come at a great cost and has eliminated to severely reduced the abundance of species dependent on these ecosystems. Restoration of bottomland hardwoods would provide significant benefits to terrestrial wildlife resources that were historically found in the project area.

- Although the project reduces the frequency and duration of flooding primarily to agricultural areas, the compensatory mitigation features would result in a net gain to waterfowl. Therefore, there will be an increase to waterfowl habitat as a result of the project.

- The project would not result in a net impact or benefit to shorebird habitat or fish and wildlife habitat, as concluded by the models. However, as previously discussed, unquantifiable benefits are anticipated as a result of compensatory mitigation.

Due to mitigation, more habitat would be available for the entire ecosystem with the project than without the project. As previously discussed, ecological models were used to measure available habitat. The project would likely result in greater cumulative benefits considering actual habitat, because restored habitat through mitigation provides habitat year round regardless of Mississippi River stage, whereas existing leveled, drained, farmland only provides habitat when the Mississippi River is at flood stage.

Lessons learned through project monitoring and adaptive management could change overall river management in the Lower Mississippi River Valley. This draft EIS has concluded that competing environmental and socioeconomic interests can coexist with proper management and safeguards.

The St. Johns Bayou Basin and New Madrid Floodway are highly altered landscapes and their functional value has declined. Past activities have resulted in significant reductions in forested lands and wetlands throughout the area. State parks and conservation areas have been set aside to preserve the largest remaining stands of bottomland hardwood forests. Legislative regulations have been implemented to restrict further impacts to wetlands. Incentive programs are in place to encourage restoration of wetlands.

All of the forested wetland acres would remain wetlands, and none of the forested acres would be lost. Moreover, Big Oak tree State Park, which is converting from hydric to xeric plant communities would be restored. Wildlife habitat and wetland values have been historically reduced because of human activity in the project area. Although significant past cumulative impacts have already occurred, the project area has restoration potential that can be achieved through proposed mitigation measures. With the exception of fish habitat and shorebirds that have a net effect of zero, where habitat is replaced through mitigation, the project provides significant habitat enhancement in quality and quantity to all other resource categories. The project impacts mostly converted cropland that provides limited ecological values and functions to varying degrees; however, mitigation provides a significantly greater amount of habitat and functions to the entire ecosystem.

5.0 COMPENSATORY MITIGATION AND MONITORING

Presented in this section is a proposed plan for mitigating and monitoring the foreseeable effects of the proposed action. The plan is the first part (*i.e*., Phase 1) of a two-phased approach to mitigation that begins with tract-specific measures and continues, factoring in the risk and uncertainty discussed in Section 6, with additional long-term monitoring and adaptive management measures proposed in Section 7 (*i.e*., Phase 2).

The scope and scale of the mitigation contemplated in the plans for Phases 1 and 2 reflect the complexity of the proposed action and the divergence of the competing interests described in Section 1. The requirements of law, from those authorizing the proposed flood risk reduction improvements to those protecting the environment, constrain what can and cannot be done in an area whose character is nearly unrecognizable from that which existed a mere century ago. Mitigation is therefore the key to delivering the flood risk reduction benefits to the people of Missouri that Congress intended, while adhering to relevant environmental rules.

The plan proposed in this section is one that will alter—for the good and sustainably—an intensely developed landscape, increasing the values, services, and functions to be derived from a variety of ecological resources. The net result of the plan, when combined with adaptive management, is that the project area will also benefit over time, not only from flood risk reduction, but from greater ecological diversity of several kinds, while retaining managed connectivity to the Mississippi River, and all without disturbing use of the Birds Point – New Madrid Floodway, when needed, for its essential purposes.

The information presented in this section, as well as information presented in other sections of this draft EIS, serve as a compensatory mitigation plan according to the requirements of the Mitigation Rule, as set forth in Compensatory Mitigation for Losses of Aquatic Resources, 33 CFR part 332. Although the Mitigation Rule requires mitigation for impacts to aquatic resources, as per section 404 of the Clean Water Act, mitigation is also proposed for impacts to fish and wildlife resources in non-jurisdictional areas, as per USACE policy (Engineer Regulation 1105-2-100). Mitigation requirements were calculated in a consistent manner in which impacts were quantified in Section 4 and each applicable appendix. A detailed discussion regarding compensatory mitigation is found in Appendix R.

Instead of a static plan that solely bases mitigation on an overall acreage or measure (*e.g.*, reforestation), a flexible mitigation strategy is recommended. This flexible mitigation strategy is recommended for a variety of reasons. First, a single mitigation measure does not compensate for all resources in which impacts were quantified. For example, reforestation does not compensate for impacts to shorebirds. Likewise and although ecologically designed borrow pits and floodplain lake restoration provide excellent mitigation to compensate for floodplain fisheries impacts (*i.e.*, impacts to flooded agricultural lands, forested areas, and waterbodies), they do not necessarily compensate for impacts to wetlands. Therefore, numerous methods are recommended. Second, specific mitigation tracts have not been identified. Once sites are selected and acquired, mitigation decisions would be made based upon tract-specific parameters such as soil conditions, anticipated hydrology, elevation, etc. These tract-specific parameters would influence the overall mitigation method (*e.g.*, ecologically designed borrow pit, floodplain lake restoration, vegetated wetland restoration, etc.) as well as specific types of vegetation that would be planted. For example, cypress trees are more flood tolerant than red oaks. Therefore, flexibility must be maintained to maximize mitigation potential. Lastly, flexibility is required to address tract-specific problems that may arise in the future such as whether or not the intended mitigation is functioning as designed as well as in order to make future adaptive management decisions for the overall project. Adaptive management is discussed in Section 7.

This flexible mitigation strategy is a programmatic approach with the overall plan and concepts described in this draft EIS. For example, the overall amount of mitigation requirements are based on the impacts described in Section 4 and the anticipated gains from mitigation measures are discussed in Appendix R. Many factors can influence the overall amount of mitigation credit that any one specific tract could provide. For example, areas that flood more frequent and for longer durations provide greater benefits to fish. These areas occur at the lowest elevations of the project area. Therefore, the programmatic approach defines the overall amount of mitigation based as habitat or functional units and not on an overall amount of acreages. Once tracts are acquired, mitigation benefits would be quantified on a tract-by-tract basis, and mitigation would not be considered complete until all impacted habitat/functional units have been compensated. Furthermore, mitigation sites would be monitored to verify mitigation benefits and USACE is committed to adaptively managing the project. Additional details and discussion regarding this programmatic, flexible strategy is discussed in the following sections.

5.1 Compensatory Mitigation Measures

Constructing flood risk reduction improvements may affect a variety of resources, though the scope and scale of impact will depend on several factors including underlying land use, flood frequency, and flood duration. As some proposed flood control features have potential to affect multiple resources, some mitigation measures have potential to compensate for multiple resources. Mitigation that compensates for impacts to multiple resources is usually of greater incremental value than that which does not, but, of course, not all mitigation measures compensate for impacts to multiple resources. Table 5.1 synopsizes the expected benefits from several mitigation measures.

Table 5.1. Compensatory mitigation benefits, St. Johns Bayou Basin and New Madrid Floodway.

Measure	Wetlands	Terrestrial Wildlife	Waterfowl	Shorebirds	Fish	Riparian Zone
Big Oak Tree State Park Hydrology	X		X		X	
Vegetated Wetland Restoration	X	X	X		X	X[1]
Vegetated Buffer Strips					X	X
Ecologically Designed Borrow Pits	X[2]		X		X	
Seasonally Inundated Farmland	X		X	X		
Floodplain Lakes	X[2]		X		X	
Ten Mile Pond CA	X		X	X		

[1]Can be credited if it can also serve as a buffer to an existing ditch.
[2]Only portions of the borrow pit/lake that would be less than three feet in depth and contain wetlands vegetation.

In addition to the options depicted in Table 5.1, preserving high-value ecological resources may be appropriate on a case-by-case basis. The Mitigation Rule allows for preservation under the following circumstances:

- The resources to be preserved provide important physical, chemical, or biological functions for the watershed;
- The resources to be preserved, as shown by the results of quantitative assessments, contribute significantly to the ecological sustainability of the watershed;
- Preservation is appropriate and practicable;
- The resources are under threat of destruction or adverse modifications; and
- The preserved site would be permanently protected through an appropriate real estate or other legal instrument.

Sites with potential to be preserved would be screened utilizing these five criteria. Although the Mitigation Rule states that higher mitigation ratios are generally required for preservation, preservation for this project would be based on the same ecologically based models that were used to determine project impacts. Should preservation be considered, the inter-agency team would be engaged in the site selection process and in determining the appropriate number of mitigation credits for each site.

In 2004, USACE purchased the Bogle Woods tract, an approximate 1,000-acre parcel of bottomland hardwoods, located in the New Madrid Floodway adjacent to the Ten Mile Pond Conservation Area. The purchase was made in anticipation of the need to acquire mitigation lands in the New Madrid Floodway. Although the site was previously purchased, it remains a good candidate for preservation because:

- The ecological benefits associated with bottomland hardwoods are well known and provide important physical, chemical, and biological functions;
- The majority of the project area was historically bottomland hardwood wetlands. Remaining bottomland hardwood wetlands in the project area consist of

relatively small, isolated tracts. Thus, preservation of this tract would contribute significantly to the ecological sustainability of the watershed;

- Due to the significant value of bottomland hardwood wetlands and their scarcity within the watershed, bottomland hardwood preservation would be environmentally beneficial;
- Prior to purchase by the Federal Government for project mitigation, the Bogle Woods tract was under threat of clearing for timber production; and
- The tract could be permanently protected.

If a determination is made to construct flood control improvements in the New Madrid Floodway, the benefits associated with preserving this tract would be quantified, in collaboration with the Inter-Agency Team, during formulation of a tract-specific mitigation plan. Mitigation benefits would be calculated by comparing the tract without mitigation, assuming that it would be cleared, and with mitigation, assuming that it would be preserved. If it would not be desirable or cost effective to preserve the tract, it would likely be transferred out of Government ownership. Its timber would then likely be removed, with a commensurate degrading of the tract's ecological value.

In addition to preservation, mitigation can occur in two basic methods. Mitigation can restore floodplain connectivity in areas that are no longer connected to the flood pulse, or mitigation can increase habitat function/value in areas that remain connected to the flood pulse.

5.1.1 Restore Floodplain Connection

The Mississippi River Levee has severed floodplain connection throughout the Lower Mississippi River Valley. Therefore, most areas are no longer connected to the flood pulse. Restoring a connection can be problematic due to high costs (structures would have to be placed in the levee to allow for flooding), real estate issues (real estate would have to be acquired on all areas that would be subject to flooding), and social acceptability (the population that are afforded protection generally prefer this degree of protection and would not be in favor of doing away with this protection). Although this type of mitigation is problematic is some areas, it is desirable and implementable in Big Oak Tree State Park. Therefore, restoring the floodplain connectivity to Big Oak Tree State Park is a mitigation priority for this project.

5.1.1.1 Big Oak Tree State Park Hydrologic Connection Restoration

McCarty (2005) described the valuable natural resources in Big Oak Tree State Park. In summary, they are:

- Big Oak Tree State Park contains the Mississippi Alluvial Basin's only bottomland hardwood forest to survive essentially uncut, out of the estimated 2.5 million acres that existed in pre-modern settlement times. Within the 1,000-acre Park, 80 acres have been designated a National Natural Landmark.

- Big Oak Tree State Park is one of the few remaining large blocks of bottomland forest swamp in the Mississippi Alluvial Basin. The 1,000-acre Big Oak Tree Natural Area is protected by the Missouri Natural Area Committee.

- Big Oak Tree State Park is contains the Missouri state park system's only cypress swamp, which along with its bottomland hardwood forests contain over thirty plant and animal species that in Missouri are found only in the Mississippi Embayment Physiographic Region. These are living links to the southern coastal plain aspect of our natural heritage.

- Over 250 native plant, 150 bird, 25 mammal, 44 fish, 28 reptile, and 14 amphibian species have been recorded within the Park, including 19 state-listed species of conservation concern and five state champion trees, two of which are also national champion trees.

- Virtually the entire Park is classified as wetlands under the Clean Water Act.

- The Park has long been, and remains, one of the southeast Missouri's most significant bird hotspots. It is especially prominent as a location for forest interior species dependent upon large mature bottomland hardwood and swamp ecosystems. Big Oak Tree State Park contains critical habitat for 12 of Partner's In Flight's priority bird species for the Mississippi Embayment Physiographic Region.

- Big Oak Tree State Park is part of the River Bends Conservation Opportunity Area.

Although Big Oak Tree State Park provides bountiful habitat, it has been observed that shifting tree regeneration patterns, loss of old-growth canopy trees, the absence of fire, and significantly altered flooding patterns threaten the Park's integrity and longevity (McCarty, 2005). The United States Secretary of the Interior reports that the Big Oak Tree National Natural Landmark is threatened or damaged by progressive drying, changing forest composition, and lack of replacement of its namesake oaks. The shifts in forest composition and altered flood cycles are the most serious and profound things that could happen to the Park's natural community (McCarty, 2005).

Although the park experienced prolonged flooding during the spring/summer of 2011, this event did nothing to change the park's long-term need for frequent low-level inundation. Operation of the Floodway does not occur at a frequency sufficient to be the park's primary source of water, and surrounding flood control measures prevent regular inundation/connectivity with the Mississippi River. Previous plans developed in the original Memorandum of Understanding between USACE and MDNR still apply in regards to elevations (K. McCarty, MDNR, personal communication).

Operation of the Floodway also resulted in sediment deposition to a relatively small section of the park (*i.e.*, sanding). Approximately 20 acres of the park could experience forest mortality as a result of this sediment deposition. Measures are being investigated that would reduce the potential mortality. However, in the event forest mortality is experienced by the park, early successional species such as black willow and cottonwood are expected to regenerate rapidly. Although certain tree species may be replaced, land use would not change (*i.e.,* it would still be forested). The park is investigating the potential of giant cane restoration in parts of the park that may experience mortality. Regardless, operation of the Floodway did not significantly change topography or vegetation, and elevations in the Memorandum of Understanding are still accurate (K. McCarty, MDNR, personal communication).

USACE and the Missouri Department of Natural Resources (MDNR) have signed a Memorandum of Understanding regarding project mitigation and the hydrologic restoration to Big Oak Tree State Park. Specifically, USACE shall accomplish the following:

1. Land Acquisition: Acquire from willing sellers approximately 1,800 acres of land immediately surrounding Big Oak Tree State Park. These would be a priority focus of the project mitigation plan and among the first areas pursued for acquisition.

2. Restoration of Acquired Lands: Reforest these frequently flooded lands with a variety of bottomland hardwood species. All tree species would be those known to naturally occur in the park, and the planting stock would be from native genotypes.

3. Design and Construct Hydrology Project: Design and construct the proposed Big Oak Tree State Park hydrology project. At a minimum, this must be sufficient to deliver Mississippi River water to the park via gravity feed, inundate it during periods of high water to at least elevation 291 feet, and drain the park via gravity feed to at least elevation 288 feet. This includes:

    a) Acquiring the easements alongside the park (including the new acquisitions) that would be necessary to build and maintain the berms and water control structures. The berms, if necessary, would be constructed on acquired lands or USACE obtained easements along the existing park boundaries.

    b) Providing a direct surface water connection to the park from the Mississippi River via a gated culvert to allow river water to flow through the frontline levee at times of higher stages, to mimic natural flooding.

    c) Providing the necessary design work and construction for berms and water control structures, and include all new acquisitions within the perimeter of the berms. Berms shall not be constructed until all acquisition is complete to maximize effective park hydrologic unit area.

4. Time Frame: Although acquisition efforts may continue for some time, the Big Oak Tree State Park hydrology restoration work would be constructed concurrently with other floodway features of the USACE project. The hydrology project shall be completed prior to operation of the proposed New Madrid Floodway project.

A hydrologic connection to the Mississippi River would be restored to the park by constructing a water delivery system. The restored flood pulse would inundate the park and mimic a flood regime as if the levees had not been constructed. Depending on Mississippi River stages, the system would provide water to the park to an elevation of 291 feet. Based on an elevation of 291 feet, the hydrologic connection would be provided at a frequency of less than 2 years. Although the park would likely be managed to allow for prolonged inundation after Mississippi River elevations fell, an outlet structure would also be constructed to allow the park to drain to an elevation of 288 feet. The purpose of this structure is to allow for water-level management to ensure that the park's vegetation is being managed to mimic natural conditions.

A gated structure (two five-foot diameter culverts) would be constructed within the Mississippi Mainline levee. A channel would also be constructed from the structure to the park itself. The proposed hydrologic restoration feature location is shown in Figure 5.1. Restoring hydrology to the park would likely require modifications to the park's perimeter levee system to ensure that adjacent landowners are not inadvertently flooded. In addition, some of the localized drainage may have to be modified.

Lands surrounding the park have been designated a priority for compensatory mitigation as well. These adjacent lands would be incorporated into the park's hydrologic restoration area. A minimum of 1,800 acres of farmland surrounding the park would be targeted for additional compensatory mitigation from willing sellers. In addition to restoring the hydrologic connection, restoration of the 1,800 acres includes site preparation (e.g., deep disking, sub-soiling), restoration of site-specific hydrology (*e.g.*, plugging drainage ditches, removing farm drains, etc.) restoration of microtopography through shallow excavation of deeper areas and filling higher areas to create topographical heterogeneity, and planting of appropriate vegetation according to the site-specific hydrologic zones detailed in the Big Oak Tree State Park Natural Resource Management Plan (McCarty, 2005). Utilizing GIS elevations and the assumptions of McCarty (2005), the restored forest would contain the following composition: 39 percent of the area planted with cypress/tupelo, 5 percent of the area planted with cypress, pumpkin ash, and tupelo, and 56 percent of the area planted with various oak and hickory species. It is anticipated that pioneer species (*i.e.*, black willow and cottonwood) would naturally re-colonize the area as well.

The extent of the perimeter levee modification and local drainage changes would not be finally designed until adjacent properties are identified for mitigation purchase. Due to these unknown variables as well as the complex nature of the water delivery system, the detailed design would be deferred until a Record of Decision is signed and resource agencies, particularly MDNR, have the opportunity to participate in the planning and design process.

5.1.2 Increase Habitat/Function in Connected Areas

With the exception to shorebirds, farmland provides sub-optimal habitat conditions. Therefore, mitigation can also occur in farmland that still experiences a seasonal flood pulse. Mitigation involves changing the land use from a sub-optimal agricultural condition to an optimal habitat condition (*e.g.,* vegetated wetlands, ecologically designed borrow pits, etc.).

5.1.2.1 Vegetated Wetland Restoration

The restoration of vegetation on agriculture mitigation tracts involves preparing the site, restoring site-specific hydrology (*e.g.,* plugging farm drains, plugging ditches, etc.), and reforesting cleared/agricultural areas with species that naturally occur or historically occurred within the project area. Tract-specific conditions are required to be known prior to determining specific details such as species of trees to be planted. Likewise, site-specific tracts are required to be known to refine compensatory mitigation benefits of any particular mitigation tract. Restoration includes the following:

- Reestablishment of micro/macrotopography – The vast majority of project area lands have been laser leveled/graded to promote drainage. Reestablishment of heterogeneity is accomplished by excavating areas within the mitigation tract and side casting the material to create topographical variation such as ridge and swale complexes. The overall topography restoration design depends on site specific conditions and geomorphological characteristics.

- Site-Specific Hydrologic Restoration – Virtually every farm field in the project area has undergone past hydrologic modifications to promote drainage. These modifications include but are not limited to ditches, culverts/farm drains, perimeter levees, water control structures, sluice gates, etc. These structures would receive hydrologic restoration including removal/capping to promote water detention/retention.

- Deep Disking/Sub-soiling – Sites would be sub-soiled prior to tree planting to promote growth. Sub-soiling is necessary in many areas due to the results of decades of agricultural practices that have created a hard-pan layer that is problematic for root development.

- Tree Planting – Trees would be planted by utilizing a variety of techniques but could include direct seeding/acorns, seedlings, or natural regeneration.

The species of trees as well as the appropriate planting method would be described in the detailed tract-specific mitigation plan.

Herbaceous wetlands would also be restored on a portion of vegetated tracts to the extent practical. For example, planting of trees in restored topographical features may not be necessary due to expected flood durations; herbaceous wetlands would be allowed to regenerate naturally in these areas.

As previously discussed, preservation of large tracts of bottomland hardwoods would also be considered for compensatory mitigation. For example, the Bogle Woods tract has been previously purchased to serve as compensatory mitigation.

5.1.2.2 Vegetated Riparian Buffer Strips

Every natural water course in the project area has been channelized and miles of new ditches have been constructed to facilitate drainage. There are approximately 774 miles and 408 miles of ditches and drainage canals in the St. Johns Bayou Basin and New Madrid Floodway, respectively. Although some of these artificially created canals have stream characteristics and functions, many ecological functions are impaired. There are numerous miles of ditches and canals within the project area with limited to no riparian buffer strip. Therefore, farming generally occurs to the top bank of these ditches.

The ecological benefits associated with buffer strips are numerous and include but are not limited to providing structure, sediment retention, nutrient removal, filtering agricultural runoff, as well as providing habitat to a variety of terrestrial/semi-aquatic wildlife resources.

Establishment of buffer strips would coincide with and complement other compensatory mitigation measures. For example, forested buffer strips would be placed along ditches that are within vegetated wetland mitigation tracts as well as ecologically designed borrow pits. However, the establishment of forested buffer strips would not be conducive to maintenance activities along some ditches due to the agricultural nature of the area. Likewise, many agricultural drainage ditches have to be periodically cleaned out to maintain drainage and aerial application of herbicides is commonly employed throughout the region. Establishment of forested buffer strips would not be practical along both banks of project area ditches in these two situations. However, the establishment of forested buffer strips on one side of the channel and the establishment of warm season grass buffers on the opposite bank is practical.

The overall buffer width would depend on site specific conditions but a 25-foot minimum width would be established along both banks.

5.1.2.3 Ecologically Designed Borrow Pits

Borrow pits are an excellent method to compensate for fish spawning and rearing habitat to existing waterbodies as well as inundated floodplain (J. Jackson, IEPR panel, personal communication). Borrow pits provide excellent nursery habitat if properly constructed. Larval fish densities have been estimated to be 10 to 100 times greater than the highest densities reported for main channel habitat, natural floodplain habitat, or backwater habitats of the Mississippi River (Sabo and Kelso, 1991). Therefore, borrow pits are proposed to compensate for impacts to existing waterbodies as well as to compensate for impacts to inundated farmland and forested areas.

Construction of the closure levee, Frontline Levee grade raise, and Setback Levee grade raise would require borrow material. Borrow pits would be ecologically designed by following the guidelines established by Aggus and Ploskey (1986). These guidelines recommend some areas of deeper water (*e.g.,* six to ten feet), a sinuous shoreline, establishment of islands, and variable bottom topography. A representative ecological design for a borrow pit is provided as Figure 5.2. Although the ecologically designed borrow pits would compensate impacts associated with floodplain fish spawning and rearing habitat, they also have excellent potential for becoming and remaining wetlands for long duration (Battelle, 2009).

Each pit would be designed so approximately half of the borrow material would be taken from areas excavated an average of six feet in depth, and the remaining half of material would be from areas excavated an average of three feet in depth. Utilizing these ratios and the need of 2.4 million cubic yards of material, approximately 387 acres of ecologically designed borrow pits would be constructed in the lower portion of the St. Johns Bayou Basin. Likewise, an estimated 60 acres of borrow pits are required in the lower portion of the New Madrid Floodway. Several pits would likely be needed to reach the total acreage. Locations of proposed borrow pits would be identified during the completion of site-specific mitigation planning. However, borrow pits are anticipated to be constructed within prior converted cropland in the post-project 5-year flood frequency footprint to ensure that they would produce beneficial fish spawning and rearing habitat (Figure 5.3).

5.1.2.4 Ten Mile Pond Conservation Area

The Ten Mile Pond Conservation Area is owned and operated by the Missouri Department of Conservation. The Conservation Area consists of 3,755 acres of predominantly cropland and wetlands that are managed for dove, shorebirds, wading birds, and waterfowl. Moist soil units are a common management feature of the conservation area.

Moist soil management is a technically effective method that is widely employed to manage waterfowl and shorebird resources in the project area and region. Moist soil unit construction basically involves building perimeter levees around a site, installing a water control structure (*i.e.*, stop log structure) to precisely manage water levels/depths, and providing a source of water, usually through groundwater pumps. Moist soil units are managed to promote wetland vegetation and aquatic macroinvertebrate production to provide a food source for waterfowl and shorebirds. This involves keeping the areas inundated or saturated (*i.e.*, mudflats) during portions of the year that are beneficial to the resource.

The project's authorization contains specific language regarding lands acquired by the State of Missouri after January 1, 1982 as being able to "count" as part of the total quantity of mitigation lands required for the project. The project's authorization is based on the Chief of Engineer's report dated 4 January 1983. This report, and subsequent General Design Memoranda, included specific mitigation boundaries. Although Ten Mile Pond Conservation Area includes area outside this designated boundary, only those areas purchased by the State of Missouri within the prescribed boundaries of the General Design Memorandum would be credited. Therefore, of the total of 3,755 acres, a total of 1,917 acres can be credited for the project's mitigation pursuant to the project's authorization (Figure 5.4). There are approximately 993 acres of moist soil units within the 1,917 acres of mitigation land. Remaining land is made up of mostly agricultural area.

5.1.2.5 Seasonally Inundated Farmland

Numerous farmlands in the project area are managed for waterfowl during the waterfowl season, which require perimeter levees, water control devices, and water sources. A portion of these areas can be managed for shorebirds through inundation at depths that are suitable for shorebirds during the spring and fall migration periods. Likewise, additional agricultural areas could be purchased and water control devices, perimeter levees installed to allow for water management.

Agricultural areas would be inundated during portions of the shorebird migratory period. Following the migratory period, the area would be planted for an agricultural commodity. Some agricultural techniques that require inundation, such as techniques for rice production may also be utilized to compensate for impacts if those techniques are complimentary to shorebird management.

5.1.2.6 Floodplain Lake Creation, Restoration, or Enhancement

There are numerous floodplain lakes in the batture area (Figure 5.5). Due to anthropogenic impacts, many of these lakes are degraded due to past drainage projects and high sediment loads of the Mississippi River. Additionally, there are fewer of these lakes and new lakes are not forming due to the levee system and navigation structures. A weir can be constructed in the outlets of many of these lakes to restore surface acreage. Table 5.2 provides a list of floodplain lakes that are found within the vicinity of the project area that could be restored.

Table 5.2. Potential floodplain lakes for restoration, St. Johns Bayou Basin and New Madrid Floodway.

Description	Location (Mississippi River Mile)	Existing Surface Acres	Potential Restored Surface Acres
No. 3 Chute	930	133	201
Wolf Island Bend	930	149	270
Lake Number 7 Chute	916	59	81
Riley Lake	895	36	538
Pecan Chute	880	24	78
Point Pleasant Chute	880	205	265
Williams Chute	870	23	176
Stewart Bar Chute	865	47	197
Robinson Lake	853	3	218

5.1.2.7 Additional Measures and Trade Offs

Other potential mitigation measures that are not specifically mentioned in this document may be explored as new lands and information become available. The adequacy of these measures would be coordinated with the interagency team. Basically, this would permit the incorporation of excellent mitigation plans that may not be currently contemplated but are determined to provide a beneficial opportunity that should be pursued. Trade-offs would consist of mitigation measures that would benefit different resources than those specifically addressed in this document. An example may be to restore Mississippi River side-channel habitat. This action would significantly benefit Mississippi River fishes, including adults that may eventually spawn in the project area. However, this measure may not necessarily benefit spawning and rearing habitat. Another example may be to compensate riverine backwater wetlands with flats because flats are scarcer on a regional/national perspective (Elizabeth Murray, ERDC, personal communication). These areas may be located at higher elevations in the project area that likely would not yield the same benefit to specific resource categories as areas that are located at lower elevations. If changes are significant, additional NEPA documentation would be prepared.

5.2. Establishment of Watershed Mitigation Zones

A watershed approach to compensatory mitigation seeks to promote sustainable ecological resource functions throughout an entire watershed. Under a watershed approach mitigation measures are tailored to landscape positions and resource types. There are at present no watershed-based plans for St. Johns Bayou Basin or the New Madrid Floodway. Recalling Sections 3 and 4, and the applicable appendices, it should be remembered that the ecological resources in both basins are in sub-optimal condition with the exception of a few isolated, relatively small patches of bottomland hardwoods, or support wildlife adapted to a predominantly agrarian landscape (*e.g.*, shorebirds).

Based on the sub-optimal conditions found within both watersheds, the following assumptions were made regarding potential mitigation sites:

- The restoration of hydrology to Big Oak Tree State Park and the restoration of adjacent cropland to bottomland hardwood wetlands are mitigation priorities. Reconnecting Big Oak Tree State Park and surrounding areas to the Mississippi River would provide numerous ecological benefits and create valuable wildlife habitat.

- Areas subject to Mississippi River flooding are inherently more valuable than those that are not. Therefore, compensatory mitigation would focus on areas in New Madrid Floodway that would remain connected to the Mississippi River (including batture land) and on areas in St. Johns Bayou Basin that would continue to flood from impounded waters.
    - Areas that flood more frequent and for longer periods (i.e., lands located at the lowest elevations) are more valuable for fish.
    - Areas within the 5-year floodplain (post project) are considered to be riverine connected wetlands.

- Although habitat models do not consider isolation as a factor that reduces impacts, areas adjacent to large tracts of high-value habitat are generally more desirable for mitigation than those that are not.

- Large contiguous tracts of bottomland hardwoods that were vulnerable to clearing, and were therefore purchased as potential mitigation sites, should be retained as such because large tracts of bottomland hardwoods are virtually non-existent in the project area. Preservation of large tracts of bottomland hardwoods would serve as "core habitat" for many ecological resources. Likewise, threatened high-value habitat tracts should be considered for preservation.

- Although drainage ditches are not natural and exist only as means to drain bottomland hardwoods for agricultural use, they provide aquatic habitat that supports residential populations of fish and freshwater mussels. Mitigation of areas adjacent to ditches would also be considered. Establishing riparian habitat would be needed as compensation for ditch impacts.

The overall "ecological value" for any mitigation measure depends on the location of the tract within the watershed. For example, lands that are subject to frequent floods of high duration are generally more beneficial to fish than lands located at higher elevations. Therefore, to determine reasonable estimates of required mitigation and costs, mitigations zones were established based on the assumptions listed above. Mitigation tracts would be identified and acquired within these zones. The following zones have been established for planning purposes based upon hydrologic zones[43] and location within the watershed (Figure 5.3):

[43] Hydrologic zones are based upon post-project conditions.

- Mitigation Zone 1: Big Oak Tree State Park and 1,800 surrounding acres
- Mitigation Zone 2: Lands below elevation 285 (*i.e.*, lands that would remain subject to frequent flooding following project operation).
- Mitigation Zone 3: Lands located at elevations within the post project 5-year flood frequency
- Mitigation Zone 4: Lands located at elevations greater than the post project 5-year flood frequency
- Mitigation Zone 5: Batture Land
- Mitigation Zone 6: Ditches and Adjacent Riparian Zone
- Mitigation Zone 7: Ten Mile Pond Conservation Area

In the event that mitigation lands cannot be identified and acquired in the following mitigation zones, a contingency plan would be established and submitted to the interagency team for review and comment. Supplemental NEPA documentation would also be prepared, if needed. Regardless, impacts would not occur prior to an approval of the appropriate proportional amount of mitigation.

<u>Mitigation Zone 1: Big Oak Tree State Park and Surrounding Lands</u>

As stated, Big Oak Tree State Park and its surrounding area is a mitigation priority. The Mitigation Rule specifically allows for projects on public lands such as the proposed Big Oak Tree State Park restoration. 40 C.F.R. § 230.93(a)(3) states:

> (3) Compensatory mitigation projects may be sited on public or private lands. Credits for compensatory mitigation projects on public land must be based solely on aquatic resource functions provided by the compensatory mitigation project, over and above those provided by public programs already planned or in place. All compensatory mitigation projects must comply with the standards in this part, if they are to be used to provide compensatory mitigation for activities authorized by DA permits, regardless of whether they are sited on public or private lands and whether the sponsor is a governmental or private entity.

In addition to restoring hydrology to the park, land acquisitions would also be pursued adjacent to the park. A minimum of 1,800 acres of land surrounding the park would be acquired for restoration of vegetated wetlands. Based on discussions with the project sponsor (L. Bock, St. John Levee and Drainage District) and previously identified willing sellers, it is reasonable to assume that these 1,800 acres could be acquired.

<u>Mitigation Zone 2: Agricultural Lands below an Elevation of 285 feet</u>

There are approximately 1,654 acres and 1,547 acres of agricultural lands at or below the 285-foot elevation in the St. Johns Bayou Basin and in the New Madrid Floodway, respectively, which constitute approximately half of the total number of these acres. Since the condition of lands at and below this elevation would be least altered by constructing any of the proposed flood control improvements, and because there a relatively high risk of flooding would continue to exist in these areas, it was estimated that 25 percent of such lands should be acquired for compensatory mitigation. Although 25 percent of these lands were used for planning purposes, additional lands over the 25 percent would be pursued for acquisition since these lands provide the greatest mitigation benefit.

Mitigation Zone 3: Agricultural Lands located above an Elevation of 285 feet but within the Future 5-Year Floodplain

The 5-year flood frequency is important to many ecological resources. For example, wetlands that occur within the 5-year flood frequency are considered riverine connected and the 5-year flood frequency serves as the upper limit in defining optimal fish spawning and rearing habitat. The projected future 5-year flood frequency elevation (20% chance of being flooded in any given year) is 292.6 feet in the St. Johns Bayou Basin and an elevation of 288.7 feet in the New Madrid Floodway. Between these elevations (285 feet to 292.6 feet, and 285 feet to 288.7 feet) lie more than 21,000 acres of agricultural lands, 10,818 in the St. Johns Bayou Basin and 9,678 in the New Madrid Floodway. For planning purposes, it was estimated that 25 percent of such lands should be acquired for compensatory mitigation. Likewise, based on discussions with the project sponsor (L. Bock, St. John Levee and Drainage District) and previously identified willing sellers it is reasonable to assume that these lands could be acquired.

Mitigation Zone 4: Agricultural Lands located above the Post-Project Five Year Flood Frequency Elevation

According to the ecological models and consistent with impact methodology, restoration of agricultural lands above the five year flood frequency would not provide any compensation to fish habitat or riverine connected wetlands. Although these lands would not provide benefit for riverine connected wetlands or fish, if managed properly they can provide mitigation for shorebirds. Therefore, lands in Mitigation Zone 4 would be pursued for shorebirds.

Mitigation Zone 5: Batture Land

Restoration of agricultural lands within the batture area to bottomland hardwoods/riverfront forests and/or the restoration of floodplain lakes would provide significant compensatory mitigation benefits. Furthermore, it is anticipated that agriculture land in the batture would have a high likelihood of acquisition. Once restored through mitigation, flooded bottomland hardwood/riverfront forests in the batture land would have physicochemical characteristics similar to forested areas in the New Madrid Floodway: slackwater, structural diversity, and directly accessible. Swales, ridges, and various types of waterbodies in the batture create habitat similar to the New Madrid Floodway: deep, warm water that persists after floodwaters recede and a corridor for movement within the floodplain. Batture land is also directly accessible to fish and has heterogeneous habitat suitable for fish spawning and rearing. In many cases batture land is superior for mitigation purposes, especially for fish and wetlands (Battelle, 2012). For example, the New Madrid Floodway is man-made, trees have been cleared from most ditch banks, high turbidity prevails for much of the year, and the floodplain is comprised of mostly agricultural fields. Conversely, batture land is more diverse, experiences a regular flood pulse, and with reforestation of frequently flooded agricultural land, can provide quality wetland functions and habitat for many fish and wildlife resources. For these reasons, USACE believes that mitigation in the batture is suitable to mitigate for impacts in the New Madrid Floodway.

Mitigation Zone 6: Ditches and Adjacent Riparian Area

Riparian buffers along the project area ditches are limited. The ecological benefits associated with riparian zones are well known. Therefore, mitigation will target riparian zones to mitigate for impacts to ditch habitat. Likewise, opportunities will be explored during mitigation acquisition to reestablish riparian zones along project area ditches for other mitigation tracts and ecologically designed borrow pits.

Mitigation Zone 7: Ten Mile Pond Conservation Area

The project's authorization allows for fish and wildlife mitigation credit from lands previously purchased by the State of Missouri within the Ten Mile Pond Conservation Area.

5.3 Mitigation Implementation

Following a project decision, landowners would be queried in the project area regarding their willingness to sell. Once suitable tracts available to be acquired are identified, preliminary information (*e.g.,* landscape position, hydrology, etc.) would be gathered to determine what type(s) of mitigation measure would be most beneficial. For example, based on the preliminary information, a determination would be made whether or not to construct a borrow pit, restore vegetated wetlands, or seasonally inundate farmland for shorebirds.

Upon acquisition, a draft, tract-specific mitigation plan would be developed and disseminated for review to the interagency team according to the overall concepts described in this draft EIS with tract-specific refinements. The tract-specific mitigation plans would contain baseline information, planned earthwork activities, hydrologic restoration features, and anticipated compensatory mitigation benefits quantified in a consistent manner in which impacts were quantified. Additional information is found in the following sections. Following an opportunity for the inter-agency team to comment and any issue resolution on the draft plan, a final plan for each tract would be formally submitted to MDNR for purposes of any water quality certification requirements.

Identification and treatment of historic properties, in compliance with National Historic Preservation Act (NHPA), will be included in the development of tract-specific detailed mitigation plans. USACE will consult with MDNR SHPO and other interested parties. Mitigation sites will be surveyed to determine whether mitigation proposals will affect historic properties. Protection of cultural resources sites that may be identified will be incorporated into the natural resources mitigation plan and long term management of mitigation lands(s).

Mitigation would progress concurrent with construction of flood control features. Following the Mitigation Rule, USACE will compensate anticipatorily for unavoidable impacts on aquatic resources from each construction increment by using tract-specific mitigation plans. A satisfactory amount of mitigation is that which is equal to or greater than the habitat/functional units directly impacted or that is proportional habitat/functional units indirectly impacted.[44] For example, assume that a proposed construction activity would directly impact 100 low gradient riverine backwater wetland FCU. Prior to awarding a construction contract, a mitigation plan must be formulated and approved that restores or otherwise compensates for a minimum of 100 low gradient riverine backwater wetland FCU. USACE will develop and maintain a database of identifying its mitigation needs, approved mitigation plans, and construction-related impacts.

The flexible-programmatic mitigation management strategy contemplated in this draft EIS is premised on a voluntary forbearance from operating either the proposed St. Johns Bayou Basin pumping station or the proposed New Madrid Floodway pumping station, and from closing the proposed Mud Ditch outlet structure. For purposes of this strategy it is presumed that it would be environmentally preferable to withhold the operation of these improvements, in both the St. Johns Bayou Basin and the New Madrid Floodway, until all mitigation lands have been acquired, all mitigation measures put in place, and all mitigation plans for those lands have been approved by MDNR.

5.4 Determination of Mitigation Credits

Assumptions and calculations regarding mitigation are discussed in Appendix R and applicable environmental appendices. Tables 5.3 and 5.4 summarize impacts and mitigation in the St. Johns Bayou Basin and the New Madrid Floodway, respectively.

[44] The majority of project impacts are considered indirect due to modifications to the frequency, timing, depth, and duration of flooding as a result of the closure levee and pumping stations. It is anticipated that multiple construction contracts would be awarded to construct the closure levee and pumping stations. The proportional amount of each contract would be determined for each flood risk management feature and a proportional amount of mitigation would be required in an approved tract-specific mitigation plan(s). For example, assume a $5 million dollar contract is awarded to construct features of the St. Johns Bayou pumping station. This sum represents approximately 28% of the overall St. Johns Bayou pumping station costs. Therefore, approval of tract-specific mitigation plans that demonstrate 28% of the indirect impacts to each specific ecological resource is required prior to awarding the contract.

Table 5.3. St. Johns Bayou Basin compensatory mitigation techniques.

Mitigation Measure	Acres	Wetlands[1]			Terrestrial Wildlife (AAHU)	Waterfowl (DUD)			Shorebirds (Optimal Acres)	Fisheries (AAHU)		
		LGRB (FCU)	LGRO (FCU)	CD (FCU)		Nov	Dec-Jan	Feb-March		Early	Mid	Late
Impacts		-116	-397	0	-766	-549,913	+633,575	-1,319,448	-117	-386.6	-442.7	-245.7
Seasonally Inundated Farmland	244	tbd	tbd	tbd	0	43,563	41,991	42,789	117	0	0	0
Ecologically Designed Borrow Pits	387	0	0	37	0	348,687	252,324	216,488	0	268.4	268.4	268.4
Vegetated Grass Buffer	112	tbd	tbd	tbd	0	11,064	9,330	9,360	0	NP[2]	NP[2]	NP[2]
Vegetated Tree Buffer	70	tbd	tbd	tbd	0	19,331	16,068	16,369	0	5.9	5.6	1.8
Vegetated Wetland												
Below 285	400	232	0	0	292	114,720	84,160	129,120	0	40.7	41.9	15.4
285 – 288	1816	690	397	0	1,489	1,390,447	1,494,929	1,196,046	0	124.2	127.9	50.1
NET EFFECT		**+806**	**0**	**+37**	**+1,015**	**+1,377,899**	**+2,532,377**	**+290,724**	**0**	**+52.6**	**+2.5**	**+90.4**

[1]For simplicity, impacts to wetlands was based on the function that required the greatest amount of required mitigation.
[2]NP – not presented. However, benefits are included in the woody vegetation buffer category.
tbd – to be determined during completion of site specific detailed mitigation plans, if applicable.

Table 5.4. New Madrid Floodway compensatory mitigation techniques.

Mitigation Type	**Acres**	**Wetlands[1]**			**Terrestrial Wildlife (AAHU)**	**Waterfowl (DUD)**			**Shorebirds (Optimal Acres)**	**Fisheries (AAHU)**		
		LGRB (FCU)	LGRO (FCU)	CD (FCU)		Nov	Dec-Jan	Feb-March		Early	Mid	Late
Impacts		-3481	-35	-124	-13	-974,545	+519,602	-4,157,013	-615	-1729.5	-2061.1	-1165.8
Big Oak Tree State Park	1,025	966	0	48	0	732,800	791,300	627,600	0	914.0	889.5	577.3
Big Oak Tree State Park Surrounding Area	1,800	1076	0	0	1,746	852,235	880,949	760,450		NP[2]	NP[2]	NP[2]
Seasonally Inundated Farmland	1,286[3]	0	0	0	0	2,238,366	1,886,097	1,591,812	615	0	0	0
Ecologically Designed Borrow Pits	60	0	0	17	0	54,060	39,120	33,564	0	41.6	41.6	41.6
Floodplain Lakes	432	0	0	91	0	389,232	281,664	241,661	0	326.8	326.8	326.8
Vegetated Wetland												
Below 285	387	232	0	0	283	83,244	61,069	93,693	0	61.7	70.5	0.0
285 – 288	1,970	1,182	0	0	1,615	1,508,360	1,621,702	1,297,473		179.3	84.7	0.0
Batture	3,050	1,952	154	0	2,440	2,125,698	1,765,493	1,797,060		692.4	692.3	310.2
NET EFFECT		**+1927**	**+119**	**+32**	**+6071**	**+7,009,450**	**+7,846,996**	**+2,286,300**	**0**	**+486.3**	**+44.3**	**+90.1**

[1]For simplicity, impacts to wetlands was based on the function that required the greatest amount of required mitigation (LGRB = detain floodwater, LGRO = export organic carbon, and CD = maintain plant communities).
[2]NP – not presented. However, benefits are included in the Big Oak Tree State Park category.
[3]Including the acreage located in Ten Mile Pond CA.
tbd – to be determined during completion of site specific detailed mitigation plans, if applicable.

5.4.1 St. Johns Bayou Basin

Section 404 of the Clean Water Act

Wetlands

Channel modification would directly impact 409 acres of Low Gradient Riverine Overbank Wetlands, resulting in a loss of wetlands functions. This impact would be compensated by restoring Low Gradient Riverine Overbank Wetlands on 623 acres of farmland (see Appendix R and Appendix E, Part 4).

Operation of the pumping station would indirectly impact wetland functions on 792 acres of Low Gradient Riverine Backwater Farm Wetlands and 3,848 acres of Low Gradient Riverine Backwater Wetlands. To compensate for the indirect impact resulting from reduced hydrology, 201 acres of farmland would be restored to Low Gradient Riverine Backwater Wetlands (See Appendix R and Appendix E, Part 4).

Ditches

Impacts to ditch habitat were quantified by using the Missouri Stream Mitigation Method. It is projected that 699,685.6 credits would be needed. The following mitigation measures would be used to fully compensate unavoidable impacts:

- Constructing nine transverse dikes in the lower 3.7 miles of St. Johns Bayou, to create a sinuous, low-flow channel.
- Constructing a bank stability structure (*i.e.*, weir) at the confluence of St. Johns Bayou and Setback Levee Ditch.
- Constructing a bank stability structure at the confluence of Setback Levee Ditch and St. James Ditch.
- Creating stream bank slopes within construction reaches.
- Establishing buffer strips within construction reaches. Buffer strips would consist of a 40-foot grassy area on the construction side of the ditch (benefits not quantified) and establishing a forested buffer on the opposite bank.
- Establishing buffer strips around ecologically-designed borrow pits, consisting of forested buffer strips planted with an appropriate mixture of bottomland hardwood wetlands or riverfront forest species.
- Establishing buffer strips along an additional 18.8 miles of ditches, consisting of a 40-foot grass buffer along one bank (benefits not quantified), to be used as a means of access for future maintenance, and of a similarly-sized forested buffer on the opposite bank.

Fish and Wildlife Resources

Impacts to fish and wildlife resources are discussed in Section 4 and applicable appendices. The following mitigation is proposed to fully compensate unavoidable impacts:

- Restore vegetated wetlands on 400 acres of agricultural land below an elevation of 285 feet (Mitigation Zone 2).
- Restore vegetated wetlands on 1,816 acres of land lying within the projected future 5-year floodplain (Mitigation Zone 3).
- Ecologically design and construct 387 acres of borrow pits (Mitigation Zone 3).
- Inundate 244 acres of farmland during the spring shorebird migration period (Mitigation Zone 4).

Table 5.3 provides impacts of the project to each specific resource and the result of mitigation features to each specific resource. Since mitigation benefits multiple resources, compensating for fish and wildlife resources also compensates for mitigation required pursuant to the Clean Water Act.

Vegetated Wetland Restoration

Restoration of vegetation on mitigation tracts involves preparing the site, restoring hydrology to the extent practical (based on projected future hydrology) and reforesting cleared and agricultural areas with naturally-occurring and historically-occurring species. With the exception of shorebirds, vegetated wetlands provide benefits to fish and wildlife. Vegetated wetlands restoration would be accomplished in two areas: one, below an elevation of 285 feet (Zone 2), and the other, between the 285- to 288-foot elevations (Zone 3).

Mitigation Zone 2 - Below Elevation 285 feet

An estimated 400 acres would be obtained below the 285-foot elevation. Considering the projected future hydrology in these areas, restoration would involve planting cypress-tupelo vegetation in addition to creating microtopography, providing earthwork, and other hydrologic restorative activities. After restoration, these areas would be expected to become, and be sustained as, low gradient riverine backwater wetlands
Restoring 400 acres of cypress-tupelo forest is estimated to provide:

- 232 Low Gradient Riverine Backwater FCU
- 292 AAHU for terrestrial wildlife;
- 114,720, 84,160, and 129,120 DUD during the November, December-January, and February-March time periods, respectively; and
- 40.7, 41.9, and 15.5 AAHU for early-, mid-, and late-season fish spawning and rearing habitat, respectively.

Mitigation Zone 3 - Elevation 285-288 feet

Other mitigation to compensate for impacts to fish and wildlife was formulated so that no net gain or loss of mid-season fish spawning and rearing habitat would occur. An additional 1,816 acres of restored vegetated wetlands would be needed. A mixture of bottomland hardwood vegetation would be planted according to site conditions, as well as creating microtopography, providing earthwork, and conducting other hydrologic restorative activities. Based on their conditions, restored sites would either be low gradient riverine backwater wetlands or low gradient riverine overbank wetlands. For planning purposes, 623 of the 1,816 acres would be low gradient riverine overbank wetlands; a minimum of 397 detain floodwaters FCU (equating to approximately 623 acres) must be mitigated to the low gradient riverine overbank subclass.

Restoring 1,816 acres of vegetated wetlands is estimated to provide:

- 690 Low Gradient Riverine Backwater FCU
- 397 Low Gradient Riverine Overbank FCU
- 1,489 AAHU for terrestrial wildlife
- 1,390,447, 1,494,929, and 1,196,046 DUD during the November, December-January, and February-March time periods, respectively; and
- 124.2, 127.9, and 50.1 AAHU for early-, mid-, and late- season fish spawning and rearing habitat, respectively.

Ecologically Designed Borrow Pits

The number of acres of ecologically-designed borrow pits recommended to compensate for impacts to fish and wildlife is based on the size of the area needed to obtain material to raise the New Madrid Floodway setback levee, using an ecological design. This would amount to 387 acres and would be located in Mitigation Zone 3.

Borrow pits provide an excellent opportunity to compensate for impacts to inundated floodplain habitat (J. Jackson, personal communication; Battelle, 2010). Since borrow pits would be located in the projected future 5-year floodplain, they would provide benefits to fish spawning and rearing habitat because they would remain seasonally connected to the flood pulse. The 387 acres of borrow pits would provide 268.4 AAHU during each of the early-, mid-, and late-spawning and rearing periods (see Appendix R).

Ecologically designed borrow pits also have the greatest potential for successful wetlands mitigation (Battelle, 2010). Since half of the borrow pits are anticipated to have a depth of less than three feet, these areas would likely support wetlands vegetation. Therefore, only half of the 387 acres were used to quantify wetlands mitigation benefits (Connected Depressions). No impacts to connected depression wetlands are anticipated in the St. Johns Bayou Basin. Therefore, these areas would not be needed for compensation; rather, they would be a net benefit to wetlands resources.

Waterfowl are also anticipated to utilize ecologically-designed borrow pits. Since water would be retained for prolonged periods, ecologically-designed borrow pits were considered to be within the 1.01 three-consecutive day recurrence interval. Therefore, borrow pits would provide 348,687, 252,324, and 216,488 DUD during the November, December-January, and February-March time periods, respectively (see Appendix R).

Seasonally Inundated Farmland

The amount of seasonally inundated farmland recommended to compensate for impacts to fish and wildlife resources was determined based on impacts to shorebirds. Since the project would impact 117 optimal equivalent acres, 244 compensatory acres are required (see Appendix R). Seasonally inundated shorebird areas would be located at elevations above the projected future 5-year floodplain (Mitigation Zone 4). Therefore, no gains in wetlands or fish habitat were quantified. Likewise, according to the terrestrial model and the selected species utilized, seasonally inundating farmland does not provide any gains to terrestrial wildlife resources.

Although seasonally inundating farmland is primarily a method to compensate for impacts to shorebirds, waterfowl would also be expected to utilize this kind of habitat. To benefit shorebirds, farmland would need to be inundated prior to March 15. Stop logs would therefore be emplaced in outlet structures beginning in February, to coincide with the waterfowl migration period. In addition, some areas could be purposefully flooded in the November-January timeframe, both to provide waterfowl habitat and recreational opportunities. Since sites would be actively inundated, the 3-day flood recurrence interval is expected to be 1.01. It is anticipated that seasonally inundated farmland would provide 43,563, 41,991, and 42,789 DUD during the November, December-January, and February-March time periods, respectively.

Riparian Buffer Strips

Although buffer strips are proposed primarily as compensation for ditch impacts, following the Missouri Stream Mitigation Method, they also provide some benefit to waterfowl and fish.

Grass buffer strips (112 acres, total) are anticipated to provide 11,064, 9,330, and 9,360 DUD during the November, December-January, and February-March time periods, respectively. Woody buffer strips (70 acres, total) are anticipated to provide 19,331, 16,068, and 16,369 DUD during the November, December-January, and February-March time periods, respectively (see Appendix R).

Half of the buffer strips were assumed to be located below an elevation of 288 feet (in the projected future 5-year floodplain). Therefore, 5.9, 5.6, and 1.8 fish spawning and rearing AAHU are anticipated during the early-, mid-, and late-season periods, respectively.

5.4.2 New Madrid Floodway

Section 404 of the Clean Water Act

Wetlands

Section 4.8.1 and Appendix E, Part 4 discuss impacts to wetlands likely to occur if a levee to close the New Madrid Floodway gap is constructed and a pumping station in the floodway is built and operated. In summary, the Tentatively Selected Plan would reduce hydrology on 306 acres of farmed wetlands, 300 acres of connected depression, 1,163 acres of Low Gradient Riverine Overbank wetlands, and 7,337 acres of Low Gradient Riverine Backwater wetlands. Of the 7,337 acres of Low Gradient Riverine Backwater wetlands, 2,216 acres would change from this to the flats subclass since they would no longer be located within the projected future 5-year floodplain (see Section 4.8.1 and Appendix E, Part 4).

Multiple mitigation measures are proposed to compensate for the impacts to wetlands (see Appendix R and Appendix E, Part 4).

- Restoring hydrology to Big Oak Tree State Park (Mitigation Zone 1)
- Ecologically designing and constructing 60 acres of borrow pits (Mitigation Zone 3). Wetlands credit (Connected Depressions) would only be taken for half of the area that would be shallowly flooded.
- Restoring floodplain lakes in the batture area (Mitigation Zone 5). Likewise, only the shallow areas of the lake would be credited for wetlands (Connected Depressions).
- Restore low gradient riverine backwater vegetated wetlands on 4,213 acres of cropland (Mitigation Zones 1, 2, 3, and 5).
- Restore low gradient riverine overbank wetlands on 57 acres of cropland (Mitigations Zones 2, 3, and 5).

Ditches

According to the Missouri Stream Mitigation Guidelines, constructing the closure levee and gravity outlet structure across Mud Ditch would result in a need to provide 1,087 stream credits (see Section 4.11.5). Mitigation consists of providing a 25-foot tree buffer around the ecologically designed borrow pits (Mitigation Zone 3). Providing the buffer around 60 acres of ecologically designed borrow pits would provide 7,249 stream credits, resulting in a mitigation surplus.

Fish and Wildlife Resources

Impacts to fish and wildlife are discussed in Section 4 and applicable appendices. The following mitigation is proposed to compensate for impacts:

- Restore hydrology to Big Oak Tree State Park by means of a gated culvert through the Mississippi River Frontline Levee (Mitigation Zone 1).
- Restore vegetated wetlands on a minimum of 1,800 acres of farmland surrounding Big Oak Tree State Park (Mitigation Zone 1).
- Restore vegetated wetlands on 387 acres of farmland below an elevation of 285 feet (Mitigation Zone 2).
- Restore vegetated wetlands on 1,970 acres of farmland below the projected future 5-year floodplain (Mitigation Zone 3).
- Remove 3,050 acres of cropland from production in the batture (Mitigation Zone 5) and allow them to revert to bottomland hardwoods/riverfront forest naturally (vegetated wetlands).
- Ecologically design and construct 60 acres of borrow pits (Mitigation Zone 3).
- Seasonally inundate 1,286 acres of farmland during the spring shorebird migration period. This would include the 993 acres of shorebird habitat provided by Ten Mile Pond Conservation Area (Mitigation Zone 7) and 293 additional acres of seasonally inundated farmland (Mitigation Zone 4).
- Restore 432 acres of floodplain lakes, such as Riley Lake (Mitigation Zone 5).

Table 5.4 shows the foreseeable impacts of the compensatory mitigation proposed for the New Madrid Floodway.

Big Oak Tree State Park and Surrounding Area

Restoring hydrology to Big Oak Tree State Park and restoring wetlands on a minimum of 1,800 acres surrounding the park are priorities (Mitigation Zone 1). Restoration would consist of constructing a water control structure in the levee to the south of the park and associated channels to deliver Mississippi River surface water via gravity drainage. Thus, the park wetlands (976 acres of low gradient riverine backwater wetlands and 49 acres of connected depression wetlands) would be restored to conditions that existed prior to hydrologic modifications that have taken place in the park vicinity. Restoring hydrology would provide 966 low gradient riverine backwater FCU and 48 Connected Depression FCU.

Likewise, restoring the 1,800 acres surrounding the park would result in 1,800 acres of low gradient riverine backwater wetlands. Mitigation includes creating microtopography, providing earthwork, and other hydrologic restorative activities. Planted vegetation would be consistent with other park vegetation based on specific elevations and hydrologic zones. It is anticipated that restoring vegetated wetlands on 1,800 acres of cropland surrounding the park would provide 1,076 low gradient riverine backwater wetland FCU.

Restoring the flood pulse to the park and the surrounding 1,800 acres would provide significant habitat benefits to numerous fish and wildlife resources.

- 732,800, 791,300, and 627,600 DUD to the footprint of the park during November, December – January, and February – March time periods, respectively;
- 852,235, 880,949, 760,450 DUD to the surrounding 1,800 acres during November, December – January, and February – March time periods, respectively;
- 1,746 AAHU to terrestrial wildlife habitat; and
- 914.0, 889.5, and 577.3 AAHU to early, mid, and late season fish spawning and rearing habitat, respectively.

Vegetated Wetlands Restoration

Restoration of vegetation on mitigation tracts involves preparing the site, restoring hydrology to the extent practical (based on projected future hydrology) and reforesting cleared and agricultural areas with naturally-occurring and historically-occurring species. With the exception of shorebirds, vegetated wetlands provide benefits to fish and wildlife. Vegetated wetlands restoration would be accomplished in two areas: one, below an elevation of 285 feet, and the other, between the 285- to 288-foot elevation.

<u>Mitigation Zone 2 - Below Elevation 285</u>

An estimated 387 acres would be obtained below the 285-foot elevation. Considering the projected future hydrology in these areas, restoration would involve planting cypress-tupelo vegetation in addition to creating microtopography, providing earthwork, and other hydrologic restorative activities. After restoration, these areas would be expected to become, and be sustained as, low gradient riverine backwater wetlands

Restoring 387 acres of cypress-tupelo forest is estimated to provide:

- 232 low gradient riverine backwater wetland FCU
- 283 AAHU for terrestrial wildlife;
- 83,244, 61,069, and 93,693 DUD during the November, December-January, and February-March time periods, respectively; and
- 61.7, 70.5, and 0.0 AAHU for early-, mid-, and late-season fish spawning and rearing habitat, respectively.

<u>Mitigation Zone 3 - Elevations 285-288</u>

In addition to the 1,800 acres of mitigation adjacent to Big Oak Tree State Park, an estimated 1,970 acres of restored wetlands would be created between the 285- to 288-foot elevations. Based on site-specific location, restored sites would either be low gradient riverine backwater wetlands or low gradient riverine overbank wetlands. For planning purposes, all sites were classified as low gradient riverine backwater wetlands.

Restoring 1,970 acres of bottomland hardwoods is estimated to provide:

- 1,182 low gradient riverine backwater FCU
- 1,615 AAHU for terrestrial wildlife;
- 1,508,360, 1,621,702, and 1,297,472 DUD during the November, December-January, and February-March time periods, respectively; and
- 179.3, 84.7, and 0.0 AAHU for early-, mid-, and late-season fish spawning and rearing habitat, respectively.

<u>Mitigation Zone 4 - Batture Land</u>

There are areas in the batture that could be restored. Restoration includes natural plant succession but also includes creating microtopography and other site-specific hydrologic restoration. Taking 3,050 acres of cropland out of production and allowing natural reforestation is estimated to provide:

- 1,952 low gradient riverine backwater FCU
- 154 low gradient riverine overbank FCU
- 2,440 AAHU for terrestrial wildlife;
- 2,125,698, 1,765,493, and 1,797,060 DUD during the November, December-January, and February-March time periods, respectively; and
- 692.4, 692.4, and 310.2 AAHU for early-, mid-, and late-season fish spawning and rearing habitat, respectively.

Ecologically Designed Borrow Pits

The number of acres of ecologically-designed borrow pits recommended to compensate for impacts to fish and wildlife is based on the size of the area needed to obtain material to build a levee to close the New Madrid Floodway gap, using an ecological design. This would amount to 60 acres and would be located in Mitigation Zone 3.

Borrow pits provide an excellent opportunity to compensate for impacts to inundated floodplain habitat (J. Jackson, personal communication; Battelle, 2010). Since borrow pits would be located in the projected future 5-year floodplain, they would provide benefits to fish spawning and rearing habitat. The required 60 acres of borrow pits would provide 41.6 AAHU during each of the early-, mid-, and late-spawning and rearing periods (see Appendix R).

Ecologically designed borrow pits also have the greatest potential for successful wetlands mitigation (Battelle, 2010). Since half of the borrow pits are anticipated to have a depth of less than three feet, these areas would likely support wetlands vegetation. Therefore, only half of the 60 surface acres was used towards wetlands mitigation benefits (Connected Depressions). Ecologically designed borrow pits would provide 17 connected depression FCU.

Waterfowl are also anticipated to utilize ecologically designed borrow pits. Since water would be retained for prolonged periods, ecologically designed borrow pits are expected to have a 3- day flood recurrence interval of 1.01. Therefore, borrow pits would provide 54,060, 39,120, and 33,564 DUD during the November, December-January, and February-March time periods, respectively (see Appendix R).

Seasonally Inundated Farmland

The amount of seasonally inundated farmland recommended as compensation for impacts on fish and wildlife was based on mitigation for shorebirds. Since the proposed project would likely affect 615 optimal equivalent acres, 1,286 compensatory acres will be needed (See Appendix R). Note this value does not include the mitigation benefits attributable to the Ten Mile Pond Conservation Area (Mitigation Zone 7). Seasonally inundated shorebird areas would be located at elevations above the projected future 5-year floodplain (Mitigation Zone 4). Therefore, no gains in wetlands or fish were quantified. Likewise, according to the terrestrial model and the selected species utilized, seasonally inundating farmland does not produce any gains in terrestrial wildlife resources.

Although seasonally inundating farmland is primarily a method to compensate for impacts to shorebirds, waterfowl would also be expected to utilize this kind of habitat. To benefit shorebirds, farmland would need to be inundated prior to March 15. Stop logs would therefore be emplaced in outlet structures beginning in February, to coincide with the waterfowl migration period. In addition, some areas could be purposefully flooded in the November-January timeframe, both to provide waterfowl habitat and recreational opportunities. Since sites would be actively inundated, the 3-day flood recurrence interval is expected to be 1.01. It is anticipated that seasonally inundating 1,286 acres of farmland would provide 229,924, 221,630, and 225,841 DUD during the November, December-January, and February-March time periods, respectively.

Floodplain Lakes

Similar to ecologically designed borrow pits, floodplain lakes are excellent ways to compensate for impacts to inundated floodplain habitat. Additionally, since the Mississippi River is no longer free to meander as in the past, restoring this historical type of habitat is even more valuable (J. Jackson, personal communication; Battelle, 2010). Several lakes could be restored in batture areas. Riley Lake (located on Donaldson Point adjacent to the New Madrid Floodway) is an example. A weir could be constructed in the outlet ditch to restore the lake surface to approximately 432 acres. Therefore, 326.8 AAHU to fish spawning and rearing habitat would be generated in each of the early-, mid-, and late-season periods (see Appendix R).

Floodplain lakes would also provide wetlands habitat through connected depressions. One-third of the restored lake would have a depth of three feet or less. Therefore, wetlands vegetation would be restored on 144 acres (91 CD FCU) of connected depression wetlands (see Appendix R).

Waterfowl would also likely utilize the restored lake. Similar to borrow pits, the lake would have a three-day flood recurrence interval of 1.01. Therefore, restoring 432 acres of floodplain lakes would provide 389,232, 281,664, and 241,661 DUD during the November, December-January, and February-March time periods, respectively.

5.5 Compliance with Mitigation Rule

USACE and EPA regulations on Compensatory Mitigation for Losses of Aquatic Resources (collectively "the Mitigation Rule") (33 C.F.R. parts 325 and 332; 40 C.F.R. part 230) prescribe that mitigation plans for wetlands compensatory mitigation projects shall contain the following twelve elements: (1) objectives; (2) site selection criteria; (3) site protection instruments (e.g., conservation easements); (4) baseline information (for impact and compensation sites); (5) credit determination methodology; (6) mitigation work plan; (7) maintenance plan; (8) ecological performance standards; (9) monitoring requirements; (10) long-term management plan; (11) adaptive management plan; and (12) financial assurances. *See* 33 C.F.R. § 332.4(c) and 40 C.F.R. § 230.94(c). Each of the twelve criteria is discussed in order.

5.5.1 Objective

The objective of mitigation is to avoid, minimize, and compensate environmental impacts. It is the policy of the Corps of Engineers Civil Works program to avoid and minimize impacts to terrestrial and aquatic resources to the extent practicable, and that unavoidable impacts are compensated. A variety of measures to avoid and minimize impacts are described in Section 2.0. Compensatory mitigation for unavoidable impacts is described in Appendix R and the other resource-specific appendices. Although mitigation ratios are commonly used for USACE-permitted activities, a more rigorous function- and habitat-based assessment was used to determine what and how much mitigation would be appropriate in this case. Each ecological model used in this case underwent independent review; all were determined to be suitable. The HGM and fish models utilize a temporal lag that considers the amount of time necessary to achieve habitat and function replacement. 33 C.F.R. § 332.2(f) states:

> If the district engineer determines that compensatory mitigation is necessary to offset unavoidable impact to aquatic resources, the amount of required compensatory mitigation must be, to the extent practicable, sufficient to replace lost aquatic resource functions. In cases where appropriate functional or condition assessment methods or other suitable metrics are available, these methods should be used where practicable to determine how much compensatory mitigation is required. If a functional or condition assessment or other suitable metric is not used, a minimum one-to-one acreage or linear foot compensation ratio must be used.

Table 5.5 shows the unavoidable impacts reasonably likely to occur if Alternative 3.1, the Tentatively Selected Plan, were implemented.

Table 5.5. Project impacts, St. Johns Bayou Basin and New Madrid Floodway

Resource Category		St. Johns Bayou Basin	New Madrid Floodway
Wetlands[1] (FCU)	Low Gradient Riverine Backwater	-116	-3,481
	Low Gradient Riverine Overbank	-397	-35
	Connected Depressions	0	-124
Ditch Impacts (credits)		-699,685.6	-1,087.2
Terrestrial Wildlife (AAHU)		-766	-13
Waterfowl (DUD)	Nov.	-549,913	-974,545
	Dec. – Jan.	+633,575[2]	+519,602[2]
	Feb. – March	-1,319,448	-4,157,013
Shorebirds (Optimal Acres)		-117	-615
Fish (AAHU)	Early	-386.6	-1,729.5
	Mid	-442.7	-2,061.1
	Late	-245.7	-1,165.8

[1]Mitigation required pursuant to Section 404 of the Clean Water Act
[2]No mitigation is required. This would be a benefit of implementing Alt. 3.1.

The overall objective of mitigation is to compensate for impacts provided in Table 5.5. Tract-specific objectives will be developed for each tract-specific mitigation plan. For example, an unavoidable loss of 100 acres of shorebird habitat in St. Johns Bayou Basin may be compensated by seasonally inundating 300 acres of farmland during peak shorebird migration periods. Another example would be to compensate an unavoidable loss of 22.7 early-, mid-, and late-season fish AAHU in the New Madrid Floodway by reforesting 100 acres of farmland in the batture. Since some mitigation measures benefit multiple resources, the mitigation objectives for each to-be-acquired tract would reflect this, by clearly stating the anticipated benefits for each resource.

5.5.2 Site Selection Criteria

If a decision is made to implement an action alternative, landowners in the proposed mitigation zones would be surveyed to identify willing sellers. Preliminary information would then be gathered on each prospective tract including elevation, geomorphic setting, soils, flood frequency, adjacent drainage patterns, and proximity and relation to other desirable tracts, based on which each tract would be assessed for suitability and sustainability, and prioritized accordingly for acquisition. It is reasonable to presume that this process will take several years before all needed lands are identified and purchased, and all compensatory mitigation is satisfactorily accomplished. Because the undertaking will be long and complex, and will be coordinated with the Inter-Agency Team, USACE will build flexibility and adaptability into the process to, among other things adjust to changes in the willingness of prospective sellers to convey property to the Government.

Therefore, landowners would be periodically surveyed on their amenability to sell mitigation land.

5.5.3 Site Protection Instrument

Several different real estate acquisition methods are proposed for the St. John Levee and Drainage District and the Federal government to procure interests in real estate (Table 5.6). Acquisition of interests by both the St. John Levee and Drainage District and the Federal Government would result from the differing roles, local and federal, that each would play in paying for, operating, and maintaining the proposed flood risk reduction improvements. Mitigation lands would be acquired by the St. John Levee and Drainage District for impacts in the St. Johns Bayou Basin and New Madrid Floodway (relating to the pumping station). The Federal government would acquire mitigation lands in the Floodway (relating to the levee proposed to close the gap between the frontline levee and the setback levee). Interests that may be acquired, all of which are intended to be perpetual, include fee title, third-party conservation easements, and restrictive covenants. Temporary construction easements would be needed for public lands (*e.g.*, Big Oak Tree State Park).

Table 5.6. Compensatory mitigation real estate mechanisms, St. Johns Bayou Basin and New Madrid Floodway.

Mitigation Measure	Fee Title	Conservation Easement	Restrictive Covenant	Construction Easement
Big Oak Tree Hydrologic Restoration				X
Vegetated Wetlands Restoration	X	X		
Buffer Strips	X	X	X	
Borrow Pits	X	X		
Seasonally Inundated Farmland	X	X	X	
Floodplain Lakes	X	X		X
Ten Mile Pond CA				

All compensatory mitigation lands retained in private ownership, but subject to third-party conservation easements, would be inspected on an annual basis according to the terms and conditions of the easement. Supplemental or corrective action would be taken, as needed.

Details on the real estate mechanism(s) needed for each site would be incorporated into each tract's mitigation plan.

5.5.4 Baseline Information

Baseline conditions across the project area are presented and analyzed in Sections 3 and 4. Information on the most recent conditions pertaining to each prospective mitigation site would be acquired and assessed as part of the process of preparing mitigation plans.

This would include project future (without mitigation) hydrology, soil types, elevations, delineation of waters of the United States (if applicable), and geomorphologic characteristics. In addition, where practical, historic conditions (i.e., prior to large-scale ditching) would also be described. Finally, any information on historical and cultural resources, as well as any hazardous contamination, would also be included.

5.5.5 Credit Determination Methodology

The amount of compensatory mitigation credits needed would be calculated for each compensatory mitigation tract using the models employed to determine impacts. Assumptions and calculations regarding mitigation are discussed in Appendix R and each resource-specific appendix.

5.5.6 Mitigation Work Plan

Mitigation features are discussed throughout the draft EIS. However, the work plan would be refined for each tract specific mitigation plan. Each tract-specific work plan would include the following information:

- Geographic boundaries of the site.
- Mitigation implementation methods, sequencing, and timing of implementation.
- Hydrologic sources including projected future flood frequency elevations and site specific additional sources (*e.g.*, plugging farm drains, perimeter levee degradation), connections, durations, depths, timing, and fish access measures.
- Detailed plantings (*e.g.*, natural regeneration, 12-foot center seedlings plantings, direct seeding)
- Proposed grading plans, including the establishment of microtopography and sub-soiling.
- Soil management measures.
- Erosion control measures.

In addition to the above, tract-specific mitigation work plans necessary to compensate for ditch impacts would also include channel dimensions and profiles, cross sections, hydraulics and hydrology information, and riparian plantings. The mitigation work plan necessary to restore hydrology to Big Oak Tree State Park would also include engineering designs for necessary gated structures, fish access channels, ditch work, and perimeter drainage/levee modifications to the park itself.

5.5.7 Maintenance Plan

40 CFR 332.7(b) states: "mitigation projects should be designed, to the maximum extent practicable, to be self-sustaining once performance standards have been achieved. This includes minimization of active engineering features (e.g., pumps) and appropriate siting to ensure that natural hydrology and landscape context will support long-term sustainability. Where active long-term management and maintenance are necessary to ensure long-term sustainability (e.g., prescribed burning, invasive species control,

maintenance of water control structures, easement enforcement), the responsible party must provide for such management and maintenance. This includes the provision of long-term financing mechanisms where necessary". The Corps acknowledges that some mitigation features require the utilization of engineered structures such as the one proposed to restore hydrology to Big Oak Tree State Park

Maintenance of mitigation sites would be subject to specific authorization for each specific portion of the project. The majority of reforestation sites (cypress-tupelo, bottomland hardwood, riverfront/batture), including the 1,800 acres of land surrounding Big Oak Tree State Park, and ecologically designed borrow pits would be relatively maintenance-free and self-sustaining once established. However, some specific sites may require perimeter levees to ensure that adjacent properties are not inadvertently flooded due to mitigation measures. Additionally, some borrow pits may have small grade control structures. Based on the project authority, the project sponsor, the St. John Levee and Drainage District would be responsible for any routine maintenance on both the St. Johns Bayou and New Madrid Floodway portion of the project as well as the New Madrid Floodway closure. Routine maintenance includes the necessary mowing and minor repair of any perimeter levees. Routine maintenance would be identified in the tract-specific mitigation plan.

The project sponsor would be responsible for maintaining buffer strips and in-stream structures associated with compensating ditch impacts. Buffer strip maintenance would include periodic burning of grass buffer areas as well as protection of woody vegetation on the opposite bank. Any falling or overhanging trees that could impede flow would continue to be removed as part of the sponsor's legal mandate to provide drainage. Likewise, routine maintenance would be identified in the tract-specific mitigation plan.

Shorebird mitigation sites would require more extensive maintenance due to the anticipated management. To maintain sparse vegetation, shorebird mitigation sites would remain in agricultural production following shorebird migration periods. An agricultural lease or leases would accomplish this necessary maintenance responsibility, and the project sponsor would manage the lease(s). Leases would be similar to existing agricultural leases utilized by MDC on the Ten Mile Pond Conservation Area. Any funds obtained from the lease would go into financing maintenance and management activities. Shorebird sites would likely involve perimeter levees and possibly small interior levees (*e.g.*, rice dikes) to maintain shallowly flooded depths. The project sponsor would be responsible for routine maintenance of necessary perimeter and interior levees. Shorebird mitigation sites would include the necessary water control structures. Stop-log style structures would be utilized. The project sponsor would be responsible for routine maintenance including debris removal, board replacements, and necessary management (insertion or removal of stop logs). The project sponsor would be responsible for stop-log structure replacement for sites acquired for the St. Johns Bayou and New Madrid Floodway portion of the project. The Federal government would be responsible for replacement of stop-log structures on sites acquired for the New Madrid Floodway closure portion of the project. Management of shorebird tracts would involve the placement and removal of stop logs at appropriate periods of time during the peak of spring shorebird migration.

With the exception of routine maintenance provided by the project sponsor, the Federal government would be responsible for maintaining the structure necessary to restore hydrology to Big Oak Tree State Park. Routine maintenance conducted by the sponsors includes drift removal, mowing, upkeep of gates and gears, and management such as opening and closing the gates at specified times. Specific management plan of gate opening and closing would be provided in the tract-specific mitigation plan. The Federal government would be responsible for any major repairs or replacements, sediment removal of inflow ditches, erosion control, and levee repairs. Since this structure is located within the Mississippi Mainline Levee, it will undergo routine maintenance and inspection. Any deficiencies will be corrected. Adherence to water levels would be a requirement of the Project Cooperation Agreement between the Federal government and the non-federal sponsor.

Once established, any necessary weirs required for the restoration of floodplain lakes would also be relatively maintenance free. However, the Federal government would be responsible for any major maintenance activities including erosion protection.

Sponsor required mitigation site maintenance would be specified in the Project Cooperation Agreement as well as each tract-specific mitigation plan. If appropriate, a separate operation and management manual would be provided for specific tracts that require more detailed information such as shorebird sites or Big Oak Tree State Park.

5.5.8 Ecological Performance Standards

The goal of mitigation is to compensate significant unavoidable impacts to the extent justified and mandated by law. Therefore, the ecological performance standards for the overall project are as follows:

<u>St. Johns Bayou Basin</u>

- Wetlands
  - 116 Low Gradient Riverine Backwater FCU
  - 396 Low Gradient Riverine Overbank FCU
- 766 Terrestrial Wildlife AAHU
- Waterfowl
  - 549,913 November DUD
  - 1,319,448 February-March DUD
- 117 optimal equivalent shorebird acres
- Fish
  - 386.6 early season AAHU
  - 442.7 mid-season AAHU
  - 245.7 late season AAHU

New Madrid Floodway

- Wetlands
  - 3,481 Low Gradient Riverine Backwater FCU
  - 35 Low Gradient Riverine Overbank FCU
  - 124 Connected Depression FCU
- 13 Terrestrial Wildlife AAHU
- Waterfowl
  - 974,545 November DUD
  - 4,157,013 February-March DUD
- 615 optimal equivalent shorebird acres
- Fish
  - 1,729.5 early season AAHU
  - 2,061.1 mid-season AAHU
  - 1,165.8 late season AAHU

Ecological performance standards would be refined during the completion of each tract-specific mitigation plan. Each plan would provide the anticipated mitigation benefit to each resource from implementing the plan. Therefore, the ecological success of mitigation is quantified in a consistent manner with the way impacts were quantified.

5.5.9 Mitigation Tract Monitoring Requirements

Each compensatory mitigation tract would be monitored to determine if mitigation features have been successfully established. In addition, the overall project would also be monitored (see Phase 2 Monitoring - Section 7). Table 5.7 provides a summary of parameters that would be analyzed on each specific mitigation tract. The focus on monitoring is to answer whether or not the mitigation tracts are providing the anticipated benefits. Thus, monitoring parameters focus on the requirements for each of the ecological models. Monitoring would include the development of baseline conditions that are present pre-mitigation implementation. Post mitigation-implementation would be compared to pre-implementation to measure success. Monitoring would occur annually for a period of five years. A site-specific monitoring report would be prepared each year and results furnished to the interagency team.

Table 5.7. Preliminary compensatory mitigation monitoring parameters, St. Johns Bayou Basin and New Madrid Floodway, Missouri.

Mitigation Type	Monitoring Parameter
Big Oak Tree Hydrologic Restoration	• Hydrology functioning as designed (*i.e.*, inundate the park with Mississippi River surface water up to an elevation of 291 feet). • Vegetation Present (percent Composition, diversity, percent coverage) • HGM Variables (see applicable HGM field data sheets, Appendix E, Part 3, pp. 180-198).
Forested/Herbaceous Areas	• Vegetation Present (percent Composition, diversity, percent coverage) • Success of Planted Vegetation • Hydrology functioning as designed (duration, depth, timing) • HGM Variables (see applicable HGM field data sheets, Appendix E, Part 3, pp. 180-198).
Buffer Strips	• Establishment of buffer width • Vegetation Present (% Composition) • Growth Rate (grasses) • HGM Variables (see applicable HGM field data sheets, Appendix E, Part 3, pp. 180-198).
Ecologically Designed Borrow Pits	• Hydrology functioning as designed (duration, timing, depth) • Vegetation Present (% Composition) • Bathymetry • HGM Variables for shallow water portion (see applicable HGM field data sheets, Appendix E, Part 3, pp. 180-198).
Seasonally Inundated Farmland	• Hydrology functioning as designed (duration, timing and depth)
Floodplain Lakes	• Hydrology (including connection) • Vegetation Present (% Composition) • Bathymetry

Hydrology

Hydrology would be monitored by a variety of methods. Three gages would be installed upstream of the St. Johns Bayou closure, upstream of the New Madrid Floodway closure, and at Big Oak Tree State Park. These gages would provide daily sump elevations. Therefore, with the exception of shorebird sites, hydrologic parameters (daily elevations) could be monitored to determine flood timing, duration, and depth of all mitigation sites located within the post-project 5-year floodplain. Likewise, the existing Mississippi River gage at New Madrid (MS115) could be used to determine hydrology for batture land reforestation sites or floodplain lake connectivity. Gages would only measure inundation, not saturation.

Hydrology of shorebird sites would be monitored with staff gages that are calibrated to site-specific conditions. For example, precise contours would be determined for each tract during the development of site-specific monitoring plans. A staff gage could be installed at each site and hydrology (depth, duration, and timing) could be measured by direct observation of the gage.

Hydrology of borrow pits and floodplain lakes would be measured by determining surface acres that remain inundated. This would be accomplished by aerial photography and GIS.

Vegetation

Vegetation (or lack of vegetation) would be monitored by visually inspecting each mitigation site annually for a period of five years. Parameters measured would include vegetation present (percent composition), success of planted vegetation, diversity, and percent coverage. Anticipation and desire are that early succession species would colonize mitigation sites, but the established mitigation sites would be subject to self-design, not human desire (Mitsch *et al.*, 2012). Therefore, the draft EIS has not recommending a percent survivorship of newly planted vegetation. Instead, the project plan assumes that necessary micro/macro-topography and hydrology would influence plant communities, with the assistance of planted vegetation.

Hydrogeomorphic Method

On applicable mitigation sites (*e.g.*, Big Oak Tree State Park, forested/herbaceous wetlands, etc), HGM measurements would also be made. The specific parameters are listed in the HGM manual and the specific field data sheets are located in Appendix E, Part 3, pp. 180-198.

Tract-Specific Monitoring Reports

Each tract-specific monitoring report would quantify the benefit of each resource category (wetlands, shorebirds, fish, etc). The monitoring reports would be coordinated with the interagency team. Likewise, the interagency team would be invited to participate in all applicable monitoring activities. Differences among the interagency team would be resolved through coordination; however since monitoring may be included in any subsequent Section 401 Water Quality Certification, MDNR would likely be the approval agency. The site specific monitoring report would determine initial mitigation success and would be based on the tract-specific mitigation work plan (see Section 5.5.6).

5.5.10 Adaptive Management Plan

USACE intends to conduct Adaptive Management in two phases. The Mitigation Rule requires adaptive management of mitigation sites. Therefore, this section is devoted to adaptive management for each particular mitigation tract and is defined as Phase 1 Adaptive Management. Phase 2 adaptive management would be based on overall project performance, risk, and uncertainty (see Section 7).

5.5.10.1 Tract-Specific Adaptive Management Objectives

The adaptive management objective is to determine whether or not each tract is functioning as anticipated, or if changes to the tract-specific mitigation plan are warranted. After the initial five-year monitoring timeframe an adaptive management report would be prepared. The report would be coordinated with the interagency team. The overall objectives for adaptive management are as follows:

- Monitor tract-specific environmental responses as a result of implementing mitigation.
- Determine whether observed responses match expected ecological success outcomes concluded in the tract-specific plan.
- Determine if any tract-specific modifications are necessary to achieve the goals and objectives as determined by the ecological success criteria.
- Seek continuous improvement based upon new information resulting from changed or unforeseen circumstances or new scientific or technical information.

5.5.10.2 Tract-Specific Adaptive Management Thresholds

Adaptive management promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process (NRC, 2004). Adaptive management thresholds would be based on the tract-specific ecological performance standards as concluded by the ecological models. Based upon the results of monitoring, three potential scenarios are likely.

Scenario A – Success

If the tract is functioning as designed (vegetation and hydrology established) to each ecological resource (waterfowl, fish, etc), ecological success is considered achieved and the site will enter long-term management (see Section 5.5.11).

Scenario B – Partial Success

There may be some instances in which one particular resource is being compensated at planned levels while others are not. An example is whether or not planted vegetation becomes established. With the exception of batture land restoration, all mitigation sites would be planted with appropriate vegetation based upon its geomorphic setting and location in the watershed. It is anticipated that pioneer species (black willow and cottonwood) would become established naturally. Tree survivorship influences some models (*i.e.*, waterfowl and terrestrial HEP) but does not influence the fish model.[45] Likewise, some HGM functions require tree survivorship (*i.e.*, maintain plant communities) while other functions (*i.e.*, detain floodwater) do not. Therefore, in the

[45] The fish model only requires the presence of trees. Species of trees is not a factor. Therefore, a black willow forest or an oak forest provides equal habitat value when all other factors are equal.

event that no planted trees survive but the site has naturally vegetated with pioneer species, ecological success may be achieved for fish habitat but not for waterfowl and or terrestrial habitat.

Each adaptive management report would discuss the reason why any particular resource or wetland function may be successful while others are not. Since the project over-compensates some resources (waterfowl and terrestrial habitat), remedial actions may not be warranted. Instead of immediately rectifying a deficiency, data from other monitoring sites would first be used to determine if the overall resource category has been compensated. If results from other tracts determine that the resource has been compensated, ecological success would be considered achieved and the tract would enter long-term management (see Section 5.5.11).

If results from other tracts determine that the resource has not been compensated, remedial action would take place on the site (see Section 5.5.10.3). Results would be furnished to the interagency team prior to making any adaptive management decision.

Scenario C – Mitigation Deficiency

One or more resources are not functioning as anticipated under Scenario C and mitigation is considered deficient. Therefore, remedial action is necessary (see Section 5.5.10.3). Examples of potential problems include hydrology not functioning as designed due to erosion in the vicinity of plugged farm drains, ecologically designed borrow pits not holding water due to underlying geotechnical criteria (*i.e.*, sand lenses), and tree die off due to flood/drought conditions.

5.5.10.3 Tract-Specific Remedial Actions

Adaptive management remedial actions would first attempt to remedy the cause of the deficiency on the site-specific tract. A 25% contingency has been added to the overall mitigation costs. Including in this contingency is the cost of real estate, mitigation planning, mitigation implementation, and monitoring. Therefore, potential remedial action costs such as replanting or addressing erosion concerns are included in the cost estimate.

It may be determined that a remedy is not cost effective. Examples include borrow pits or seasonally inundated farmland not being able to hold water at anticipated durations. Therefore, it may be determined to change the overall mitigation feature to a different feature. For example even though a shorebird site may not be able to hold water, it may be suitable for bottomland hardwood restoration. Therefore, a new mitigation plan would be developed for the tract and a determination would be made if additional land(s) would be required to compensate for any overall deficiency to the resource. A 25 percent contingency has been added to the overall cost of real estate in the event that additional lands are required. Any revisions/changes to the mitigation plan would be coordinated with the interagency team.

In the event of significant deficiencies on multiple mitigation tracts, the overall operation of the project may be modified through overall project adaptive management (see Section 7).

5.5.11 Long-Term Management Plan

Under current authorities and policies, mitigation lands acquired in fee for the New Madrid Floodway portion of the project, specifically lands acquired by the Federal government could be transferred over to the USFWS once mitigation acquisition is completed and determined to meet ecological success criteria. The USFWS could then transfer the lands over to a state agency/third-party for long-term management. Lands acquired by the St. John Levee and Drainage District could be transferred to a state agency or third party if determined appropriate. If the USFWS determines not to accept the lands, USACE would maintain long-term management. USACE would likely license long term management to a suitable third party, such as MDC, MDNR, or other interested partner. The interagency team would be consulted with prior to turning over any mitigation lands. It is the intent of USACE to turn over mitigation lands to a suitable third party. However, USACE and the sponsor are ultimately responsible in ensuring that mitigation is achieved and maintained.

5.5.12 Financial Assurances

Financial assurances required by the non-Federal sponsor, including mitigation and monitoring requirements, would be documented in the Project Cooperation Agreement and follow the cost sharing requirements established by the project's authorization. Assurances for the Federal government's portion of the project would be subject to annual appropriations.

6.0 RISK AND UNCERTAINTY

During Independent External Peer Review (IEPR), the expert panel stated the following:

> "It is unclear if the proposed mitigation plan will compensate for impacts on environmental resources because the models do not incorporate uncertainty"

The panel provided two potential solutions to resolve the issue.

> a. Incorporate variance estimates with parameters for each of the models, allowing for 95% confidence intervals with the model point estimates. The upper 95% confidence limit could then be used as an estimate of required mitigation. Although this approach would not account for error due to invalid assumptions, it would likely ensure most impacted resources are appropriately mitigated. Important assumptions could be assessed later during the adaptive management phase and an appropriate modification to the mitigation could be made as needed. The Panel acknowledges that there are data limitations that may prevent the use of this approach.
>
> b. Identify an increase in the level of mitigation required to ensure the mitigation is adequate for all impacted resources. In the past, Federal agencies have increased mitigation by a ratio of 2:1 to 4:1, estimated level of resource mitigation to estimate level of resource loss, to account for uncertainty in the estimates.

Upon closer inspection of the original comment the panel is requesting two distinct issues.

> a. Recognize uncertainty in the models.
> b. Increase the project's compensatory mitigation to account for the uncertainty.

6.1 Recognize Uncertainty in Environmental Models

By definition, models are abstractions of real-world systems and, as such, are inherently simpler than the ecosystems they represent (Battelle, 2010). Fish and wildlife habitat models utilized for this project represent the maximum potential carrying capacity for areas/habitats by assuming all habitat requirements are needed. All ecological models have undergone extensive review and have been determined suitable for project use.

There is a great deal of uncertainty with impact analysis because of the use of multiple ecological models. These multiple models quantify habitat conditions to a variety of ecological resources, across multiple habitats, at varying flood frequencies, different flood durations, varying flood depths, and at different periods of the year. For example, if project decisions were based on the waterfowl model only, late spring floods that occur outside of the waterfowl season (*e.g.,* May-June) would not be considered. In addition, most model analyses were refined to address impacts during specific periods. For example, a decision based only on the annual results of the waterfowl model would show tremendous gains in available waterfowl habitat from project implementation and not require additional mitigation. However, the waterfowl analysis was divided into specific periods. Although there is a large overall gain to available waterfowl resources for the entire year, these gains occur during December-January and not during February-March. There is a project impact in February-March. Therefore, separating the analysis into specific periods addresses uncertainty by targeting mitigation to the period of greatest impact.

Combing model output into an average habitat unit or functional unit would not address resource-specific mitigation requirements. For example, averaging habitat units across resources would combine waterfowl, fish, shorebird, and wetland habitats into one overall measure. Providing mitigation for fish through reforestation would not provide habitat for shorebirds. Likewise, some specific resources could be under-compensated by averaging overall scores since other resources are over-compensated. Therefore, the only way to address risk and uncertainty is to conduct separate analysis for each individual resource.

Uncertainty was recognized and qualitatively described for each of the models by using risk registers. Risk was identified by comments received through interagency coordination, model review, and IEPR. In addition, the IEPR panel stated that the most scientifically appropriate method of quantifying uncertainty with the model outputs is to include 95% confidence intervals when presenting results. After consulting with model developers, USACE planners, and statisticians, confidence intervals were calculated for three of the four models. Risk was also identified for additional project features. A discussion regarding the analysis of risk is found in the following sections.

6.1.1 Hydrologic Model

A 67-year period of record analysis was conducted to estimate no action conditions. Major large scale land use changes or structural changes that would affect the Lower Mississippi River hydrograph have not been identified. The model assumes that everything remains stationary, recognizing that the Mississippi River hydrograph and precipitation are highly variable from year to year and will continue to do so under future conditions within the unchanging envelope of observed conditions in the period of record. Therefore, the model assumes future wet and dry years at the same frequency, duration, and seasonality as that observed from the period of record. This 67-year period of record used for this project, minimizes risk because of the number of wet/dry and flood/drought conditions that have occurred over this period. Although application of non-stationarity is an emerging topic in water resources research, stationarity is an accepted contemporary theory. Likewise, the Hydraulic and Hydrologic (H+H) model does not quantify any future changes to the Mississippi River hydrograph due to global climate change. However, potential ramifications of global climate change are addressed in Section 4.

Although the period of record is accepted contemporary theory, USACE acknowledges uncertainty exists regarding no action H+H conditions. Therefore, impacts could be overestimated or under-estimated resulting in the possibility of over-compensating or under-compensating the resource. The consequence of undercompensating the resource is a failure to adequately mitigate the project. The consequence of over-compensating the resource is the unnecessary utilization of public funds. To address this risk, USACE intends to monitor project performance and adaptively manage the project (See Section 7).

6.1.2 HGM Wetland Model

The HGM model measures functional capacity units by multiplying acreage by a functional capacity index. The functional capacity index is determined by field observation (see HGM model for additional information, Appendix E, Part 3). Impacts are based on the difference between future without project conditions and future with project conditions. Likewise, mitigation is based on future with project conditions (*i.e.*, post-project hydrology) without mitigation and future with project with mitigation.

Functional Capacity Index (FCI) Variance Estimates

The HGM model does not include FCI variance estimates and associated frequency distributions for model input or output. The potential consequence of undercompensating the resource is a failure to adequately mitigate significant project impacts. The potential consequence of over-compensating the resource is the unnecessary utilization of public funds.

Inclusion of variance estimates was discussed among USACE planners, model developers, and statisticians. Variance estimates were determined to be inappropriate for a variety of reasons including but not limited to the following:

- HGM utilized field work to develop FCI for each wetland subclass. Field observations were made by model developers and recorded wetland functions on 67 sites. The model developers are considered the leading experts in regards to observing and assigning appropriate FCI model parameters. Although field work was conducted on the vast majority of the project area and results are considered reliable, the process is not conducive to the determination of variance estimates.

- With the exception of areas that are within the direct footprint, the project would not impact overall wetlands acreages. However, the project would change flood frequencies impacting the wetlands by changes to flood frequency and duration. This is a major strength of the HGM model in analyzing wetlands for the project. According to the model, project implementation would result in FCI reductions to some project area wetlands from existing values of 1.0 to 0.8, 0.6, or 0, depending on the change in flood frequency recurrence intervals. This type of analysis is not conducive to the determination of confidence intervals. In fact, the reduction in wetland function is likely the most impacted function as a result of the project.

Since compensatory mitigation for fish and wildlife resources results in an over-compensation to wetlands, the uncertainty in the HGM analysis is not considered a significant issue.

<u>Acreage Estimates</u>

Uncertainty exists regarding the amount of acreage used in the model. The potential consequence of under-compensating the resource is a failure to adequately mitigate the project. The potential consequence of over-compensating the resource is the unnecessary utilization of public funds.

Vegetated Wetlands

Vegetated acreages were determined by summing all available vegetated land cover types at and below the five-year floodplain in each respective basin (see Section 4.8.1). This procedure maximized vegetated wetland estimates. Since it is highly likely that not all vegetated areas are wetlands, this is an extremely conservative estimate, meaning that impacts would be over-mitigated. That reduces the risk of uncertainty.

Furthermore, the HGM analysis included future WRP estimates that may occur, assuming that any future WRP enrollment would be functioning wetland habitat. However, many existing WRP sites are actively managed with perimeter levees, water control structures, and groundwater pumps. Vegetation is controlled in some of the sites to provide for waterfowl hunting opportunities. It is likely that a portion of future WRP enrollment would also be actively managed. Since active managed sites have a lower FCI than naturally occurring wetlands, the likelihood of providing insufficient mitigation is further reduced because the HGM model assumed that the WRP sites would be functioning natural wetlands.

Agricultural Areas

Consistent with the manner in which the project area is regulated, USACE relied on the NRCS estimate to provide acreages that are farmed wetlands. Although USACE is confident in the procedures that NRCS utilized, uncertainty exists because of the discrepancies between the NRCS estimate and if one were to utilize the WETSORT inundation analysis. Available agricultural acreages that correspond to the elevations determined by WETSORT are provided in Table 6.1.

Table 6.1. Corresponding agricultural areas to WESTORT analysis.

Basin	Alternative	WETSORT Elevation	Available Agricultural Acres
St. Johns Bayou Basin	1	287.1	2,117.85
	2.1	282.7	277.25
	3.1	282.7	277.25
New Madrid Floodway	1	287.7	6,090.86
	2.2	276.0	0.00
	3.1	283.6	388.04
	3.2	283.1	178.56
	4.1	287.1	4,427.46
	4.2	287.1	4,427.46

Similar to changes in flood frequency elevations, project alternatives would reduce the elevations that correspond to the 14-day inundation criterion determined by WETSORT. Therefore, there would be fewer lands that meet the 14-day criterion following the construction and operation of the project. To recognize the risk to potential farmed wetlands in the project area, USACE included impacts to agricultural lands that are at or below the WETSORT elevation but as a result of the project will no longer be at or below the WETSORT elevation (Table 6.2).

Table 6.2. Acres of agricultural land removed from the WETSORT elevation by project alternatives.

Basin	Alternative	WETSORT Elevation	Available Agricultural Acres	Acres Lost
St. Johns Bayou Basin	1	287.1	2,117.85	N/A
	2.1	282.7	277.25	1,840.60
	3.1	282.7	277.25	1,840.60
New Madrid Floodway	1	287.7	6,090.86	N/A
	2.2	276.0	0.00	6,090.86
	3.1	283.6	388.04	5,702.82
	3.2	283.1	178.56	5,912.30
	4.1	287.1	4,427.46	1,663.40
	4.2*	287.1	4,427.46	6090.86

* - Assumes total loss of agricultural land for reforestation.

N/A - Not Applicable.

Additional agricultural acreages were included in the HGM analysis for the selected plan. The analysis assumed that agricultural lands that would no longer be located at or below the WETSORT elevation to change in wetland status from the LGRB subclass to the flat subclass. The purpose of this hypothetical analysis was to demonstrate that the project would compensate for impacts to wetland considering the WETSORT analysis (Tables 6.3 and 6.4). The results show that mitigation required for compensating unavoidable impacts to fish and wildlife resources would still result in an overcompensation of impacts to wetlands even considering additional cropland acreage. Therefore, uncertainty in the analysis of farmed wetlands is considered to be properly addressed.

Table 6.3. St. Johns Bayou Basin hypothetical analysis, alternative 3.1.

	Previously Described Impacts (FCU)		Additional Impacts (FCU)	Previously Described Compensatory Mitigation (FCU)			Net Gain (FCU)		
Function	LGRB	LGRO	LGRB	LGRB[1]	LGRO[2]	CD[3]	LGRB	LGRO	CD
Detain Flood Water	-116	-397	-466	+922	+440	+37	+340	+43	+37
Detain Precipitation	0	-307	-994	+1010	+625	NA	+16	+318	NA
Cycle Nutrients	0	-344	-442	+1147	+493	+81	+705	+149	+81
Export Organic Carbon	-115	-319	-356	+1115	+480	+76	+644	+161	+76
Maintain Plant Communities	-50	-374	0	+1191	+513	+29	+1141	+139	+29
Provide Fish and Wildlife Habitat	0	-210	0	+423	+404	+29	+423	+194	+29

[1]Caluclated by adding FCU from benefits attributed to BLH restoration below an elevation of 285 and LGRB sites below the 5-year flood frequency.
[2]Calculated by adding FCU from benefits attributed to BLH LGRO sites below the 5-year flood frequency elevation and woody riparian buffer strips.
[3]Calcualted by benefits attributed to ecologically designed borrow pits.
[4]Note: Mitigation values do not include gains attributed to shift to different subclasses.

Table 6.4. New Madrid Floodway hypothetical analysis, alternative 3.1.

	Previously Described Impacts (FCU)			Additional Impacts (FCU)	Previously Described Compensatory Mitigation (FCU)			Net Gain (FCU)		
Function	LGRB	LGRO	CD	LGRB	LGRB[1]	LGRO[2]	CD[3]	LGRB	LGRO	
Detain Flood Water	-3481	-35	-97	-1465	+5408	+159	+131	+462	+62	+34
Detain Precipitation	-2416	0	0	-3080	+6602	+226	NA	+1106	+226	NA
Cycle Nutrients	-2086	0	-94	-1369	+6458	+156	+149	+3003	+156	+55
Export Organic Carbon	-3552	-35	-118	-1115	+5901	+154	+152	+1234	+36	+34
Maintain Plant Communities	-2576	-35	-124	0	+6109	+167	+156	+3533	+43	+32
Provide Fish and Wildlife Habitat	-1965	-12	-89	0	+4632	+111	+140	+2667	+99	+51

[1]Caluclated by adding FCU gains associated with LGRB Big Oak Tree State Park, lands surrounding Big Oak Tree State Park, reforesting lands below 284 and the five-year flood frequency, and LGRB **batture** land

[2]Caluclated by adding FCU gains to 250 acres of **batture** land mitigation.

[3]Calculated by adding FCU gains to Big Oak Tree State Park, half of the ecologically designed borrow pits, and a third of restored floodplain lakes.

[4]Note: Mitigation values do not include gains attributed to shift to different subclasses.

Change in Land Use

Channel modification within the St. Johns Bayou Basin would result in direct impacts to vegetated wetlands. The impacts have been previously described and mitigation has been formulated to address those impacts. However, potential impacts were not assessed for disposal areas that would be located on agricultural areas. USACE purposefully decided to locate disposal areas on agricultural sites to avoid impacts to vegetated wetlands. Additionally, USACE plans to allow all disposal sites to become vegetated. No ecological benefits were quantified as a result of allowing vegetation to become established in these areas. However, it is likely that the "upland" habitat provided would be ecologically beneficial considering the highly agrarian landscape.

Based on discussions with EPA, utilization of agricultural lands for sediment disposal may constitute a change in land use. Prior converted cropland would change to an upland forest.[46] EPA suggested that disposal piles that remained in agricultural production would not represent a change in land use. Thus, no requirement for mitigation pursuant to the Clean Water Act would be needed. The local sponsor could potentially farm the area following channel modifications. However, uncertainty remains regarding the arability of the spoil area and the ecological appropriateness of such an allowance.

The authorized project rights-of-way would impact an additional 329 acres of agricultural land while the avoid and minimize project would impact only an additional 120.5 acres. It is anticipated that these sites are prior converted cropland. To address this uncertainty, prior to awarding a specific contract that includes channel modifications; a jurisdictional determination would be made in the effected rights-of-way. In the event that farmed wetlands exist, a mitigation plan would be developed prior to the impact. Likewise, attempts would be made to lessen the potential mitigation requirements by avoidance, for instance by spreading the material out on adjacent farmland or using spoil for fill material elsewhere. However, in the event that mitigation is required, impacts could result in 178 and 65.1 Functional Capacity Units (FCU) [LGRB – detain precipitation function] for the authorized and avoid and minimize alternatives, respectively. Therefore, impacts would still be compensated as a result of the overcompensation of wetland functions through mitigation required for the unavoidable impacts to fish and wildlife resources.

6.1.3 Waterfowl

The waterfowl model measures Duck use Days by multiplying the daily energy provided from different habitat types (farm land, bottomland hardwood, borrow pit) by acres, multiplied by the corresponding three consecutive day recurrence interval frequency (0 to 0.99).

[46] There is currently no clear guidance regarding this subject.

Variance Estimates

Waterfowl analysis was conducted using the Duck Use Day (DUD) model. The DUD model is energy-based, as different habitat types contribute different energetic outputs available to waterfowl. Energy production estimates were acquired from various locations throughout the Mississippi Alluvial Valley (MAV), often with no reported standard error. However, gathering data from many sites, not just one or two, captures variance seen in natural settings and is considered a strength of the model. Based on discussion with model developers, USACE planners, and statisticians, it is statistically inconsistent to place variance estimates on the energy production estimates because the data was gathered from multiple studies that used different methods to establish results. However, to establish confidence intervals to address uncertainty in the model, variance was calculated on the 3-day inundation recurrence, and changes in available habitat were generated using the point estimate and upper and lower confidence interval associated with the 3-day inundation recurrence. Impacts to waterfowl are attributed to changes in the 3-day inundation recurrence intervals. No impacts are attributed to habitat clearing. Therefore, calculating confidence intervals on the 3-day recurrence intervals is appropriate to generate variance estimates (Table 6.5).

Table 6.5. Gains or losses (-) in DUD, stated as the point estimate and lower (L90) and upper (U90) 90% confidence intervals for project alternatives compared to the future without the project for various month time periods.

Month Period	Estimate	2.1	2.2	3.1	3.2	4.1	4.2
November	L90	-23,015	-26,507	57,590	57,604	58,148	62,638
	Point	-100,891	-26,508	57,590	57,604	58,148	59,353
	U90	-202,705	-254,266	-166,277	-166,246	-163,733	-115,236
December-January	L90	1,403,184	-1,234,106	1,445,840	1,445,840	1,276,207	4,547,031
	Point	978,809	-1,256,402	1,376,754	1,376,754	1,230,746	4,263,350
	U90	625,659	-4,026,846	-1,536,007	-1,536,007	-1,305,783	2,226,494
February-March	L90	-725,941	-6,182,286	-3,284,598	-3,723,021	-2,721,512	1,693,185
	Point	-995,104	-6,241,577	-3,290,786	-3,739,251	-2,727,716	1,404,541
	U90	-1,196,735	-8,623,730	-5,245,167	-5,569,324	-4,651,564	-300,283

6.1.4 Shorebirds

The shorebird model quantifies optimal equivalent shorebird acres based on daily flooding depths during optimal periods of the year.

Variance Estimates

Shorebird impact analysis was not based on overall species presence; rather impacts were calculated by the reduction of available habitat and habitat quality. Total and optimal habitat was quantified using a geographic information system (GIS) analysis using hydrologic, land use classification, and topographic information. The model does not assume that daily habitat is an exact point estimate that requires an associated variance estimate. Rather, the model incorporates each daily estimate as representative of the variation that may be available within each migration period of each year. Uncertainty and annual variability were addressed by using the period of record stage data. Habitat was quantified on a daily basis during shorebird migration seasons over the entire period of record. Therefore, some degree of uncertainty was accounted for within each season of the year. From the 67-year hydrologic period of record, a bootstrap analysis (with replacement) was used on a random selection of 50 years, repeated 200 times, to generate the 50-year average of available shorebird habitat. To address uncertainty, 95% confidence intervals were generated based on the bootstrap output (Table 6.6).

Table 6.6. Daily area (acres) of optimally equivalent shorebird habitat during spring and fall migration periods with upper and lower 95% confidence intervals.

Basin	Migration Period	Conditions	Mean	Low 95% CI	Upper 95% CI
St. Johns Bayou	Spring	Existing	371	282	459
		Authorized	254	180	328
	Fall	Existing	14	6	22
		Authorized	9	4	14
New Madrid Floodway	Spring	Existing	865	645	1,084
		Authorized	13	2	24
		Alt. 3.1	250	198	302
		Alt. 3.2	123	92	154
		Alt. 4	539	415	662
	Fall	Existing	24	0	51
		Authorized	0	0	1
		Alt. 3.1	1	0	1
		Alt. 3.2	1	0	1
		Alt. 4	18	0	38

Model Validation

The Shorebird analysis for this study included the development of a new model. Assumptions made in the model were based on scientific literature and shorebird studies, however the assumptions have not been validated. Therefore, uncertainty remains regarding model results. Risk is considered moderate because shorebird mitigation is based on replacing impacted habitat only. Therefore, mitigation does not result in over compensating shorebird impacts.

The risk can be addressed by verifying the validity of the assumptions specified during model to ensure the model accurately predicts the availability and suitability of potential foraging habitat for shorebirds. Appendix H, Part 2 demonstrates the proposed laboratory and field validation of six underlying assumptions which influence model predictions of the availability of potential foraging habitat for shorebirds. Based upon feedback received from the Phase 3 IEPR, panel members were of the opinion that the model could be validated following a decision for the project (*i.e.*, Record of Decision). Therefore, after the ROD is signed, shorebird model validation would be one of the first tasks conducted.

In the event that model verification and validation concludes the assumptions used in the model were not valid, compensatory mitigation would be revised accordingly. Any changes to compensatory mitigation would be coordinated with the interagency team.

6.1.5 Fish

The fish model determines impacts to Average Annual Habitat Units by multiplying Average Daily Flooded Acres by Habitat Suitability of various land cover types.

Variance Estimates

A fisheries impact analysis was conducted by calculating average daily flooded acres (ADFA) for each day during the fish spawning and rearing season throughout the 67-year hydrologic period of record. The ADFA is then multiplied by the habitat suitability index (HSI) for various land cover types to calculate a habitat unit. Impacts are identified as the change in habitat units from future without-project conditions to project alternatives with the addition of the fish access coefficient. Similar to the shorebird methodology, a bootstrap resampling method was used to replicate the model output 1,000 times to generate an annual mean with associated confidence intervals. Variance estimates are provided in Tables 6.7 and 6.8.

Table 6.7. Bootstrapped summary statistics for average daily flooded acres (acres) and habitat units (HU) by alternative and season for St. Johns Basin

Alternative	Spawning and Rearing Season					
	March		1 Apr - 15 May		16 May - 30 Jun	
	Acres	HU	Acres	HU	Acres	HU
Alt. 1						
Mean	2,711.2	1,860.0	2,812.7	1,960.9	1,367.3	1,065.7
St. Dev.	383.4	212.3	371.1	209.3	201.2	128.1
CV	11.5	12.4	11.0	12.1	13.6	15.8
95% lower CL	2,015.2	1,461.8	2,123.2	1,527.1	1,012.1	825.9
95% upper CL	3,523.4	2,303.7	3,577.8	2,367.0	1,779.6	1,342.7
Alt. 2.1						
Mean	1,806.2	1,337.6	1,815.7	1,351.9	848.7	726.3
St. Dev.	272.4	178.5	255.2	158.9	114.6	77.8
CV	13.5	14.2	12.8	14.1	16.6	18.5
95% lower CL	1,329.8	1,000.0	1,350.3	1,054.0	640.3	581.7
95% upper CL	2,373.8	1,699.0	2,326.1	1,671.1	1,089.0	893.0

Table 6.8. Bootstrapped summary statistics for average daily flooded acres (acres) and Habitat Units (HU) by alternative and season for the New Madrid Floodway

Alternative	Spawning and Rearing Season					
	March		1 Apr - 15 May		16 May - 30 Jun	
	Acres	HU	Acres	HU	Acres	HU
Alt. 1						
Mean	5,788.4	3,247.2	5,711.0	3,266.4	2,575.1	1,812.5
St. Dev.	912.8	383.1	879.7	378.3	449.9	218.3
CV	15.8	11.8	15.4	11.6	17.5	12.1
95% lower CL	4,196.7	2,540.3	4,086.7	2,571.1	1,782.3	1,424.4
95% upper CL	7,520.1	4,000.4	7,548.5	4,080.4	3,532.9	2,295.0
Alt. 2.2						
Mean	692.6	675.8	674.1	664.7	635.6	629.1
St. Dev.	38.2	29.8	15.5	13.8	10.5	10.0
CV	5.5	4.4	2.3	2.1	1.7	1.6
95% lower CL	638.2	630.8	648.0	642.2	619.2	612.5
95% upper CL	785.3	739.7	708.2	694.9	657.5	652.4
Alt. 3.1						
Mean	2,667.2	2,087.2	1,922.5	1,668.1	897.7	883.2
St. Dev.	254.2	158.4	138.1	99.9	26.8	25.6
CV	9.5	7.6	7.2	6.0	3.0	2.9
95% lower CL	2,159.3	1,792.9	1,675.8	1,471.6	848.7	833.9
95% upper CL	3,148.6	2,380.2	2,201.1	1,863.0	952.8	934.4
Alt. 3.2						
Mean	1,964.2	1,677.5	1,378.1	1,287.8	819.9	810.3
St. Dev.	141.6	99.1	67.8	57.9	17.4	16.2
CV	7.2	5.9	4.9	4.5	2.1	2.0
95% lower CL	1,689.5	1,483.2	1,248.1	1,183.5	786.0	779.4
95% upper CL	2,244.9	1,869.3	1,517.9	1,405.0	854.9	843.0
Alt. 4.1						
Mean	3,297.2	2,369.8	3,408.1	2,460.6	1,841.4	1,496.9
St. Dev.	369.4	211.4	371.5	211.8	220.2	138.2
CV	11.2	8.9	10.9	8.6	12.0	9.2
95% lower CL	2,622.0	1,994.9	2,722.8	2,084.6	1,437.3	1,245.0
95% upper CL	4,073.4	2,798.0	4,145.9	2,891.8	2,331.4	1,799.1
Alt. 4.2						
Mean	4,330.2	4,293.1	4,649.5	4,624.2	2,453.2	2,435.1
St. Dev.	485.7	494.4	507.0	494.6	311.7	308.7
C	11.2	11.5	10.9	10.7	12.7	12.7
95% lower CL	3,404.9	3,339.2	3,689.2	3,671.3	1,913.9	1,850.8
95% upper CL	5,294.9	5,267.5	5,671.4	5,637.6	3,138.5	3,090.8

Habitat Suitability Indices

Model developers established the specific HSI values utilized for corresponding land cover based upon research conducted in the Lower Mississippi Valley. This proposal was discussed with an independent expert panel during the review of the EnviroFish model; discussed with the IEPR panel; and, coordinated with concurrence from the interagency team. HSI values are un-tested in the project area. For example, agricultural areas are widely accepted to provide inferior fish spawning and rearing habitat compared to other land cover types, such as forested area or water bodies. Therefore, the relative ranking of an HSI value for agricultural land is lower than for a forested area or waterbody. However, uncertainty exists regarding how much "more valuable" one particular habitat is over another. A decision was made to assign an HSI value of 1.0 to all optimal habitats. Although the extensive coordination and conservative estimates reduce the risk, there is still limited uncertainty regarding HSI values. Risk is considered moderate because fish mitigation results in the greatest required acreages[47] and mitigation is based on replacing impacted habitat only. Therefore, the resource is not anticipated to be over or undercompensated.

To address any risk, spawning and rearing habitat would be monitored to assess the habitat suitability of different land cover to spawning and rearing fish. Results would be used to adaptively manage the project (see Section 7).

6.2 Recognize Uncertainty to Other Project Features

There is additional uncertainty that has been identified throughout the development of the EIS by model certification review, public scoping, interagency coordination, and the IEPR.

6.2.1 Habitat/Functions Provided by Mitigation Tracts

USACE is of the opinion that mitigation is logistically feasible for the following reasons:

- Mitigation is based on a watershed approach (Section 5);
- Mitigation methods (reforestation, ecologically designed borrow pits, inundated agricultural fields) are all common practices that are utilized throughout the Lower Mississippi Valley;
- The project has undergone extensive IEPR that resulted in major revisions to the document to ensure that impacts and mitigation are based on scientifically valid assumptions; and
- Continued coordination with the interagency team will take place throughout the acquisition, planning, and implementation of tract-specific mitigation plans,

Since tract-specific areas have not yet been identified, there is uncertainty regarding the overall amount of mitigation benefits provided by any particular tract. The draft EIS estimates habitat/function provides for from mitigation based upon the post-project hydrologic zones. Although this approach errs on the side of the resource, uncertainty still exists. To address this

[47] This results in overcompensation of other resource impacts.

risk, USACE intends to develop tract specific mitigation plans prior to the impact taking place (Section 5), monitor mitigation tracts (Section 5), monitor the overall project (Section 7), and adaptively manage the project (Section 7).

6.2.2 Management of Mitigation Tracts

With the exception of the shorebird sites and the Big Oak Tree State Park structure, most mitigation does not involve management. Shorebird mitigation involves shallowly inundating agricultural fields to optimal depths during peak shorebird migration periods. This requires active management with the utilization of perimeter levees, interior levees, water control structures, and a source of water (precipitation would likely be sufficient but tracts may utilize groundwater/surface water). Shorebird management allows for a slow drawdown to expose mudflats/shallow water. Perimeter levees and water control structures require routine maintenance, monitoring, and management. Therefore, uncertainty exists associated with a potential failure to shorebird management structures resulting in a potential to under mitigate the resource during some years. To address risk, USACE intends to monitor mitigation tracts and adaptively manage the project (see Section 5).

An operation manual that provides specific management guidelines would be developed during the completion of the Big Oak Tree State Park mitigation plan. The sponsor and MDNR will follow the specific operation plan. There is a potential risk to mitigation benefits in the event that the structure is not operated as planned. To address risk, USACE intends to monitor the park and surrounding area and daily surface water elevations via a river gage (see Section 5). Furthermore, the project will be adaptively managed (see Section 7).

6.2.3 Ten Mile Pond Conservation Area

Based on the Congressional authorization, credit can be taken for lands purchased in the Ten Mile Pond Conservation Area by the State of Missouri. The existing moist soil units provide a large percentage of mitigation benefits for shorebird impacts. There is uncertainty regarding shorebird habitat provided by the existing moist soil management areas because MDC primarily manages for waterfowl. To address this risk, mitigation costs assumed that Ten Mile Pond would not be factored into mitigation costs and 1,286 total acres would be purchased within the Floodway and managed for shorebirds. The risk would be further addressed during the development of tract specific mitigation plans that will include the Ten Mile Pond moist soil management areas

6.2.4 Fish Passage

Fish can pass through culverts such as the ones proposed in the New Madrid Floodway based upon results of the fish passage studies conducted in the St. Johns Bayou Basin. The fish access study was also used to quantify potential impacts to fish passage through a culvert compared to open access. A fish access coefficient was used to discount remaining habitat in the New Madrid Floodway and the value of mitigation. The coefficient is considered a low estimate, because it is based on the management of the St. Johns Bayou structure. Management of this structure does not allow for any backwater flooding from the Mississippi River in the St. Johns Bayou Basin.

Gates are closed whenever the Mississippi River elevation is greater than the interior sump elevation. Although management of the structure limits passage opportunities, fish can clearly access the basin. Operation of the New Madrid Floodway would keep gates open for a longer period and allow for backwater flooding to still inundate a relatively large portion of the Floodway. Therefore, fish would have a greater opportunity to enter the New Madrid Floodway from the Mississippi River compared to observed conditions in the St. Johns Bayou Basin. Therefore, the coefficient value is considered low because the value is based on the St. Johns Bayou structure.

Although the risk is reduced due to a conservative estimate, there is uncertainty regarding fish passage. To address the risk, fish passage would be monitored and the project would be adaptively managed (see Section 7).

6.2.5 Unforeseen Additional Impacts

There is an expected shift in wetland subclass, but wetland areas would remain following construction and operation of the project. This assumption is supported by the fact that wetlands exist above the five-year frequency elevation in both basins. Impounded interior runoff or backwater flooding does not play a significant role in maintaining wetland function. Hydrology is maintained through precipitation or groundwater interactions. Likewise, wetland status is expected to be maintained through precipitation and groundwater interactions for areas no longer subject to backwater flooding or impounded interior runoff.

Although this assumption is based on observed conditions in the project area, uncertainty exists. The potential consequence of inadequately addressing the impact is under compensating the resource. To address this risk, the project would be monitored (See Section 7).

6.3 Increase Mitigation to Address Uncertainty

Since the existing point estimates provide the most likely impacts on resources, project mitigation would be based on these point estimates and not on a confidence limit value. The IEPR panel is concerned that the amount of mitigation provided would not adequately compensate project impacts. Therefore, following construction completion, the project would be monitored and adaptively managed to ensure mitigation is adequate. Monitoring parameters would be based on ecological performance standards for each resource as well as the conclusions of the risk register. In the event that monitoring identifies a mitigation deficiency, adaptive management would rectify the deficiency first by taking actions on site-specific mitigation tracts and, if necessary, by changing the overall management of proposed gates and pumping operations to the extent authorized. Additional information regarding project monitoring and adaptive management is found in Section 7.

7.0 LONG-TERM MONITORING AND ADAPTIVE MANAGEMENT

Presented in this section is a proposed plan for long-term monitoring and adaptive management of the project area. This plan is for the second part (*i.e*., Phase 2) of a two-phased approach to mitigation that begins, as outlined in Section 5, with tract-specific measures (*i.e*., Phase 1) and continues, factoring in the risk and uncertainty discussed in Section 6, with additional monitoring and measures suitable to adaptively manage the project area, with the goal of delivering the intended benefits of mitigation. The plan and the organization needed to execute the plan must be robust and resilient, so that the results achieved in the project area, over many thousands of acres and over a long period of time, are equal to the objectives stated in the plan.

The National Research Council (NRC), in 2004, prepared a report entitled *Adaptive Management for Water Resources Project Planning.* Although adaptive management has mainly been used for environmental or ecosystem restoration projects, it may be applied to navigation and flood control projects, too, given the similarities inhering in the complex environmental interactions and uncertain mitigation outcomes common to all water resources development projects. Likewise, the term adaptive management is used in Section 5 regarding tract-specific management. The term adaptive management in this section refers to overall project management decisions.

NRC, emphasizing the flexibility, durability, and resourcefulness needed to successfully deliver the intended benefits of mitigation, describes adaptive management this way:

> There are multiple views and definitions regarding adaptive management, but elements that have been identified in theory and in practice are: management objectives that are regularly revisited and accordingly revised, a model(s) of the system being managed, arrange of management options, monitoring and evaluating outcomes of management actions, mechanisms for incorporating learning into future decisions, and a collaborative structure for stakeholder participation and learning.
>
> Adaptive management aims to enhance scientific knowledge and thereby reduce uncertainties. Such uncertainties may stem from natural variability and stochastic behavior of ecosystems and the interpretation of incomplete data, as well as social and economic changes and events (e.g., demographic shifts, changes in prices and consumer demands) that affect natural resources systems. Adaptive management aims to create policies that can help organizations, managers, and other stakeholders respond to, and even take advantage of, unanticipated events. Instead of seeking precise predictions of future conditions, adaptive management recognizes the uncertainties associated with forecasting future

outcomes, and calls for consideration of a range of possible future outcomes. Management policies are designed to be flexible and are subject to adjustment in an iterative, social learning process.

7.1 Objectives

The overall objectives of long-term monitoring and adaptive management in Phase 2 are:

- Determine how the environment responds, or does not respond, to the action implemented.
- Determine whether observed responses match expected ecological success outcomes.
- Determine whether the proposed action must be modified to achieve the ecological success criteria.
- Provide continuous improvement adapted to changed conditions and new information.

Accomplishment of these objectives would be recorded, along with recommendations for other or additional work, in reports prepared at prescribed intervals over a 50-year period (*i.e.,* the expected project life of the flood risk reduction improvements proposed to be constructed). Such adaptive management reports would be prepared as of the time that these improvements become operational and at 5-, 15-, 25-, and 50-year intervals thereafter, until such time as it is determined that ecological success criteria have been met.[48]

The adaptive management reports should answer the following questions:

- Have unavoidable environmental impacts been adequately compensated?
- Are the selected alternative and mitigation measures functioning as designed?
- Are environmental impacts occurring at expected rates?
- Do gate closures and pumping station operations need to be adjusted for environmental reasons?

By answering these questions, the reports will describe the achievement of ecological success criteria as of that date. Additionally, the reports will relate the level of progress in implementing the mitigation plan, the projected timeline for achieving additional success, and how the plan may be improved.

Information gathered from project monitoring would be provided to decision-makers for the purpose of assessing whether changes should be made to operations or mitigation. Decisions on these matters would be made with input from the project sponsor, the Inter-Agency Team, and interested stakeholders, using draft monitoring reports as vehicles for

[48] The time at which the flood risk reduction improvements would become operational would be the date that the Mud Ditch outlet structure and the two pumping stations are ready to be placed in operation which, as previously noted, will not occur until all mitigation tracts have been acquired and all mitigation measures have been put in place.

review and comment. Comments on draft reports would be used to finalize the reports, incorporating decisions made and actions to be taken.

The Mississippi Valley Division commander would also review draft reports and suggest improvements to the district engineer. Final reports would be furnished to the Inter-Agency Team, project sponsor, and interested stakeholders. If needed, supplemental environmental impact assessment would be conducted.

7.2 Project Monitoring

The project area would be monitored for changes in land use, mitigation measures, hydraulics, and hydrology. Additional monitoring would be conducted in key uncertainty areas described in Section 6. Results of monitoring would be used to replicate the modeling conducted for this draft EIS to quantify project impacts. Therefore, the same models (*i.e.*, EnviroFish, Duck-Use-Day, Shorebird, and HGM) that were used to quantify impacts would be used to monitor the project area. These results would be provided in the adaptive management reports.

7.2.1 Land Cover

An updated land cover map would be part of all adaptive management reports. These will show, for example, whether forested areas have been converted to farmland and farmland converted to other land uses as a result of mitigation. Notable changes in land use would be highlighted in the reports.

7.2.2 Hydraulic and Hydrology (H+H) Data

Gages would be installed at three locations; (1) upstream of the existing St. Johns Bayou outlet structure; (2) upstream of the proposed Mud Ditch outlet structure; and (3) at Big Oak Tree State Park. These gages would monitor daily interior sump elevations. The readings would serve three main purposes.

1. Assist the project sponsor to make decisions on when to open and close outlet structure gates, open and close structure at Big Oak Tree State Park, and when to operate the pumping stations.
2. Provide daily water level information, via the Internet, that is necessary for tract-specific mitigation monitoring.
3. Provide and record daily water level information that would be used to determine how the project area responds to the action. Data from the three proposed gage would be compared to the Mississippi River gage at New Madrid, to show the hydrological effect of the proposed action on conditions in the New Madrid Floodway. Since gates are already installed in the St. Johns Bayou outlet structure, a H+H simulation would have to be conducted to determine the effects of pumping operations in St. Johns Bayou Basin.

7.2.3 Wetlands

A HGM assessment would be completed on a representative portion of compensatory mitigation tracts to determine if proposed mitigation measures are adequate. HGM assessments would occur prior to each reporting interval, and the results would be furnished in the adaptive management reports.

Forested wetlands located in the 5-year floodplain, that, after implementing the proposed action would no longer be in the 5-year floodplain are assumed to retain their jurisdictional status.[49] Thus, there would be no reduction in the number of such acres of wetlands. Likewise, wetlands at elevations above the existing five-year floodplain are also assumed to retain jurisdictional status.

As a means to address any uncertainty underlying these assumptions, forested wetlands within the project area would be monitored prior to project operation and for 15 years thereafter.[50] Monitoring sites would be established in St. Johns Bayou Basin and in the New Madrid Floodway. Each site would be approximately 10 acres in size. Site selection would be based on elevation, land use, geomorphic setting, and access. In addition, land use would be updated as described in subsection 7.2.1, above. Changes to land use would be evaluated to determine whether jurisdictional wetlands had been converted in, or without, compliance with Clean Water Act section 404 requirements.

Restorative actions (see Section 7.4) may be warranted in the event that monitoring demonstrates an impact that was not quantified during the formulation of the draft EIS.

7.2.4 Waterfowl

A customary compensatory mitigation measure for waterfowl involves replacing food sources for ducks. The availability of food for waterfowl would be assessed, consistent with the Duck Use Day Manual, on a portion of the to-be-selected mitigation sites including Big Oak Tree State Park, restored vegetated wetlands, ecologically designed borrow pits, restored floodplain lakes, and seasonally inundated agricultural fields. How much food would be available to waterfowl would be projected using standard methods to compare the chosen mitigation sites to the estimated annual production of major food sources (measured in kg/ha) found in Table 10 of the Manual. The assessment would occur at least once prior to each adaptive management report and cover each type of waterfowl habitat listed above. Waterfowl mitigation measures would be assessed until ecological success criteria are achieved.

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[49] Although they will still maintain their jurisdictional status and be subject to Clean Water Act section 404 regulations, the impacts associated with a decrease in frequency and duration of floods have been quantified utilizing the HGM Method.

[50] The phrase "prior to project operation" is a short-hand way to refer to the date that the Mud Ditch outlet structure and the two pumping stations would be ready to be placed in operation, as noted in subsection 7.1 above.

Restorative actions (see Section 7.4) may be warranted in the event that monitoring demonstrates an impact that was not quantified during the formulation of the draft EIS.

7.2.5 Shorebirds

Compensatory mitigation measures for shorebirds primarily include seasonally inundating farmland during peak shorebird migration periods. Within a portion of the to-be-selected mitigation sites, water management for shorebirds would be assessed by measuring the depths and durations of inundation during shorebird migration periods (*e.g.*, the number and length of times that agricultural areas would be covered by less than 3 inches of water, less than 6 inches of water, and deep water) and by counting shorebirds during migration periods. The assessment would occur at least once prior to each adaptive management report and cover a representative sample of seasonally inundated agricultural fields used for mitigation. Shorebird mitigation measures would be assessed until ecological success criteria are achieved.

Restorative actions (see Section 7.4) may be warranted in the event that monitoring demonstrates an impact that was not quantified during the formulation of the draft EIS.

7.2.6 Fish

<u>HSI Values</u>

A portion of compensatory mitigation sites would be used to assess habitat for fish spawning and rearing and to assess HSI values. Adult fish usage would be monitored at these sites using conventional collection techniques, and the reproductive condition of these fish would also be determined. Telemetry may be used to assess movement and habitat use by spawning adults. Larval fish would be collected to determine that spawning is occurring. The assessment would include, but would not be limited to, documenting fish usage by spawning adults (richness and diversity), fish usage by rearing larvae and young of the year (richness and diversity), connectivity, fish access, habitat transition periods, and the hydrograph (*i.e.*, rising and falling stages). The assessment would occur at least once prior to each adaptive management report and cover each type of mitigation site, including ecologically designed borrow pits, Big Oak Tree State Park, vegetated wetlands, and batture land. Fish mitigation measures would be assessed until ecological success criteria are achieved.

Restorative actions (see Section 7.4) may be warranted in the event that monitoring demonstrates an impact that was not quantified during the formulation of the draft EIS.

<u>Resident Fish</u>

An Index of Biotic Integrity (IBI) would be developed from existing fish usage data and newly acquired data obtained through monitoring of fish usage of various habitat conditions (water quality, instream structure, landscape, and hydraulic indices) in St. Johns Bayou Basin and in the New Madrid Floodway. The IBI is an approach to monitor environmental changes (impacts or benefits). Metrics, such as, tolerance to habitat changes and, species richness and abundance, would be derived using acceptable statistical procedures before and after mitigation. By tracking metrics, the relative changes in important attributes can be determined and applied to an adaptive management approach. In addition, population modeling can be conducted on key species of interest to determine benefits to recreational, commercial, or sensitive fishes that may benefit from the mitigation.

Existing information on delta fishes and habitat utilization in the Lower Mississippi Valley would be used to supplement development of the IBI and establish a rating system. Resident fish would be monitored and the IBI developed before construction activity is undertaken. Post-construction surveys would take place 2 years after completing work in each affected stream or ditch reach. An additional survey would be conducted in all reaches 5 years after the operation of the project. Post-construction surveys would be compared to pre-construction conditions and the survey conducted by Sheehan *et al*. (1998).

Restorative actions (see Section 7.4) may be warranted in the event that the IBI demonstrates an impact that was not quantified during the formulation of the draft EIS.

<u>Fish Passage</u>

The on-going fish passage telemetry study would continue to assess movement of Mississippi River fishes through large culverts. If Mississippi River conditions are favorable, fish passage would be assessed for two seasons prior to construction of the Mud Ditch outlet and 1,500-foot levee in the New Madrid Floodway. Once the proposed action is implemented, passage of fish through the proposed Mud Ditch outlet structure would be assessed for two seasons prior to, for inclusion in, each adaptive management report. Fish passage studies would also include an evaluation of the gated structure at Big Oak Tree State Park. Fish passage would be assessed until ecological success criteria are achieved.

Restorative actions (see Section 7.4) may be warranted in the event that monitoring demonstrates an impact that was not quantified during the formulation of the draft EIS.

7.2.7 Water Quality

Water quality would be monitored in both basins. The rages previously discussed in Section 7.2.2 would be capable of water quality monitoring. The gages, which would be similar to those used by the U.S. Geological Survey, would measure “real-time” temperature, conductivity, pH, dissolved oxygen, turbidity, nitrate, and discharge. Water quality would be monitored prior to construction, during construction, and after construction until ecological success criteria are achieved.

Restorative actions (see Section 7.4) may be warranted in the event that monitoring demonstrates an impact that was not quantified during the formulation of the draft EIS.

7.2.8 Aquatic Macroinvertebrates

Aquatic macroinvertebrates would be sampled in ditch and stream channels that would be modified by following aspects of the Rapid Bioassessment Protocols (Plafkin *et al*., 1989) and its revisions (Barbour *et al*., 1997). Samples would be collected bi-annually during periods of stable flow and temperature, prior to construction of any channel enlargement features and annually for 2 years thereafter. Additional sampling would be conducted 5 years after the mitigation measures (*e.g.*, buffers, transverse dikes, etc.) constructed in a reach become established.

Richness measurements (*i.e.*, total number of taxa and percent change in taxa richness), composition measurements (*i.e.*, community loss index, Jaccard similarity index, and Shannon-Weiner index), feeding measurements (*i.e.*, percent of each functional feeding group, and percent similarity of functional feeding groups), and dominant taxa observed would be observed. Post-construction conditions would be compared to pre-construction conditions to determine if the construction sites have recovered to pre-construction levels and if mitigation measures are successful.

Restorative actions (see Section 7.4) may be warranted in the event that monitoring demonstrates an impact that was not quantified during the formulation of the draft EIS.

7.2.9 Freshwater Mussels

Although current surveys indicate that mussels are not present in large numbers, mussels historically existed in several of the streams and ditches would be modified if the proposed action is implemented. Therefore, mussels would be surveyed prior to construction and the results would be furnished to the interagency-team to determine if any additional sampling, monitoring, or mitigation is necessary.

The survey would be conducted in the lower portions of each of the following streams: St. Johns Bayou, Setback Levee Ditch, and St. James Ditch. Hand searches would be conducted by diving and wading to locate freshwater mussels. A minimum of one person-hour would be spent searching at each specific site. Searches would continue at least 15 minutes after the last new species was collected. All available microhabitats within the survey site would be searched. Mussels encountered (live and fresh dead) would be placed in cloth mesh bags and kept submerged until transport to the surface. At the surface, collected mussels would be sorted, identified, measured, and recorded on site-specific data sheets. Nomenclature would follow Turgeon *et al*. (1998). Once identified and measured, live mussels would be returned to the substrate where they were collected. For each site the total number of live and dead mussels, catch per unit effort, and growth rates would be recorded, as well as general habitat (depth, current, turbidity) and substrate of each site.

Additional mitigation may be warranted in the event that mussels become re-established in large numbers that historically existed.

7.3 Adaptive Management Thresholds

Ecological success criteria are a product of environmental modeling, defining the nature and extent, that is, the goals, of compensation for impacts to be achieved by mitigation. To reach these goals, adaptive management thresholds would be set, at which additional or other mitigation measures would be taken (i.e., above or beyond those described in Section 5).

The thresholds for instituting adaptive management actions would be based on the point estimates necessary to compensate for project impacts with the inclusion of variance estimates determined in Section 6 (Figure 7.1). Although Figure 7.1 depicts shorebird results for the New Madrid Floodway, it illustrates how adaptive management thresholds could be set for all resource categories. As shown, future without-project conditions (with variance estimates) and habitat remaining in the project area under the preferred alternative is represented in blue. Compensatory mitigation based on the point estimate is represented in red. Monitoring results are represented in green. Although variance estimates would be included with future monitoring results, the values depicted in Figure 7.1 are strictly hypothetical. Likely monitoring scenarios are presented below.

Monitoring Scenario 1

Both the monitoring point estimate and the upper variance estimate are below the future without project condition lower variance estimate, which demonstrates the existence of a substantial deficit in mitigation. Although multiple factors could be responsible for the deficiency, an incorrect assumption in the model itself, such as HSI value, fish access coefficient, or acreage could be a cause. Immediate restorative action, or other measures, would be indicated.

Monitoring Scenario 2

The monitoring point estimate is below the future without-project point estimate and the lower variance estimate; however, the upper monitoring variance estimate is within the future without-project condition variance estimates. This, too, demonstrates the existence of a substantial deficit in mitigation. As in the first scenario, multiple factors could account for the deficiency. These include incorrect assumptions regarding future without project river conditions and regarding habitat value, DUD/acre or HSI value, for instance. Adaptive management reports would analyze the reason(s) for deficiencies and recommend appropriate action.

Monitoring Scenario 3

The monitoring point estimate is below the future without project point estimate but within the future without project variance estimates, and the upper monitoring result variance estimate is greater than the future without-project condition point estimate, which suggests that a slight deficit in mitigation exists. Numerous reasons could explain the deficiency, such as a failure of some of the mitigation tracts, discrepancies in future-without project H+H assumptions, or incorrect estimates of mitigation transition periods. Adaptive management reports may conclude that restorative action or other measures, is or is not necessary. For example, it may be that additional monitoring is needed before it could be determined that responsive action should be taken.

Monitoring Scenario 4

The monitoring point estimate is above the future without-project point estimate but the lower monitoring variance estimate is below the future without-project point estimate, which suggests that a modest surplus in mitigation exists. Remedial action is not necessary; indeed, it may be concluded that ecological success has been achieved. Further monitoring would not then be necessary.

Monitoring Scenario 5

The monitoring point estimate and the lower variance estimate is above the future without-project point estimate, but the lower monitoring variance estimate is below the future without-project upper variance estimate, which would indicate that a substantial surplus of mitigation exists. Here, too, remedial action is not warranted, as ecological success has likely been achieved. Likewise, further monitoring would not be necessary.

Monitoring Scenario 6

The monitoring point estimate and lower variance estimate is above the future without project point estimate and upper variance estimate, from which it could be concluded that an even greater surplus of mitigation exists, that remedial action is not warranted, and that ecological success has been achieved.

7.4 Restorative Action and Other Responsive Measures

Additional and other measures for individual mitigation tracts were discussed in Section 5. This subsection looks at restorative actions and other responsive measures that might be appropriate to adaptively manage the project area and achieve ecological success in all resource categories. Although the flood risk reduction improvements proposed to be constructed have relatively small footprints and are reasonably likely to cause few impacts to the human environment, operation of outlet structure gates (for St. Johns Bayou and for Mud Ditch) and the to-be-constructed pumping stations may affect a large part of the project area. Consequently, the operations plan for these features will have a direct and important bearing on the success of the mitigation plan. Modifying the operations plan could both reduce impacts and alleviate deficiencies in mitigation. By itself, flood water management would play a leading role in achieving ecological success.

7.4.1 Wetlands

The greatest impact to wetlands would result from shifts between subclasses caused by a change in the 5-year floodplain from before to after implementation of the proposed action. Riverine subclasses would likely shift to flats, for example. Adaptive flood water management, if needed, could counter this phenomenon, contributing to the success of wetlands mitigation, by maintaining flood waters at greater depths for longer durations. For example, the tentatively selected plan calls for lowering the elevation at which pumping occurs from 289.5 feet, during the November 15 to February 28 periods, to 288 feet on March 1. Alternatively, the elevation could be maintained at 289.5 feet until March 15 or 30, or the elevation could be increased to 285 or 286 feet during the April 16 to May 30 timeframe.

7.4.2 Waterfowl

A measure that may aid waterfowl mitigation would be to adaptively manage flood waters for their benefit from December into February and possibly early March, rather than curtailing this activity by January 31. Retaining flood waters for purposes of maintaining a waterfowl management pool for a longer period would not adversely affect the agricultural growing season, but would provide even more suitable habitat for migrating waterfowl.

7.4.3 Shorebirds

Similar to what might be done for wetlands and waterfowl purposes, gate and pumping operations could be managed to control water levels for the benefit of shorebirds. For example, higher levels of flood waters could be maintained into the shorebird migration season, reducing impacts on these species. Likewise, the draw-down of flood waters could be slowed, maintaining mudflat habitat over a wider area for a longer time. For example, while all outlet structure gates would normally be opened to allow for expeditious drainage whenever the Mississippi River elevation falls below the interior sump elevation, if some number of the gates (e.g., three out of six in the St. Johns Bayou outlet structure and two out of four in the proposed Mud Ditch outlet structure) were left closed for a longer time, flood waters would drain more slowly, enhancing mudflat habitat.

7.4.4 Fish

Adaptive flood water management may also be used to address deficits in habitat for fish spawning and rearing. Flood water retention in St Johns Bayou Basin and in the New Madrid Floodway could enhance spawning and rearing. For example, a spawning and rearing pool could be created in St. Johns Bayou Basin or in the New Madrid Floodway by retaining flood waters at the 284-foot elevation for a period of 21 days sometime between March 1 and June 30. Gate and pumping operations could be adjusted according to rainfall, the level of the Mississippi River, and other relevant factors to increase beneficial habitat for fish and contribute to the achievement of ecological success.

Table 7.1 compares Average Daily Flooded Acres (ADFA) for Alternative 3.1 with and without a spawning and rearing pool. Holding water for 21 days during a falling river stage results in an increase to ADFA compared to no management.[51]

Table 7.1. Fish spawning and rearing habitat contingency, ADFA, New Madrid Floodway.

	Alt 3.1			Spawning and Rearing Pool		
Land Use	Early	Mid	Late	Early	Mid	Late
Agriculture	606	227	1	661	273	2
Developed	18	10	1	19	11	1
Fallow	9	6	2	10	6	2
Forest	1,074	758	179	1,166	867	186
Herbaceous	328	301	81	394	374	87

If necessary, a spawning and rearing pool could be developed in either the St. Johns Bayou Basin or the New Madrid Floodway. Specific elevations and durations would be determined based upon any deficiency. Habitat value would be based on land use prior to holding water; no conversion to a waterbody HSI value would be made. Depending on the specific time period, creation of a spawning and rearing pool for fish would likely result in additional benefits to waterfowl and shorebirds.

[51] Calculated by a similar operation plan of Alternative 3.1 except gates would closed on a falling hydrograph at an elevation of 284 and remain closed for 21 days or until 30 June. Gates would be re-opened to previously described plans in the event that the river rose above an elevation of 284 feet.

8.0 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS PROVIDED A COPY OF THIS DRAFT EIS

Elected Officials

The Honorable Senator Blunt, U.S. Senate, Missouri, Washington, DC
The Honorable Senator Claire McCaskill, U.S. Senate, Missouri, Washington, DC
The Honorable Mr Jason T. Smith. House of Representatives, Missouri, Washington, DC
The Honorable Senator Richard Durbin, U.S. Senate, Illinois, Washington, D.C.
The Honorable Mr. William Enyart, U.S. House of Representatives, Illinois, Washington, D.C.
The Honorable Mr. Bill White, Missouri House of Representatives, 161st District, Charleston, MO
The Honorable Mr. Carlin Bennett, President, Mississippi County Commission, Charleston, MO
The Honorable Mayor Donnie Brown, Mayor, City of New Madrid, New Madrid, MO
The Honorable Mayor Jackie Whiteside, Mayor, City of Charleston, Charleston, MO
The Honorable Senator Doug Libla, Missouri Senate, District 25, Dexter, MO
The Honorable Mr. Bill Reiboldt, Missouri House of Representatives, 160th District, Sikeston, MO
The Honorable Mayor Jerry Pullen, Mayor, City of Sikeston, Sikeston, MO
The Honorable Mr. Charlie Davis, Missouri House of Representatives, 162nd District, Jefferson City, MO
The Honorable Mayor Debra Tarver, Mayor, Village of Pinhook, East Prairie, MO
The Honorable Mayor Kevin Mainord, Mayor, City of East Prairie, East Prairie, MO
The Honorable Chairman Harold McNelly, Chairman Alexander County, Illinois Board of Commissioners
The Honorable Mayor Paul Farris, Mayor, City of Cairo, Illinois

Federally Recognized Consulting Tribes

Absentee-Shawnee Tribe, THPO Ms. Liana Staci Hesler
Alabama-Quassarte Tribal Town Ms. Augustine Asbury, Second Chief
Cherokee Nation of Oklahoma, Dr. Richard Allen
Chickasaw Nation of Oklahoma, THPO Ms. LaDonna Brown
Choctaw Nation of Oklahoma THPO Dr. Ian Thompson (Tribal Archaeologist)
Delaware Nation, THPO Tamara Francis
Delaware Tribe of Indians, Dr. Brice Obermeyer
Eastern Shawnee Tribe of Oklahoma, Ms. Robin Dushane
Jena Band of Choctaw Indians, THPO Ms. Dana Masters
Kaw Nation, Ms. Crystal Douglas
Kialegee Tribal Town, Mr. Henry Harjo
Muscogee (Creek) Nation , Acting THPO Emman Spain
Osage Nation of Oklahoma, THPO Dr. Andrea Huner
Peoria Tribe, Mr. Frank Hecksher
Poarch Band of Creek Indians, Mr. Robert Thrower

Ponca Tribe of Oklahoma, Mr. Bennett Arkeketa
Quapaw Tribe of Oklahoma, THPO Jean Ann Lambert
Quapaw Tribe of Oklahoma, Ms. Carrie Wilson (NAGPRA Representative)
Sac and Fox Nation of Missouri, THPO Edmore Green
Sac and Fox Nation of Oklahoma, Ms. Sandra Massey
Shawnee Tribe, Ms. Kim Jumper
Thlopthlocco Tribal Town, THPO Mr. Charles Coleman (Warrior)
Tunica-Biloxi Tribe of Louisiana, THPO Earle Barbry, Jr
United Keetoowah Band of Cherokee Indians of Oklahoma, THPO Lisa LaRue-Baker

Note: individuals not designated as THPO serve as NAGPRA representatives

Federal Agencies

Director, Office of Environmental Policy and Compliance, Washington, DC
Council of Environmental Quality, Washington, DC
District Conservationist, Natural Resources Conservation Agency, New Madrid, MO
NEPA Team Leader, EPA Region 7, Lenexa, KS
Missouri NRCS State Office, Natural Resource Specialist, WRP Coordinator
EPA Region 7, Lenexa, KS
Missouri NRCS State Office, Assistant State Conservationist, Water Resources
State Conservationist, Natural Resources Conservation Service, Columbia, MO
Acting Director, Water, Wetlands, and Pesticides Division, EPA Region 7
Missouri NRCS State Wildlife Biologist, Columbia, MO
Section Chief, Watershed Support, Wetlands & Stream Protection, EPA Region 7
Missouri Section 404, Wetlands Program Coordinator, EPA Region 7
State Soil Scientist, Missouri NRCS State Office, Columbia, MO
Attorney, Office of Regional Counsel, EPA Region 7
U.S. Fish and Wildlife Service, Missouri Ecological Services, Columbia, MO
Denver Region, Office of Environmental Policy and Compliance, Denver, CO

State Agencies

Missouri Department of Natural Resources, Jefferson City, MO
Missouri Department of Natural Resources, East Prairie, MO
District Conservationist, Natural Resources Conservation Agency, Benton, MO
Director, Missouri Department of Agriculture, Jefferson City, MO
Director, Missouri Department of Conservation, Jefferson City, MO
Missouri Department of Agriculture, Jefferson City, MO
Missouri Department of Natural Resources, MO
Missouri Department of Conservation, Jefferson City, MO
Policy Coordinator, Office of the Director, Missouri Department of Natural Resources
Director, Missouri Department of Natural Resources, Jefferson City, MO
Manager, Ten Mile Pond Conservation Area, East Prairie, MO
Park Scientist, Division of State Parks, Missouri Department of Natural Resources

Levee Districts

St. John Levee District, East Prairie, MO
Mississippi Valley Flood Control Association, Collierville, TN
St. John's Bayou Basin Drainage District, New Madrid, MO
Consolidated Drainage District #1, Wolf Island, MO
Levee District No. 3, Mississippi County, Wyatt, MO

Libraries

Sikeston Public Library, Sikeston, MO
Main Library, Mississippi County Library, Charleston, MO
Mitchell Memorial Library, Mississippi County Library, East Prairie, MO
New Madrid County Library, New Madrid, MO
Missouri State Library, Jefferson City, MO
Benton Branch, Riverside Regional Library, Benton, MO

Newspapers

Enterprise-Courier, East Prairie, MO
The Weekly Record, New Madrid, MO

NGOs

Missouri Farm Bureau Federation, Dexter, MO
Chief Scientist, Environmental Defense Fund, Washington, DC
President, Environmental Defense Fund, Washington, DC
Woodrow Wilson School, Princeton University, Princeton, NJ
Missouri Coalition for the Environment, Saint Louis, MO
Senior Attorney, Midwest Program, Natural Resources Defense Council, Chicago, IL
Chairperson, East Prairie Tourism Council, East Prairie, MO
National Wildlife Federation, Washington, DC
Eagle's Nest Waterfowlers, New Madrid, MO
Senior Attorney, Midwest Wild and Natural Places Project, Environmental Law and Policy Center, Chicago, IL
President, Susanna Wesley Family Learning Center, East Prairie, MO
Greenway Network, Inc., St. Charles, MO
Webster Grove Nature Study Society, St. Louis, MO
Director, Environmental Quality Program, Sierra Club, Washington, DC
Senior Counsel, Rivers and Deltas, Environmental Defense Fund, Austin, TX
Sierra Club, National Wetlands Working Group, Bryn Mawr, PA
Chairman, Swampeast Ducks Unlimited Chapter, Sikeston, MO
Agricultural Program Director, Izaak Walton League of America, St. Paul, MN
President, St. Louis Audubon Society, St. Louis, MO
National Wildlife Federation, Washington, DC
Director, Flood Management Policy, American Rivers, Washington, DC

Sierra Club, Ozark Chapter, Maplewood, MO
National Association for the Advancement of Colored People, Charleston Missouri Chapter

Memphis District, Regulatory Branch

Current list as maintained by the Regulatory Branch.

Certified E-mail List – MO

Regulatory Tribal E-mail List

Regulatory Regular E-mail List – MO

General Public – includes attendees of the public scoping meeting.

9.0 COORDINATION

9.1 Public Involvement

Pursuant to the National Environmental Policy Act, USACE conducted a public scoping meeting for the proposed St. Johns Bayou Basin and New Madrid Floodway, Missouri, First Phase Project, Environmental Impact Statement. The public scoping meeting was held on 11 May 2010, 7:00 p.m., at the East Prairie Church of God, 322 North Washington Street, East Prairie, Missouri 63845. The purpose of the meeting was to identify significant issues and determine the scope of issues that need to be addressed in this draft EIS. The public scoping meeting was detailed in the Notice of Intent to prepare a draft EIS which was published in the Federal Register on 6 April 2010. The Notice of Intent and scoping meeting information were sent to an organized mailing list built from previous interested parties, environmental groups, local, state and Federal agencies, news media, and other interested stakeholders. The Public Scoping document is located in Volume 2, Part 1.

9.2 Interagency Coordination

This section summarizes interagency coordination that has occurred during the development of the draft EIS.

Prior to making a formal decision to prepare an EIS for this project, an interagency meeting was conducted 8 January 2009 in Jefferson City, Missouri, to discuss aspects of USACE's plan to proceed with a phased IEPR process. It was determined that the interagency team would participate in the IEPR process, including the formulation of "charge" questions submitted to the IEPR panel for Phase 1 IEPR.

In addition to charge questions, the interagency team was invited to participate in the initial IEPR briefing and site visit (4-5 August 2009). This briefing included a session in which the panel could ask specific clarification questions to USACE as well as the interagency team. The purpose of this question/response session was to ensure the panel was aware of interagency opinions that may have been contrary to that of USACE.

The interagency team participated in all of the teleconferences that were conducted during the Phase 1 IEPR. In October 2009 the Phase 1 IEPR report was forwarded to the interagency team with a request for the interagency team to provide comments. Recommendations from the Phase 1 IPER panel and the interagency team were used to make a determination to prepare an EIS for the project.

Prior to the release of the Notice of Intent to prepare an EIS, the interagency team determined that an interagency charter was necessary. The interagency team utilized several facilitators to assist in the charter development.

The mission of the interagency team is to communicate, consult, coordinate, and provide input to USACE pursuant to the National Environmental Policy Act, the Fish and

Wildlife Coordination Act, the Clean Water Act, the Endangered Species Act, and other related laws, regulations, and policies. This charter sets forth a collaborative approach for issue identification and resolution, information exchange, and coordination of signatory agencies. Although the NRCS elected to not join the Interagency Team, USACE has coordinated with NRCS concerning agricultural issues.

The interagency team was consulted with during the preparation of the Project Work Plan, as well as the development of charge questions for the Phase 2 IEPR. Following interagency feedback, the Project Work Plan was submitted to the interagency team for comment. Comments received from the interagency team were submitted with the Work Plan to the Phase 2 IEPR panel. The purpose of providing the interagency team comments to the Work Plan was to ensure the panel was aware of any concerns or opinions contrary to that of USACE.

As previously stated, extensive coordination/communication with the IEPR panel occurred to ultimately reach consensus on key aspects of the methodology that would be used to quantify impacts and benefits of the project. The interagency team was invited and participated in the vast amount of discussions between USACE and the IEPR panel.

In addition to the IEPR process, the interagency team participated in the independent review conducted for the specific ecological models.

Following the Phase 2 IEPR process and model certification/review process, interagency coordination focused on five key areas.

1. Project Alternatives – An interagency meeting was conducted in Sikeston, Missouri to discuss preliminary project alternatives, including avoid and minimize measures as well as any other issues that need to be addressed in the EIS.

2. Terrestrial HEP – MDC and USFWS assisted in the selection of representative species and specific HEP HSI models. In addition, the specific sampling protocols were coordinated with the team prior to conducting the analysis.

3. Fisheries Methodology – The Phase 2 IEPR panel requested that the interagency team concur with HSI values in the analysis. A series of teleconferences were conducted with the interagency team. USACE initially intended to use a Delphi process to determine HSI values. However, after USFWS and MDC consulted with additional experts, it was determined that the HSI values were appropriate.

4. Wetlands – Extensive coordination has been maintained between USACE and EPA regarding the process to determine wetland acreages, condition, and function.

5. Endangered Species – Endangered species coordination consisted of USACE preparing a Biological Assessment of endangered species that are known to exist in or within the vicinity of the project area. Formal consultation has been initiated regarding the interior least tern.

Utilizing the methods established in the Project Work Plan, recommendations from the Phase 2 IEPR Panel, and additional interagency coordination, USACE developed a pre-draft EIS. The pre-draft EIS was submitted to the interagency team for comment. The purpose for this review was to attempt to resolve any issues as well as to forward the comments to the Phase 3 IEPR panel to ensure that the panel was aware of any unresolved interagency concerns. EPA was the only agency to provide comments. The interagency team participated in the Phase 3 IEPR discussions with the panel.

9.3 Comments and Recommended Conservation Measures of the U.S. Fish and Wildlife Service.

The U.S. Fish and Wildlife Service (USFWS) provided a Fish and Wildlife Coordination Act Report (FWCAR) on 11 July 2013 (see Appendix Q, Part 1). The document contains USFWS findings and recommendations, outlining its vision for what is best for the project area insofar as fish and wildlife are concerned, and raising several issues for further exploration. USACE will continue to work collaboratively with USFWS and others on issues raised in the FWCAR and during and after the public comment period (e.g., during Independent External Peer Review Phase 4 and in developing a final EIS).

Comment/Recommendation: 1) Construct the St. Johns Bayou Basin only alternative (2.1) that will avoid significant losses of fish and wildlife habitat and functions, while providing flood risk reduction focused on urban and residential areas, as well as public infrastructure.

Response: The idea that construction of flood risk reduction improvements should be limited to St. Johns Bayou Basin will be in light of any comments and recommendations received from the public (especially those who live and work in the project area), the Inter-Agency Team, the IEPR panel, and others.

Comment/Recommendation: 2) Minimize dredging and channel modifications to the maximum extent possible by implementing the following conservation measures: a) Installing gradient control structures at the upper end of all work reaches and at the mouths of all major tributaries to prevent headcutting.

Response: USACE will continue to examine proposed channel dimensions, soil stability profiles, and hydrologic and hydraulic parameters to identify specific locations in which grade control structures could prevent headcutting. The analysis and any changes to proposed construction will be provided in the final EIS.

Comment/Recommendation: b) Installing transverse dikes in the Setback Levee Ditch and the St. Johns Bayou reach to offset fisheries habitat losses from shallow water depths. Those dikes should be designed to maintain a sinuous, continuous thalweg along the length of the channel.

Response: Since transverse dikes may be expected to offset habitat losses as a result of ditch modifications, they are included in the proposed design for St. Johns Bayou.

Additionally, USACE will examine construction of transverse dikes in Setback Levee Ditch. All ditch-related mitigation will be based on the Missouri Stream Mitigation Method (MSMM).

Comment/Recommendation: c) Constructing a low-head weir where the Lee Rowe Ditch branches off the St. James ditch to prevent perching that channel during base flows.

Response: USACE will examine the recommended low-head weir at the confluence of St. James Ditch and Lee Rowe Ditch.

Comment/Recommendation: d) Constructing vortex weirs in the St. James Ditch to compensate for habitat losses from shallower water depths along those reaches. Vortex weirs may also function as grade control structures.

Response: USACE will examine the vortex weirs recommended for St. James Ditch. Since such structures provide mitigation credits under the MSMM, the overall ditch mitigation scheme will be re-examined, if additional weirs are constructed, accordingly.

Comment/Recommendation: e) Avoiding dredging impacts to the maximum extent possible in the entire reach of the St. James Ditch that contains suitable habitat for the State-listed golden topminnow.

Response: St. James Ditch recently underwent channel maintenance by others that removed sediment and vegetation, thereby disturbing aquatic used by the golden topminnow as habitat. USACE will, with assistance from MDC and USFWS, survey proposed channel modification reaches in St. James Ditch, to gather additional information relevant to the proposed channel modifications.

Comment/Recommendation: f) Avoiding dredging in a 9-foot strip along the right descending bank of the Setback Levee Ditch to reduce impacts to mussels and possibly leave a population to recolonize the ditch. In addition, a minimum of 1,500 mussels (species composition to be determined by the Service and MDC) should be relocated from selected sites within the dredge path to other appropriate areas in St. Johns Basin. A long-term monitoring plan should be developed, in coordination with the Service and MDC, to determine the success of those mitigation measures. In addition, that monitoring plan should contain a provision to evaluate the suitability of the above-mentioned dikes, weirs, and gradient control structures as mussel habitat.

Response: Setback Levee Ditch has also undergone maintenance by others, the result of which is that previous large concentrations of mussels are no longer found in this reach. However, USACE recognizes the potential that mussels could be re-established, and will therefore adopt the recommendation to avoid modifications along the right descending bank. USACE will conduct a mussel survey prior to construction and coordinate those results with MDC and USFWS. If appropriate, other suitable mitigation measures will be developed.

Comment/Recommendation: 3) Evaluate non-structural measures (e.g., flooding easements) to address agricultural flood damages in the New Madrid Floodway. If those are infeasible, the Corps should investigate alternative levee closure locations, such as that proposed by MDC, further north in the Floodway to avoid significant adverse effects to fish and wildlife.

Response: USACE has evaluated several non-structural measures in the New Madrid Floodway including alternative levee locations. Section 2 of this draft EIS discusses these alternatives. USACE will continue to explore further refinements that may avoid or minimize adverse effects to fish and wildlife.

Comment/Recommendation: 4) If the Corps determines there are no feasible flood control measures other than the TSP, they should incorporate the following measures as integral features of the selected plan: a) Prevent the conversion of forested wetlands in both basins due to project-related hydrologic changes. This should be done by purchasing a conservation easement or other protective measure on forested wetlands between elevations 291 and 290.4 NGVD in the St. Johns basin, and between 292.1 or 287.6 feet NGVD in the Floodway.

Response: USACE does not anticipate clearing of forested wetlands as a result of project-related hydrologic changes. USACE acknowledges the uncertainty underlying this assumption and a discussion of that uncertainty is contained in Section 6.2.5. To address this risk, USACE proposes to monitor land use and adaptively manage the project. Long-term monitoring, adaptive management, and restorative actions are discussed in Section 7.

USACE will analyze the recommendation to purchase easements. Results will be furnished in the final EIS.

Comment/Recommendation: b) Fully compensate all unavoidable losses to fish and wildfire resources. Compensation should include the following measures:

- Reforest cropland to compensate for forested wetlands habitat losses associated with channel enlargement, levee closure and pump operations (i.e., altered hydrology). If protective covenants have not been placed on bottomland hardwood forests as described in 4(b), the Corps should reforest an additional acres to compensate for induced forested wetland losses because project-reductions in flooding.

Response: USACE is committed to compensating for wetland impacts as quantified by the HGM model. A variety of mitigation techniques are recommended to compensate for impacts to wetland functions. Vegetated wetland restoration includes reforestation, re-establishment of microtopography, and tract-specific hydrologic restoration. In addition to vegetated wetland restoration, impacts are also being compensated through the restoration of hydrology to Big Oak Tree State Park, floodplain lake restoration, and ecologically designed borrow pits.

Comment/Recommendation:

- Reforest cropland to compensate for losses in spring waterfowl migration habitat. Acreage to compensate for forested wetland losses mentioned above could also meet waterfowl compensation needs, provided the sites were reforested with a least 50 percent red oak species and flooded during later winter and early spring to depths no greater than 24 inches.

Response: USACE is committed to compensate for losses to waterfowl as quantified by the utilization of the waterfowl model. The waterfowl model has undergone revisions since the last time it was used for this project. There is no longer a depth constraint since impacts are quantified based on underlying land use and the three-consecutive day recurrence interval. Likewise, there is no constraint regarding composition of red oaks in mitigation sites since food for waterfowl is also available from macroinvertebrates, ground tubers, etc. Although red oaks are planned for mitigation sites due to the benefits provided to waterfowl and other wildlife, the overall species composition will not be determined until tract-specific areas are identified. Selected species will depend on tract-specific conditions including elevation, hydrology, and soils. Overall species composition and benefits to waterfowl and other ecological resources would be documented in tract-specific mitigation plans.

Comment/Recommendation:

- Reforest flooded cropland that has unimpeded access for river fish during the spawning season (i.e., March through June) to compensate fisheries spawning and rearing habitat losses on the floodplain (excluding seasonally-connected waterbodeies – see below).

Response: USACE is committed to compensate for losses to fish spawning and rearing habitat. Since forested areas provide greater habitat value compared to agricultural areas, reforestation is being utilized as a mitigation method. However, additional mitigation techniques are also being recommended to compensate for spawning and rearing losses on the floodplain. These techniques include restoration of hydrology to Big Oak Tree State Park, ecologically designed borrow pits, and restoration of floodplain lakes. The Corps has considered fish access in the impact analysis and mitigation requirements. Additional discussion is found in Section 4, Section 5, and Appendix R.

Comment/Recommendation:

- To the maximum extent possible, mitigate in-kind (i.e., similar habitat) for fisheries losses of permanent waterbodies. This could include improving existing permanent waterbodies, or reconnecting old chutes, sloughs, and oxbows with the Mississippi River. If in-kind mitigation is infeasible, reforest additional acres of flooded cropland to compensate for those losses. Those sites must be easily accessible to river and floodplain fishes during spawning season (i.e., March through June). The Corps should ensure public access to those sites through fee-title purchase or easements.

Response: Ecologically designed borrow pits and floodplain lake restoration are being pursued to compensate for impacts to waterbody habitat and inundated floodplain habitat (agricultural areas, forested areas, etc.). Section 5 and Appendix R provide additional details. Improving existing permanent waterbodies, or reconnecting old chutes, sloughs, and oxbows with the Mississippi River, may also be suitable mitigation measures and will therefore be examined further. Such measures would be considered during formulation of tract-specific mitigation plans. Section 5.1.2.7 will be revised in the final EIS to address these additional opportunities.

Comment/Recommendation:

- Provide shallow flooded (i.e., 18 inches) land during spring and fall migration to compensate for project-related losses in shorebird migration habitat. Constructing moist soil areas to mitigate those losses would reduce the necessary acreage compared to cropland.

Response: USACE is committed to compensating impacts to shorebird habitat. Other information indicates that the recommended depths may be too deep for shorebird utilization. Additionally, the cost of constructing and maintaining moist soil units is high. USACE acknowledges the recommendations and will consider further whether they are feasible and reasonable. Additional information on shorebird mitigation can be found in Appendix R.

Comment/Recommendation:

- Use both the Missouri Stream Mitigation Method and the Missouri Wetlands Assessment Method to assess project impacts and compensatory mitigation for wetlands and stream and conduct a review that includes the IRT.

Response: The MSMM was used, and will continue to be used, to quantify impacts to ditch habitat from channel modifications. The recommendation to use the Missouri Wetlands Assessment Method requires further consideration. Preliminarily, based on discussions with the USACE Memphis District Regulatory Branch (Roger Allen, personal communication), the as yet uncertified/approved Missouri Wetland Assessment Method, still in draft form, may not do an adequate job of quantifying indirect impacts. Further, the IEPR panel recommended that the independently-certified HGM model is the best tool available for these purposes. USACE will continue its dialog with USFWS and others on these issues.

Comment/Recommendation:

- Acquisition of mitigation lands, reforestation, and shorebird management measures should be accomplished concurrently with most project construction activities, except for constructing the New Madrid Floodway Levee closure, and should be in place prior to project operation. Closure of the 1,500-foot gap should not be constructed until all mitigation measures are in place and functioning as planned.

Response: Section 5 of this draft EIS provides specific details on the proposed mitigation and monitoring plan. In summary, mitigation is proposed concurrent with construction and neither the proposed Mud Ditch outlet structure nor the proposed pumping plants would be operated until mitigation plans have been approved that demonstrate resources have been compensated. Although USACE proposes to construct the 1,500-foot closure levee concurrent with mitigation, the gates will not be closed and pumps operated detailed mitigation plans are approved and acquisition of mitigation lands has occurred.

Comment/Recommendation:

- Provide a detailed adaptive management program to manage all compensatory mitigation features as well as modifications to proposed project operations to fully offset losses of fish and wildlife resources.

Response: A two-phased adaptive management approach is proposed in Section 5 (phase 1) and Section 7 (phase 2). The second phase of adaptive management would be conducted to measure overall project performance to address risk and uncertainty. Information is provided in Section 7. USACE will continue to coordinate with USFWS and others on measures to avoid, minimize, and mitigate for impacts.

Comment/Recommendation:

- Do not include existing conservation lands (e.g., Ten Mile Pond Conservation Area) as part of compensatory mitigation for this project.

Response: Specific language in WRDA 1986 direct USACE to count certain lands acquired by the State of Missouri as mitigation for this project.

Comment/Recommendation: 5) Should the Corps pursue a Floodway closure alternative, we recommend alternative 4.1 which would have the fewest effects to fish and wildlife with minimal changes to project benefits, and a higher cost:benefit ratio than the preferred alternative.

Response: USACE acknowledges USFWS preference for Alternative 4.1. As a result of all revisions to this draft EIS recommended by USFWS and others, USACE will assess which alternative is environmentally preferable and take a decision, to be set forth in a record of decision, according to NEPA, CEQ’s NEPA regulations, and Army and USACE NEPA directives.

10.0 LIST OF PREPARERS/CONTRIBUTORS

Name	Agency	Experience	Role
Ashby, Steve	USACE	Ph.D.	• Water Quality Analysis
Bruchman, Barry	USACE	P.E.	• EnviroFish Model Development • Hydraulic and Hydrological Modeling
Creswell, Jodi	ECO-PCX	BS	• Waterfowl Model Review • EnviroFish Model Review • HGM Model Review • Shorebird Model Review • Alternate Shorebird Methodology Model Review
Dougherty, Mike	USACE		• Shorebird Sensitivity Review
Dunn, Robert	USACE	Ph.D.	• Cultural Resources
Heitmeyer, Mickey	Contractor	Ph.D.	• Historic Landcover Analysis • Waterfowl Model Development • Waterfowl Analysis
Hunt, Robert	USACE	Ph.D.	• EnviroFish Model Development • Hydraulic and Hydrological Modeling
Killgore, Jack	ERDC	Ph.D.	• EnviroFish Model Development • Fish Access • Fisheries Analysis
Klimas, Chuck	ERDC	Ph.D.	• HGM Model Development • HGM Analysis
Koontz, Joshua	USACE	MS	• NEPA Coordinator
Learned, Robert	USACE	MS	• Economic Analysis
Lin, Li-Yu	USACE	Ph.D.	• EnviroFish Model Development • Hydraulic and Hydrological Modeling
McNeil, Jimmy	USACE	BS	• Cultural Resources
Murray, Elizabeth	ERDC	MS	• HGM Analysis
Pagan, Jody	Contractor		• HGM Analysis
Pigott, Kevin	USACE	MS	• GIS Analysis • Freshwater Mussels
Rodriguez, Jennifer	USACE	MS	• GIS Analysis
Smith, Mark	USACE	MA	• Freshwater Mussels
Snapp, William	USACE	MS, P.E.	• GIS Analysis
Soballe, David	ERDC	Ph.D.	• Water Quality Analysis
Theiling, Charles	USACE	Ph.D.	• Waterfowl Model Review • EnviroFish Model Review • HGM Model Review • Shorebird Model Review • Alternate Shorebird Methodology Model Review
Thron, Mike	USACE	MS	• Terrestrial Habitat Evaluation Procedures • Wetland Analysis
Twedt, Dan	USGS	Ph.D.	• Shorebird Model Development • Shorebird Analysis
Ward, Daniel	USACE	MS	• Project Manager
Williams, Gregg	USACE	BS	• Interagency Coordination

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